APPENDIX D.2

ENDANGERED SPECIES ACT COMPLIANCE

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D.2 Endangered Species Act Compliance

This appendix contains pertinent correspondence related to the Combined Operational Plan (COP) and the Endangered Species Act (ESA). A brief description of pertinent correspondence is provided below. Copies of the correspondence received, follow. The COP Biological Assessment (BA) is also included within this appendix.

ESA Consultation

- September 26, 2017: U.S. Fish and Wildlife Service (USFWS) Species Request List
- October 11, 2017: Memorandum for Record Fish and Wildlife Coordination Act Report for the COP
- October 24, 2017: USFWS Correspondence Existing Conditions Baseline Assumptions
- October 31, 2017: USFWS Correspondence Species Request List Confirmation
- November 13, 2017: USFWS Service Correspondence Identification or Performance Metrics
- November 27, 2017: USFWS Correspondence Species Request List Confirmation Follow Up
- August 8, 2018: USFWS Correspondence Request for Amendment to 2016 Everglades Restoration Transition Plan (ERTP) Biological Opinion (BO)
- September 7, 2018: USFWS Correspondence Request for Amendment to 2016 ERTP BO Confirmation
- September 30, 2019: USFWS Correspondence Request for Amendment to 2016 ERTP BO
- October 9, 2019: USFWS Correspondence Request for Amendment to 2016 ERTP BO Confirmation
- December 11, 2019: U.S. Army Corps of Engineers (USACE) Biological Assessment for the COP
- January 17, 2020: USFWS Correspondence COP BA Request
- February 14, 2020: USACE Correspondence COP BA
- March 16, 2020: USFWS Concurrence on Informal Consultation Request
- May 5, 2020: USFWS BO for the COP

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DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
701 San Marco Boulevard
JACKSONVILLE, FLORIDA 32207-8175

Planning and Policy Division
Environmental Branch

SEP 26 2017

Mr. Larry Williams, Field Supervisor
U.S. Fish and Wildlife Service
1339 20th Street
Vero Beach, FL 32960

Dear Mr. Williams,

The Jacksonville District, U.S. Army Corps of Engineers (Corps) is beginning preparation of a National Environmental Policy Act (NEPA) assessment for the Combined Operational Plan (COP). The purpose of the COP is to define operations for the constructed features of the Modified Water Deliveries (MWD) to Everglades National Park (ENP) and Canal 111 (C-111) South Dade Projects, while maintaining the congressionally authorized purposes of the Central and Southern Florida (C&SF) Project to include flood control; water supply for agricultural irrigation, municipalities and industry; regional groundwater control and prevention of saltwater intrusion; enhancement of fish and wildlife; and recreation.

The COP will result in a comprehensive integrated water control plan for the operation of water management infrastructure associated with the MWD and C-111 South Dade Projects in Miami Dade County (Figure 1). Implementation of the COP is anticipated to increase the availability of water deliveries from WCA 3A to ENP through Northeast Shark River Slough and improve hydrologic conditions in Taylor Slough, the Rocky Glades, and the eastern panhandle of ENP. Water management operating criteria defined during development of the COP will be incorporated into the 2012 WCAs, ENP, and ENP to South Dade Conveyance System Water Control Plan following completion of NEPA. Development of the COP is also being pursued to address the mandated Reasonable and Prudent Alternative of the July 22, 2016 Everglades Restoration Transition Plan Biological Opinion which requires the Corps to proceed as scheduled, and as allowable by law, for completing NEPA analysis for the COP in 2019.

Pursuant to the Endangered Species Act, as amended, the Corps is requesting written confirmation of species or their critical habitat either listed or proposed for listing that may be present within the referenced project area (Figure 1) within 30 days upon receipt of this letter. The Corps has tentatively determined that the following list of threatened and endangered species may be present within the project area as illustrated in Tables 1 and

2. If you have any questions, or need further information, please contact Melissa Nasuti by email melissa.a.nasuti@usace.army.mil or telephone 904-232-1368. Thank you for your assistance in this matter.

Sincerely,

Gina Paduano Ralph, Ph.D.
Chief, Environmental Branch

Enclosure

cc:
Mr. Miles Meyer, U.S. Fish and Wildlife Service, 1339 20th Street, Vero Beach, Florida 32960
Mr. James M. Erskine, Florida Fish and Wildlife Conservation Commission, 8535 Northlake Boulevard, West Palm Beach, Florida 33412

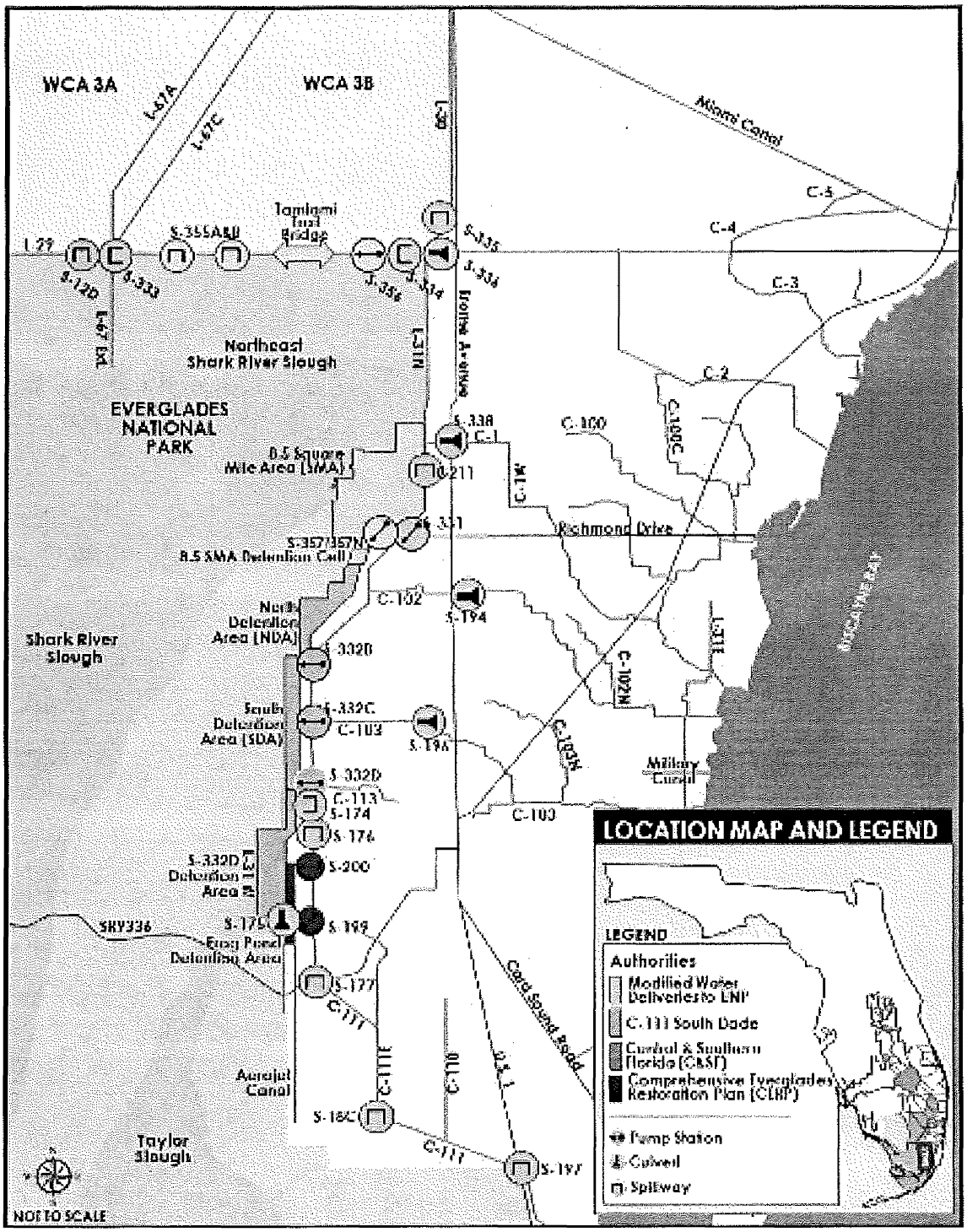

Figure 1. Project Area

Table 1. List of Federally Threatened and Endangered Species within the project area (E: Endangered, T: Threatened, SA: Similarity of Appearance, CH: Critical Habitat, C: Candidate Species; PT: Proposed Threatened; PE: Proposed Endangered)

Common Name	Scientific Name	Status
Mammals		
Florida panther	*Puma concolor coryi*	E
Florida manatee	*Trichechus manatus latirostris*	E, CH
Florida bonneted bat	*Eumops floridanus*	E
Birds		
Cape Sable seaside sparrow	*Ammodramus maritimus mirabilis*	E, CH
Everglade snail kite	*Rostrhamus sociabilis plumbeus*	E, CH
Piping plover	*Charadrius melodus*	T
Red-cockaded woodpecker	*Picoides borealis*	E
Roseate tern	*Sterna dougallii*	T
Wood stork	*Mycteria Americana*	T
Reptiles		
American Alligator	*Alligator mississippiensis*	T, SA
American crocodile	*Crocodylus acutus*	T, CH
Eastern indigo snake	*Drymarchon corais couperi*	T
Gopher tortoise	*Gopherus polyphemus*	C
Green sea turtle*	*Chelonia mydas*	E
Hawksbill sea turtle*	*Eretmochelys imbricate*	E
Kemp's Ridley sea turtle*	*Lipodochelys kempii*	E
Leatherback sea turtle*	*Dermochelys coriacea*	E
Loggerhead sea turtle*	*Caretta*	T
Fish		
Smalltooth sawfish*	*Pristis pectinata*	E
Invertebrates		
Bartram's hairstreak butterfly	*Strymon acis bartrami*	E
Elkhorn coral*	*Acropora palmata*	T, CH
Florida leafwing butterfly	*Anaea troglodyta floridalis*	E
Miami blue butterfly	*Cyclargus thomasi bethunebakeri*	E
Schaus swallowtail butterfly	*Heraclides aristodemus ponceanus*	E
Staghorn coral*	*Acropora cervicornis*	T, CH

Stock Island tree snail	*Orthalicus reses* (not incl. *nesodryas*)	T
Plants		
Crenulate lead plant	*Amorpha crenulata*	E
Deltoid spurge	*Chamaesyce deltoidea spp. deltoidea*	E
Garber's spurge	*Chamaesyce garberi*	T
Johnson's seagrass*	*Halophila johnsonii*	E, CH
Okeechobee gourd	*Cucurbita okeechobeensis* ssp. *okeechobeenis*	E
Small's milkpea	*Galactia smallii*	E
Tiny polygala	*Polygala smallii*	E
Big pine partridge pea	*Chamaecrista lineata* var. *keyensis*	E
Blodgett's silverbush	*Argythamnia blodgettii*	T
Cape Sable thoroughwort	*Chromolaena frustrata*	E, CH
Carter's small-flowered flax	*Linum carteri* var. *carteri*	E, CH
Everglades bully	*Sideroxylon reclinatum spp. austrofloridense*	C
Florida brickell-bush	*Brickellia mosieri*	E, CH
Florida bristle fern	*Trichomanes punctatum* spp. *floridanum*	E
Florida semaphore cactus	*Consolea corallicola*	E, CH
Sand flax	*Linum arenicola*	E
Florida pineland crabgrass	*Digitaria pauciflora*	PT
Florida pineland sandmat	*Chaemaesyce deltoidea pinetorium*	PT
Florida prairie clover	*Dalea carthagenesis floridana*	PT

* Marine species under the purview of National Marine Fisheries Service (NMFS); the Corps will conduct separate consultation with NMFS.

Table 2. List of State Listed Species within the project area (E: Endangered, T: Threatened, SC: Species of Special Concern)

Common Name	Scientific Name	Status
Mammals		
Florida black bear	*Ursus americanus floridanus*	T
Everglades mink	*Mustela vison evergladensis*	T
Florida mouse	*Podomys floridanus*	SC
Florida mastiff bat	*Eumops glaucinus floridanus*	E
Birds		
Piping plover	*Charadrius melodus*	T
Snowy plover	*Charadrius alexandrinus*	T
American oystercatcher	*Haematopus palliates*	E
Brown pelican	*Pelecanus occidentalis*	SC
Black skimmer	*Rynchops niger*	SC
Least tern	*Sterna antillarium*	T
White-crowned pigeon	*Columba leucocephalus*	T
Least tern	*Sterna antillarum*	T
Limpkin	*Aramus guarauna*	SC
Little blue heron	*Egretta caerulea*	SC
Tricolored heron	*Egretta tricolor*	SC
Snowy egret	*Egretta thula*	SC
Reddish egret	*Egretta rufescens*	SC
White ibis	*Eudocimus albus*	SC
Roseate spoonbill	*Ajaja ajaja*	SC
Fish		
Mangrove rivulus	*Rivulus marmoratus*	SC
Invertebrates		
Miami blue butterfly	*Cyclargus [=Hermiargus] thomasi bethunebakeri*	E
Florida tree snail	*Liguus fasciatus*	SC
Plants		
Pine-pink orchid	*Bletia purpurea*	T
Lattace vein fern	*Thelypteris reticulate*	E
Eatons spikemoss	*Selaginella eatonii*	E
Wright's flowering fern	*Anemia wrightii*	E
Tropical fern	*Schizaea pennula*	E
Mexican vanilla	*Manilla mexicana*	E

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
701 San Marco Boulevard
JACKSONVILLE, FLORIDA 32207-8175

REPLY TO
ATTENTION OF

CESAJ-PD-ES (ER 200-2-2)

MEMORANDUM FOR RECORD

SUBJECT: Fish and Wildlife Coordination Act Report for the Combined Operational Plan

PURPOSE:

To document an informal understanding between the U.S. Army Corps of Engineers, Jacksonville District, and the U.S. Fish and Wildlife Service, South Florida Ecological Services Field Office

BACKGROUND:

The Jacksonville District, U.S. Army Corps of Engineers (Corps) is beginning preparation of a National Environmental Policy Act (NEPA) assessment for the Combined Operational Plan (COP). The purpose of the COP is to define operations for the constructed features of the Modified Water Deliveries to Everglades National Park (MWD) and Canal 111 (C-111) South Dade Projects, while maintaining the congressionally authorized purposes of the Central and Southern Florida (C&SF) Project to include flood control; water supply for agricultural irrigation, municipalities and industry; regional groundwater control and prevention of saltwater intrusion; enhancement of fish and wildlife; and recreation. A notice of intent to prepare an Environmental Impact Statement (EIS) was published in the Federal Register on September 8, 2017 (Volume 82 No. 173).

The COP will result in a comprehensive integrated water control plan for the operation of water management infrastructure associated with the MWD and C-111 South Dade Projects in Miami Dade County. Development of the COP will be informed by a series of operational field tests previously conducted under the authority of the MWD Project that include relaxation of the Gage-3273 (G-3273) constraint and raising the maximum operating limit in the L-29 Canal up to 8.5 feet National Geodetic Vertical Datum of 1929 (*i.e.* Increments 1, 1.1,1.2, and 2). Information gained from water management actions taken by the Corps in response to high water levels within the Water Conservation Areas (WCAs) in 2016 and 2017 will also be utilized to inform development of the COP.

Implementation of the COP is anticipated to increase the availability of water deliveries from WCA 3A to Everglades National Park (ENP) through Northeast Shark River Slough and improve hydrologic conditions in Taylor Slough, the Rocky Glades, and the eastern panhandle of ENP. Water management operating criteria defined during development of the COP will be incorporated into the 2012 WCAs, ENP, and ENP to South Dade Conveyance System Water Control Plan following completion of NEPA.

EVALUATION:

The project delivery team (PDT) will formulate alternatives and evaluate plans for the COP based on hydrologic performance measures to determine potential effects on MWD, C-111 South Dade and C&SF Project purpose and objectives. The formulation and evaluation of alternative plans will be in accordance with Engineer Regulation (ER) 1105-2-100 and ER 200-2-2 and will fully consider a range of environmental, economic, and social factors. The PDT will coordinate development of hydrologic performance measures with the Service. The COP is being pursued to address the mandated Reasonable and Prudent Alternative (RPA) of the July 22, 2016 Everglades Restoration Transition Plan (ERTP) Biological Opinion (BO) which requires the Corps to proceed as scheduled, and as allowable by law, for completing NEPA analysis for the COP in 2019. All alternative plans will be reviewed under provisions of appropriate laws and regulations. The EIS is expected to be available for public review in 2019.

COORDINATION:

The Fish and Wildlife Coordination Act (FWCA; 16 U.S.C. 661 et seq., March 10, 1934, as amended 1946, 1958, 1978, and 1995) requires Federal agencies to consult with the Service regarding the impacts to fish and wildlife resources and the proposed measures to mitigate these impacts. Additional coordination authorities exist through the review process of NEPA (NEPA; 42 U.S.C. 4321-4347, January 1, 1970, as amended 1975 and 1982) and the consultations required under the Endangered Species Act (ESA) of 1973 (ESA; 7 U.S.C. 136, 16 U.S.C. 1532 et seq. December 28, 1973). A formal invitation to become a cooperating agency in accordance with regulations pertaining to NEPA (Title 40 CFR, part 1501.6) for the development of the COP was provided to the Service on September 22, 2017. The Service will continue to coordinate and consult with the Corps through NEPA and the ESA to ensure impacts to fish and wildlife resources are adequately addressed via these two authorities. The Service will include comments relevant to the FWCA in the Services response to the Corps' ESA coordination letter, where applicable. The Corps agrees to maintain open and cooperative communication with the Service during development of the COP.

The Corps recognizes the commitments made within the 2016 ERTP BO and remains committed to implementation of the RPA.

AGREEMENT:

The undersigned, Corps and the Service, agree to utilize the COP NEPA review and ESA consultation process to complete coordination responsibilities under the FWCA. This agreement will avoid duplicated analysis and documentation as authorized under 40 CFR section 1500.4(k), 1502.25, 1506.4, and is consistent with Presidential Executive Order for Improving Regulation and Regulatory Review, released January 18, 2011.

Gina Paduano Ralph, Ph.D
Chief, Environmental Branch

10/3/17
Date

Donald Progulske
Everglades Program Supervisor
South Florida Ecological Services Office

10/11/17
Date

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
701 San Marco Boulevard
JACKSONVILLE, FLORIDA 32207-8175

Planning and Policy Division
Environmental Branch

OCT 24 2017

Mr. Larry Williams, Field Supervisor
U.S. Fish and Wildlife Service
1339 20th Street
Vero Beach, FL 32960

Dear Mr. Williams,

The Jacksonville District, U.S. Army Corps of Engineers (Corps) is beginning preparation of a National Environmental Policy Act (NEPA) assessment for the Combined Operational Plan (COP). The purpose of the COP is to define operations for the constructed features of the Modified Water Deliveries (MWD) to Everglades National Park (ENP) and Canal 111 (C-111) South Dade Projects, while maintaining the congressionally authorized purposes of the Central and Southern Florida (C&SF) Project. Implementation of the COP is anticipated to increase the availability of water deliveries from Water Conservation Area (WCA) 3A to ENP through Northeast Shark River Slough and improve hydrologic conditions in Taylor Slough, the Rocky Glades, and the eastern panhandle of ENP. Development of the COP is also being pursued to address the mandated Reasonable and Prudent Alternative of the July 22, 2016 Everglades Restoration Transition Plan (ERTP) Biological Opinion (BO) which requires the Corps to proceed as scheduled, and as allowable by law, for completing NEPA analysis for the COP in 2019.

The Corps has developed an Existing Conditions Baseline (ECB) for purposes of alternative evaluation. The ECB represents conditions in place at the time of implementation of COP in 2019. This base condition will include the following; (1) MWD Increment 1.1 and 1.2 (operational changes required under the July 2016 ERTP BO and in response to new information gained during the 2016 Temporary Emergency Deviation; L-29 Canal maximum operating limit of 7.8 feet National Geodetic Vertical Datum of 1929); (2) existing C&SF Project infrastructure and Regulation Schedules (including the 2008 Lake Okeechobee Regulation Schedule); (3) MWD Tamiami Trail Modifications 1-Mile Bridge and Raised Roadway; (4) Tamiami Trail Next Steps 2.6 Mile

Western Bridge (completion scheduled for December 2018); (5) full construction of the C-111 South Dade Project to include Contracts 8, 8A and 9; (6) full construction of 8.5 Square Mile Area project features to include C-358 and S-357N; (7) the Miami-Dade Limestone Products Association (MD-LPA) 5-mile Seepage Cutoff wall along L-31 North; and (8) current permitted operations for the South Florida Water Management District (SFWMD) C-111 Spreader Canal project components (includes G-737 and S-199/S-200 at expanded 300 cubic feet per second each). Assumptions related to the 2019 ECB will be fully documented and reviewed by the COP Project Delivery Team.

The Corps is requesting written confirmation of concurrence on the use of a single environmental baseline (i.e. 2019 ECB) for purposes of Endangered Species Act consultation upon receipt of this letter. The NEPA requires that the lead federal agency define a No Action Alternative, or the conditions that will exist in an analysis year if a proposed action is not implemented. Under Corps, planning principles, the No Action Alternative is referred to as the Future Without Project Condition. In this instance there are no differences between the 2019 ECB and the No Action Alternative or Future Without Project Condition. If you have any questions, or need further information, please contact Melissa Nasuti by email melissa.a.nasuti@usace.army.mil or telephone 904-232-1368. Thank you for your assistance in this matter.

Sincerely,

Gina Paduano Ralph, Ph.D.
Chief, Environmental Branch

Enclosure

cc:
Mr. Miles Meyer, U.S. Fish and Wildlife Service, 1339 20th Street, Vero Beach, Florida 32960
Mr. Kevin Palmer, U.S. Fish and Wildlife Service, 1339 20th Street, Vero Beach, Florida 32960
Mr. Lori Miller, U.S. Fish and Wildlife Service, 1339 20th Street, Vero Beach, Florida 32960

United States Department of the Interior

FISH AND WILDLIFE SERVICE
South Florida Ecological Services Office
1339 20th Street
Vero Beach, Florida 32960

October 31, 2017

Gina Paduano Ralph, Ph.D.
Chief, Environmental Branch
U.S. Army Corps of Engineers
Post Office Box 4970
Jacksonville, Florida 32232

Service Federal Activity Code: 41420-2017-F-0994
Date Received: September 29, 2017
Project: Combined Operational Plan (COP)
County: Broward, Miami-Dade

Dear Dr. Paduano Ralph:

The U.S. Fish and Wildlife Service (Service) has reviewed the U.S. Army Corps of Engineers' (Corps) letter received on September 29, 2017, requesting confirmation of federally-listed species and their designated critical habitat and candidate species for listing that may be present within the action area of the Combined Operational Plan (COP). The 'species list' is a National Environmental Policy Act (42 U.S. Code (U.S.C) § 4321) requirement for the environmental analysis. This species list is also provided in accordance with the Endangered Species Act of 1973, as amended (Act) (87 Stat. 884; 16 U.S.C. 1531 *et seq.*). The project area lies within Broward and Miami-Dade Counties.

Project Description

The primary goal of the COP is to define an operating plan for the constructed elements of the Modified Water Delivery to Everglades National Park (ENP) project and the C-111 South Dade Conveyance project to enhance the delivery of water from Water Conservation Area 3A (WCA 3A) into the Northeast Shark River Slough of ENP. The project will also strive to meet its other purposes, previously mandated by the Central and Southern Florida Project, including flood control; water supply; prevention of saltwater intrusion; enhancement of fish and wildlife; and recreation. The refined operating criteria resulting from the COP planning process will be incorporated into the System Water Control Plan following completion of National Environmental Policy Act (NEPA) review. The COP has been defined by the Corps as the next logical step in the progression towards Everglade's restoration and the Corps has committed to completing this stage by 2019. The Service fully supports the development of this operating plan and will continue to coordinate and help where possible.

Threatened and Endangered Species

The list presented below (Table 1) represents the federally threatened and endangered species that may be found within the project area. It is similar to the list provided by the Corps in its correspondence dated September 26, 2017, except for the removal of several marine species that the Service does not feel will be affected by the proposed action. Table 2 is a list of State Listed species that may be found in the project area. The complete species list provided in this correspondence concludes the statutory requirements set forth in 50 CFR §402.12(d) of the Act. As you are aware, verification of current accuracy of the species list is for a time period not to exceed 90 days as stated in 50 CFR §402.12(e) of the Act. The Service looks forward to reviewing the NEPA documentation regarding this action and will respond accordingly.

Thank you for your cooperation in the effort to conserve fish and wildlife resources. If you have questions concerning this consultation process, please contact the project biologist Kevin Palmer at 772-469-4280 or by e-mail at Kevin_Palmer@fws.gov.

Sincerely yours,

for Donald (Bob) Progulske
Everglades Program Supervisor
South Florida Ecological Services Office

cc: electronic only
Corps, Jacksonville, Florida (Melissa Nasuti)

Table 1. List of Federally Threatened and Endangered Species within the project area (E: Endangered, T: Threatened, SA: Similarity of Appearance, CH: Critical Habitat, C: Candidate Species, Pr E: Proposed Endangere, Pr T: Proposed Threatened).

Common Name	Scientific Name	Status
Mammals		
Florida panther	*Puma concolor coryi*	E
Florida Manatee	*Trichechus manatus latirostris*	E, CH
Florida bonneted bat	*Eumops floridamus*	E
Birds		
Cape Sable seaside sparrow	*Ammodramus maritimus mirabilis*	E, CH
Everglade snail kite	*Rostrhamus sociabilis plumbeus*	E, CH
Piping plover	*Charadrius melodus*	T
Red-cockaded woodpecker	*Picoides borealis*	E
Roseate tern	*Sterna dougallii dougallii*	T
Wood stork	*Mycteria Americana*	T
Reptiles		
American Alligator	*Alligator mississippiensis*	T, SA
American crocodile	*Crocodylus acutus*	T, CH
Eastern indigo snake	*Drymarchon corais couperi*	T
Gopher tortoise	*Gopherus polyphemus*	C
Invertebrates		
Bartram's hairstreak butterfly	*Strymon acis bartrami*	E
Florida leafwing butterfly	*Anaea troglodyta floridalis*	E
Miami blue butterfly	*Cyclargus thomasi bethunebakeri*	E
Schaus swallowtail butterfly	*Heraclides aristodemus ponceanus*	E
Stock Island tree snail	*Orthalicus reses* (not incl. *nesodryas*)	T
Plants		
Crenulate lead plant	*Amorpha crenulata*	E
Deltoid spurge	*Chamaesyce deltoidea* spp. *deltoidea*	E
Garber's spurge	*Chamaesyce garberi*	T
Okeechobee gourd	*Cucurbita okeechobeensis* ssp. *Okeechobeenis*	E
Small's milkpea	*Galactia smallii*	E
Tiny polygala	*Polygala smallii*	E
Big pine partridge pea	*Chamaecrista lineata keyensis*	Pr E

Blodgett's silverbush	*Argythamnia blodgettii*	Pr T
Cape Sable thoroughwort	*Chromolaena frustrate*	E, CH
Carter's small-flowered flax	*Linum carteri* var. *carteri*	E, CH
Everglades bully	*Sideroxylon reclinatum* spp. *austrofloridense*	C
Florida brickell-bush	*Brickellia mosieri*	E, CH
Florida bristle fern	*Trichomanes punctatum* spp. *floridanum*	E
Florida pineland crabgrass	*Digitaria pauciflora*	C
Florida prairie-clover	*Dalea carthagenensis floridana*	C
Florida semaphore cactus	*Consolea corallicola*	E, CH
Pineland sandmat	*Chamaesyce deltoidea pinetorum*	C
Sand flax	*Linum arenicola*	Pr E

Table 2. List of State Listed Species, not also federally listed, within the project area (E: Endangered, T: Threatened, SC: Species of Special Concern).

Common Name	Scientific Name	Status
Mammals		
Everglades mink	*Mustela vison evergladensis*	T
Florida mouse	*Podomys floridanus*	SC
Birds		
Snowy plover	*Charadrius nivosus*	T
American oystercatcher	*Haematopus palliates*	SC
Brown pelican	*Pelecanus occidentalis*	SC
Black skimmer	*Rynchops niger*	SC
Least tern	*Sterna antillarium*	T
White-crowned pigeon	*Patagioenas leucocephala*	T
Least tern	*Sterna antillarum*	T
Limpkin	*Aramus guarauna*	SC
Little blue heron	*Egretta caerulea*	SC
Tricolored heron	*Egretta tricolor*	SC
Snowy egret	*Egretta thula*	SC
Reddish egret	*Egretta rufescens*	SC
White ibis	*Eudocimus albus*	SC
Roseate spoonbill	*Platalea ajaja*	T
Invertebrates		
Florida tree snail	*Liguus fasciatus*	SC
Plants		
Pine-pink orchid	*Bletia purpurea*	T
Lattace vein fern	*Thelypteris reticulate*	E
Eatons spikemoss	*Selaginella eatonii*	E
Wright's flowering fern	*Anemia wrightii*	E
Tropical fern	*Schizaea pennula*	E
Mexican vanilla	*Manilla Mexicana*	E

United States Department of the Interior

FISH AND WILDLIFE SERVICE
South Florida Ecological Services Office
1339 20th Street
Vero Beach, Florida 32960

November 13, 2017

Gina Paduano Ralph, Ph.D.
Chief, Environmental Branch
U.S. Army Corps of Engineers
Post Office Box 4970
Jacksonville, Florida 32232

Dear Dr. Paduano Ralph:

The U.S. Fish and Wildlife Service (Service) has reviewed the U.S. Army Corps of Engineers' (Corps) letter received on October 27, 2017, requesting agreement with the Corps' draft Existing Conditions Baseline (ECB) for alternative evaluation in the Combined Operational Plan (COP). The Service provides the following comments regarding the baseline and other issues to assist in developing the COP, a critical restoration initiative located in the central and southern Everglades.

Existing Condition Baseline

According to your letter, the Corps has developed an existing conditions baseline model run for alternative evaluation during COP, which represents conditions in place at the time of its implementation in 2019. The Service agrees with everything listed in the letter that will be included in the ECB but also would like to see consideration for addition of the following items:

- Structure S-333 expansion. The State has reportedly funded this initiative, which was part of the Central Everglades Planning Project (CEPP), and there should be enough information available to include it in the ECB.

- Increment 2 operations. The Corps has indicated that the National Environmental Policy Act (NEPA) review will be completed and these operations implemented by March 1, 2018, in accordance with the Everglades Restoration Transition Plan 2016 (ERTP-2016) Reasonable and Prudent Alternative. Since this is prior to the scheduled May start of the modeling effort for COP and it effectively increases the regulation stage for the L-29 canal, it should be included.

- The Service would also like clarification whether the G-3273 constraint has been removed from the ECB. Once the levee repairs for the 8.5 SMA are complete, this constraint should no longer be necessary.

Further, the Service agrees with the Corps' single-ECB approach which will reduce the complexity of alternative evaluation.

Performance Metrics

The Corps has also requested input from the Service on the performance metrics that will be used to analyze model output for COP. The list of metrics provided by the Corps that were used in ERTP-2016 and modified for use in the Western Everglades Restoration Project (WERP) appear to contain everything necessary for the Service to conduct its evaluations. One ecological tool that is still in development, but may be completed in time to use in COP, is the snail kite habitat suitability model that Dr. James Beerens, of the United States Geological Survey (USGS), is currently testing.

The Service requests standard Regional Simulation Model (RSM) output used in ERTP-2016 and requested in WERP. This output includes:

- Annual_ArcMaps (hydroperiods and stages)
- Annual_Diff_Maps (hydroperiods and stages)
- Critical Flows
- CSSS_HAED
- Stage Duration Curves
- Duration Curves_Canals
- Duration Curves_Cells (gauges)
- Hydrograph_Canals
- Hydrograph_Cells (gauges)
- Levee Seepage
- Monthly_Diff_Maps
- Transects
- Water_Supply
- WaterBudgetMaps

In addition to the output listed above, the Service requests the Excel spreadsheet of the daily time step gauge output for within the project area in case more in-depth analyses are warranted. Gauge output is requested for some of the same gauges provided during ERTP-2016 and/or the Central Everglades Planning Project modeling. These gauges include, but are not necessarily limited to:

WCA-3A	BCNP	ENP
Site 64	BCA9	SPARO
3AS3W1	Loop1	NP-205
Site 65	Loop2	TMC
W2	BCA20	P-34

The Service also supports the use of:

- *Everglades Viewing Windows* (that includes the NSM, ENP MODI, and NSRSM views)

Ecological Planning Tools:

- *Marl Prairie Habitat Suitability Index*
- *The Sparrow Helper* developed by USGS. Its standard output was also requested for use in WERP. The Service prefers the USGS run the model as an independent agency. Output for this model includes:
  - Mean depth of Cape Sable seaside sparrow (CSSS) subpopulations
  - Consecutive dry days during the CSSS breeding season (March 1 to July 15)
  - Mean annual discontinuous hydroperiod
  - Hydroperiod annual variability
- *Western Marl Prairie 4-year Average Hydroperiod modeling* developed by Leonard Pearlstine of Everglades National Park (ENP)
- *Apple Snail Production Model*
- *WADEM Wading Bird Model*

Any output for subpopulation A should include both the current boundary and the expanded boundary (CSSS-Ax).

The Service also supports the use of:

- *Small Sized Freshwater Fish Density model*
- *Alligator HSI model*

NEPA Coordination

We would like to thank the Corps for its September letter inviting the Service to become a cooperating agency for the development of the COP. At this time, the Service would prefer to continue its critical coordination with the Corps as we have in the past as a consulting agency and will not be a cooperating agency.

Finally, responses addressing Fish and Wildlife Coordination Act coordination and the official "Species List" were sent to the Corps via email on October 11, 2017, and letter on October 31, 2017, respectively. Thank you for your continued cooperation in the effort to conserve fish and wildlife resources. If you have questions concerning the contents of this letter, please contact Kevin Palmer at 772-562-3909.

Sincerely yours,

for Donald (Bob) Progulske
Everglades Program Supervisor
South Florida Ecological Services Office

cc: electronic only
Corps, Jacksonville, Florida (Melissa Nasuti)

Nasuti, Melissa A CIV USARMY CESAJ (US)

From: Palmer, Kevin <kevin_palmer@fws.gov>
Sent: Monday, November 27, 2017 10:24 AM
To: Nasuti, Melissa A CIV USARMY CESAJ (US)
Cc: Miller, Lori
Subject: Re: FW: [EXTERNAL] COP Species List 2017-F-0994

Ahh yes, good catch. I sent you an older list. Your original list in the species list letter was correct for the Big Pine Partridge pea, sand flax and Blodgett's silverbush. The other four proposed or candidate species needed updating as of Oct. 2017. You've made those corrections in the amended table you attached to this email. One other note, I believe the Florida pineland sandmat should be just the pineland sandmat.

Thanks again and sorry for the confusion!

Let me know if there are other issues.

Kevin

On Mon, Nov 27, 2017 at 9:33 AM, Nasuti, Melissa A CIV USARMY CESAJ (US) <Melissa.A.Nasuti@usace.army.mil <mailto:Melissa.A.Nasuti@usace.army.mil> > wrote:

Kevin,

I received the attached correspondence. Table 1 in the attached letter from the Service lists the Big pine partridge pea as Proposed Endangered, Blodgett's silverbush as Proposed Threatened and Sand flax as Proposed Endangered. Table 1 also lists Florida pineland crabgrass, Florida prairie clover and Florida pineland sandmat as Candidate species. Furthermore, Table 1 also lists the Everglades bully as a candidate species.

I double checked the letter provided by the Service as I noticed a discrepancy. The Big pine partridge pea and Sand flax are listed as endangered and the Blodgett's silverbush as Threatened per the Federal Register (Vol. 81, No. 189) dated Thursday September 29, 2016. Florida prairie-clover is now listed as endangered, while Florida pineland crab grass and Florida pineland sandmat is now listed as threatened per the Federal Register (Vol. 82, No. 193) dated Friday October 6, 2016. The same Federal Register publication lists the Everglades bully as Threatened.

I have gone ahead and attached a MW document with the updated listings. I would like to confirm that the provided Table in the attached letter by the Service was incorrect with regard to these species. Please let me know if I am not tracking correctly based on the listings in the Federal Register.

I have attached a MW document with my understanding of the updated listings. Do not anticipate sending another formal letter. Please let me know if this email sufficies?

Thanks

Melissa Nasuti
Planning & Policy Division
U.S. Army Corps of Engineers
Jacksonville District
☎:904-232-1368 (Office)

☎:904-629-9687 (Cell)
Melissa.A.Nasuti@usace.army.mil <mailto:Melissa.A.Nasuti@usace.army.mil>

-----Original Message-----
From: kristin_donahue@fws.gov <mailto:kristin_donahue@fws.gov> [mailto:kristin_donahue@fws.gov <mailto:kristin_donahue@fws.gov>] On Behalf Of Vero Beach, FW4
Sent: Tuesday, November 21, 2017 9:53 AM
To: Nasuti, Melissa A CIV USARMY CESAJ (US) <Melissa.A.Nasuti@usace.army.mil <mailto:Melissa.A.Nasuti@usace.army.mil> >
Subject: [EXTERNAL] COP Species List 2017-F-0994

Please see attached.

US Fish and Wildlife Service
1339 20th Street
Vero Beach, FL 32960
772-562-3909

NOTE: This email correspondence and any attachments to and from this sender is subject to the Freedom of Information Act (FOIA) and may be disclosed to third parties.

--

****
Kevin Palmer
U.S. Fish and Wildlife Service
South Florida Ecological Services Field Office
1339 20th Street
Vero Beach, Florida 32960-3559
Phone: 772-469-4280
Fax: 772-562-4288 & 564-7393
Email: Kevin_Palmer@fws.gov <mailto:Kevin_Palmer@fws.gov>

NOTE: This email correspondence and any attachments to and from this sender is subject to the Freedom of Information Act (FOIA) and may be disclosed to third parties.

Table 1. List of Federally Threatened and Endangered Species within the COP project area (E: Endangered, T: Threatened, SA: Similarity of Appearance, CH: Critical Habitat, C: Candidate Species)

Common Name	Scientific Name	Status
Mammals		
Florida panther	*Puma concolor coryi*	E
Florida manatee	*Trichechus manatus latirostris*	E, CH
Florida bonneted bat	*Eumops floridanus*	E
Birds		
Cape Sable seaside sparrow	*Ammodramus maritimus mirabilis*	E, CH
Everglade snail kite	*Rostrhamus sociabilis plumbeus*	E, CH
Piping plover	*Charadrius melodus*	T
Red-cockaded woodpecker	*Picoides borealis*	E
Roseate tern	*Sterna dougallii*	T
Wood stork	*Mycteria Americana*	T
Reptiles		
American Alligator	*Alligator mississippiensis*	T, SA
American crocodile	*Crocodylus acutus*	T, CH
Eastern indigo snake	*Drymarchon corais couperi*	T
Gopher tortoise	*Gopherus polyphemus*	C
Invertebrates		
Bartram's hairstreak butterfly	*Strymon acis bartrami*	E
Florida leafwing butterfly	*Anaea troglodyta floridalis*	E
Miami blue butterfly	*Cyclargus thomasi bethunebakeri*	E
Schaus swallowtail butterfly	*Heraclides aristodemus ponceanus*	E

Stock Island tree snail	*Orthalicus reses* (not incl. *nesodryas*)	T
Plants		
Crenulate lead plant	*Amorpha crenulata*	E
Deltoid spurge	*Chamaesyce deltoidea spp. deltoidea*	E
Garber's spurge	*Chamaesyce garberi*	T
Okeechobee gourd	*Cucurbita okeechobeensis* ssp. *okeechobeenis*	E
Small's milkpea	*Galactia smallii*	E
Tiny polygala	*Polygala smallii*	E
Big pine partridge pea	*Chamaecrista lineata* var. *keyensis*	E
Blodgett's silverbush	*Argythamnia blodgettii*	T
Cape Sable thoroughwort	*Chromolaena frustrata*	E, CH
Carter's small-flowered flax	*Linum carteri* var. *carteri*	E, CH
Everglades bully	*Sideroxylon reclinatum spp. austrofloridense*	T
Florida brickell-bush	*Brickellia mosieri*	E, CH
Florida bristle fern	*Trichomanes punctatum* spp. f*loridanum*	E
Florida semaphore cactus	*Consolea corallicola*	E, CH
Sand flax	*Linum arenicola*	E
Florida pineland crabgrass	*Digitaria pauciflora*	T
Florida pineland sandmat	*Chaemaesyce deltoidea pinetorium*	T
Florida prairie clover	*Dalea carthagenesis floridana*	E

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, JACKSONVILLE DISTRICT
701 SAN MARCO BOULEVARD
JACKSONVILLE, FLORIDA 32207-8915

AUG 1 0 2018

Planning and Policy Division
Environmental Branch

Mr. Larry Williams, Field Supervisor
U.S. Fish and Wildlife Service
1339 20th Street
Vero Beach, FL 32960

Dear Mr. Williams:

This letter pertains to the 2016 Everglades Restoration Transition Plan (ERTP) Biological Opinion (BO). The BO addresses the U.S. Army Corps of Engineers, Jacksonville District (Corps), 2012 Water Control Plan, a document that guides Corps water management activities in Water Conservation Area 3A (WCA 3A), Everglades National Park (ENP) and the South Dade Conveyance System (SDCS) to meet flood control and other Central & Southern Florida Project purposes while avoiding and minimizing adverse effects to threatened and endangered species. The BO presents a recommendation for a Reasonable and Prudent Alternative (RPA) to the Corps' proposed ERTP action for the Cape Sable seaside sparrow (CSSS).

The Corps remains committed to the actions outlined in the RPA, including actions to move more water east. Consistent with this action, the Corps signed a Finding of No Significant Impact on February 21, 2018 for the Modified Water Deliveries to Everglades National Park Increment 2 Field Test (MWD Increment 2) to raise the L-29 Canal maximum operating limit up to 8.5 feet National Geodetic Vertical Datum of 1929 (NGVD) subject to downstream constraints. Although the Corps completed the National Environmental Policy Act requirements to allow raising the maximum operating limit in the L-29 Canal up to 8.5 feet NGVD by March 1, 2018, actual raising of the L-29 Canal constraint above 7.8 feet NGVD (the maximum operating limit under Increment 1.2) was dependent upon completion of critical features necessary to operate the Canal 111 South Dade Project North Detention Area. The Corps is pleased to convey that the identified critical North Detention Area features were completed on June 30, 2018 and the Corps now has additional operational flexibility to allow incremental increases within the L-29 Canal up to the maximum 8.5 feet NGVD limit, subject to downstream constraints. The L-29 Canal stage was raised to 8.0 feet NGVD on July 1, 2018. Further incremental increases in the L-29 Canal maximum operating limit are planned during August through early October 2018, concurrent with construction completion of the Canal 111 South Dade Project South Detention Area.

Another component of the RPA included completion of the Combined Operational Plan (COP) by 2019. As discussed at our May 3, 2018 ERTP Leadership Group Meeting, completion of COP has been delayed. The BO includes a provision for Adaptive Management. The BO states, "The Service and Corps agree to implement an adaptive management process which may provide the mechanism for amendments to the current BO in lieu of preparation of a new BO. However, this may involve reinitiating the consultation if any of the conditions under the Reinitiation Notice at the end of this BO are triggered." (ERTP 2016 BO at 191).
Upon review of the Reinitiation Notice within the BO, both the U.S. Fish & Wildlife Service (FWS) and the Corps agreed that none of the triggers have been met.

The FWS and Corps instead have agreed to amend the BO to reflect the revised anticipated date for COP. A copy of the revised COP schedule reflecting a completion date of May 25, 2020 is included as Enclosure 1.

As also discussed at our May 3, 2018 meeting, the majority of the benefits that FWS is seeking for the endangered CSSS, subpopulation Ax (CSSS-Ax), will be provided within MWD Increment 2 to include raising the stage in the L-29 Canal to move water east away from CSSS-Ax. COP will serve to further refine and optimize operations within WCA 3A, ENP and SDCS and make adjustments to the WCA 3 Rainfall Plan.

The Corps will continue to look for and implement avenues to protect this subspecies to the extent practicable through water management operations. The ERTP and its predecessor, 2002-2012 Interim Operational Plan for Protection of the CSSS, were not designed to recover the CSSS; they are solely measures to improve water levels for the subspecies during its breeding season. Water management operations are only one factor in creating suitable hydrologic and habitat conditions to promote recovery of this subspecies and avoid extirpation. A collaborative group effort among all agencies that share responsibility for this subspecies is necessary to truly promote recovery. In order to recover this subspecies a Comprehensive Conservation Plan needs to be developed that includes, among other efforts: 1) identification of factors that have the greatest effect on CSSS population growth; 2) identification and reduction of the most significant factors negatively affecting population growth; 3) identification of potential future habitat for this subspecies in light of predicted flows associated with Everglades restoration projects and projected sea level rise; 4) identification of habitat and population enhancement techniques to enhance resiliency; and 5) exploration of translocation and captive breeding.

Please confirm that the BO is amended to reflect a new COP completion date. We look forward to our continued coordination on this complex issue. If you have any questions regarding information in this letter, please feel free to contact me or you may contact Dr. Gina Ralph at (904) 232-2336 or gina.p.ralph@usace.army.mil. Thank you for your assistance in this matter.

Sincerely,

Jason A. Kirk, P.E.
Colonel, U.S. Army
District Commander

CC: MR ALVIN LEE,
USACE SO ATL DIV DIR. OF PGMS

SOUTH FLORIDA ECOSYSTEM RESTORATION PROGRAM
Combined Operational Plan (COP)

Activity	Forecast
1. Round 1 Modeling (3 Alts) RSM-GL	21 Apr – 29 Jun 18
2. Round 2 Modeling (2 Alts) RSM-GL, MD-RSM	06 Sep – 27 Oct 18
3. Round 3 Optimization (RSM-GL and MD-RSM)	10 Jan 19 – 08 Feb 19
4. Recommend Preliminary Preferred Alternative	11 Mar – 24 Mar 19
5. Transmit Biological Assessment	15 Apr 19
6. Receive Biological Opinion	28 Aug 19
7. State/Agency/Tribe Public Review: Draft Systems Operating Manual/Environmental Impact Statement	12 Sep – 26 Oct 19
8. State/Agency/Tribe Public Review: Final Systems Operating Manual/Environmental Impact Statement	20 Feb – 19 Apr 20
9. Sign Record of Decision	25 May 20

US Army Corps of Engineers.

U.S.ARMY

United States Department of the Interior

FISH AND WILDLIFE SERVICE
South Florida Ecological Services Office
1339 20th Street
Vero Beach, Florida 32960

In Reply Refer To:
04EF2000-2015-F-0241

September 7, 2018

Andrew D. Kelly, Colonel
District Commander
U.S. Army Corps of Engineers
Post Office Box 4970
Jacksonville, Florida 32232

Dear Colonel Kelly:

The U.S. Fish and Wildlife Service (Service) has reviewed the U.S. Army Corps of Engineers' (Corps) letter dated August 10, 2018, requesting the Biological Opinion (BO) (Service 2016) for the Everglades Restoration Transition Plan (ERTP) be amended to reflect a change in the implementation date of the Combined Operational Plan (COP).

The Corps, in coordination with the Service, had previously established a deadline of the end of 2019 as the implementation date for the COP. This deadline was included as part of the Reasonable and Prudent Alternative (RPA) to avoid jeopardy to the endangered Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*; CSSS; Service 2016). The latest COP implementation schedule has May 25, 2020, as the date on which the Record of Decision will be signed. Therefore, the Corps is requesting that the BO be amended to reflect the revised date for the COP. The proposed May 25 implementation will miss the March 1 start of the 2020 CSSS nesting season, however, the Service expects the flexibility currently in place with the Modified Water Deliveries Increment 2 will sufficiently address operational concerns while we wait for the full flexibility of the COP to be implemented.

While it is unfortunate that this important project, which we hope will assist in the conservation and recovery of the CSSS, is delayed, it was not entirely unexpected. The RPA had contemplated project implementation delays and had included a process with which those delays could be proposed, reviewed, and incorporated in the BO if accepted. Everglades restoration and its various projects have experienced frequent delays in its nearly two decades of planning and implementation and will no doubt experience more with its enormous complexity. The Service would like to take this opportunity to acknowledge the Corps' progress and accept the amendment to the RPA by changing the implementation date of COP in the ERTP BO to May 25, 2020. We thank the Corps for its continued diligence in implementing the remaining Comprehensive Everglades Restoration, Modified Water Delivery, C-111 South Dade, and

Central Everglades Planning Projects in a timely fashion. All of the threatened and endangered species in the Greater Everglades ecosystem will benefit from it.

If you have any questions concerning this, please contact me at 772-469-4285, or Bob Progulske at 772-469-4299.

Sincerely yours,

Larry Williams
State Supervisor

cc: electronic only
Corps, Jacksonville, Florida (Gina Ralph)

U.S. Fish and Wildlife Service. 2016. Biological opinion for the Everglades Restoration Transition Plan, Phase 2 (ERTP-2016). South Florida Ecological Services Office; Vero Beach, Florida.

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, JACKSONVILLE DISTRICT
701 SAN MARCO BOULEVARD
JACKSONVILLE, FL 32207-8175

Planning and Policy Division
Environmental Branch

SEP 30 2019

Mr. Larry Williams
U.S. Fish and Wildlife Service
1339 20th Street
Vero Beach, FL 32960-3559

Dear Mr. Williams:

This letter pertains to the 2016 Everglades Restoration Transition Plan (ERTP) Biological Opinion (BO). The BO addresses the U.S. Army Corps of Engineers, Jacksonville District (Corps), 2012 Water Control Plan, a document that guides Corps water management activities in Water Conservation Area 3A (WCA 3A), Everglades National Park (ENP) and the South Dade Conveyance System (SDCS) to meet flood control and other Central & Southern Florida (C&SF) Project purposes while avoiding and minimizing adverse effects to threatened and endangered species. The BO presents a recommendation for a Reasonable and Prudent Alternative (RPA) to the Corps' proposed ERTP action for the Cape Sable seaside sparrow (CSSS).

The Corps remains committed to the actions outlined in the RPA, including actions to move more water east. Consistent with this action, the Corps signed a Finding of No Significant Impact on February 21, 2018 for the Modified Water Deliveries to Everglades National Park Increment 2 Field Test (MWD Increment 2) to raise the L-29 Canal maximum operating limit up to 8.5 feet National Geodetic Vertical Datum of 1929 (NGVD) subject to downstream constraints. Although the Corps completed the National Environmental Policy Act requirements to allow raising the maximum operating limit in the L-29 Canal up to 8.5 feet NGVD by March 1, 2018, actual raising of the L-29 Canal constraint above 7.8 feet NGVD (the maximum operating limit under Increment 1.2) was dependent upon completion of critical features necessary to operate the Canal 111 (C-111) South Dade Project North Detention Area. Following completion of the C-111 South Dade Project construction (both the North Detention Area and Southern Detention Area components) in August 2018 and following recovery of the 8.5 Square Mile Area flood mitigation system from an early September 2018 rainfall event, the L-29 Canal maximum operating limit was incrementally increased from 8.3 feet NGVD to 8.5 feet NGVD on September 19, 2018. In 2018, 343,400 acre feet of water (inflow volume of S-333 plus S-356 minus S-334 outflows) was delivered to Northeast Shark River Slough (NESRS). Increased flows have continued through 2019 and as of September 17, 2019, 338,300 acre feet has been delivered. This is an increase of more than 235,725 acre feet of water into NESRS as compared to an average of 105,125 acre feet delivered per year from 2012 through 2015 prior to implementation of the MWD Incremental Field Tests.

A component of the RPA included completion of the Combined Operational Plan (COP) by 2019. As discussed at our September 18, 2019 ERTP Leadership Group Meeting, completion of COP has been delayed. The BO includes a provision for Adaptive Management. The BO states, "The Service and Corps agree to implement an adaptive management process which may provide the mechanism for amendments to the current BO in lieu of preparation of a new BO. However, this may involve reinitiating the consultation if any of the conditions under the Reinitiation Notice at the end of this BO are triggered." (ERTP 2016 BO at 191). Both the U.S. Fish & Wildlife Service (FWS) and the Corps agreed that none of the triggers have been met as discussed at our September 18, 2019, meeting. The FWS and Corps instead have agreed to amend the BO to reflect the revised anticipated date for COP. A copy of the revised COP schedule reflecting a completion date of August, 2020 is included as Enclosure 1.

As also discussed at our September 18, 2019 meeting, the majority of the benefits that FWS is seeking for the endangered CSSS, subpopulation Ax (CSSS-Ax), are being realized as a result of MWD Increment 2. This includes raising the stage in the L-29 Canal to move water east away from CSSS-Ax. COP will serve to further refine and optimize operations within WCA 3A, ENP and SDCS and make adjustments to the WCA 3 Rainfall Plan. The purpose of COP is to define operations for the constructed features of the MWD to ENP and C-111 South Dade Projects, while maintaining the congressionally authorized purposes of the C&SF Project to include flood control; water supply for agricultural irrigation, municipalities and industry; regional groundwater control and prevention of saltwater intrusion; enhancement of fish and wildlife; and recreation.

Please confirm that the ERTP BO is amended to reflect a new COP completion date of August 2020. We look forward to our continued coordination on this complex issue. If you have any questions regarding information in this letter, please feel free to contact me or you may contact Melissa Nasuti at (904) 232-1368 or melissa.a.nasuti@usace.army.mil. Thank you for your assistance in this matter.

Sincerely,

Angela Dunn
Chief Environmental Branch

Enclosure

Table 1. Combined Operational Plan Project Schedule

Activity	Date
Round 3 Modeling Completed (Support Selection of Preliminary Preferred Plan)	May 2019
Round 3 Project Delivery Team Evaluation	June – July 2019
Identification of Preliminary Preferred Plan	July 2019
Submittal of Biological Assessment to US Fish and Wildlife Service	December 2019
State/Agency/Tribe/Public Review Draft Water Control Plan and Environmental Impact Statement	February – March 2020
Receipt of US Fish and Wildlife Service Biological Opinion	May 2020
Stage/Agency/Tribe/Public Review Final Water Control Plan and Environmental Impact Statement	June to July 2020
Signature of Record of Decision	August 2020

United States Department of the Interior

FISH AND WILDLIFE SERVICE
South Florida Ecological Services Office
1339 20th Street
Vero Beach, Florida 32960
October 9, 2019

Andrew D. Kelley, Colonel
District Commander
U.S. Army Corps of Engineers
Post Office Box 4970
Jacksonville, Florida 32232

Service Federal Activity Code: 04EF2000-2015-F-0241

Dear Colonel Kelly:

The U.S. Fish and Wildlife Service (Service) has reviewed the U.S. Army Corps of Engineers' (Corps) letter dated September 30, 2019, requesting that the Biological Opinion (BO) (Service 2016) for the Everglades Restoration Transition Plan (ERTP) be amended to reflect a change in the implementation date of the Combined Operational Plan (COP). The Corps, in coordination with the Service, had previously established a deadline of the end of 2019 as the implementation date for the COP. Subsequently, in August of 2018, the deadline was extended to May 25, 2020. This deadline was included as part of the Reasonable and Prudent Alternative (RPA) to avoid jeopardy to the endangered Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*; CSSS; Service 2016). The most recent COP implementation schedule has August 2020, as the date on which the Record of Decision will be signed. Therefore, the Corps is requesting that the BO be amended to reflect the revised date for the COP. The proposed August 2020 implementation will miss the March 1 start of the 2020 sparrow nesting season, however, the Service expects that the flexibility currently in place with the Modified Water Deliveries Increment 2 will sufficiently address operational concerns while we wait for the full flexibility of the COP to be implemented.

While it is unfortunate that this important project, which we hope will assist in the conservation and recovery of the CSSS, is delayed, it was not entirely unexpected. The RPA had contemplated project implementation delays and had included a process with which those delays could be proposed, reviewed, and incorporated in the BO if accepted. Everglades restoration and its various projects have experienced frequent delays in its nearly two decades of planning and implementation and will probably experience more delays with its enormous complexity. The Service would like to take this opportunity to acknowledge the Corps' progress and accept the amendment to the RPA by changing the implementation date of COP in the ERTP BO to August 2020. We thank the Corps for its continued diligence in implementing the remaining Comprehensive Everglades Restoration, Modified Water Delivery, C-111 South Dade, and

Central Everglades Planning Projects in a timely fashion. All of the threatened and endangered species in the Greater Everglades ecosystem will benefit from it.

Sincerely yours,

Larry Williams

Larry Williams
State Supervisor
South Florida Ecological Services Office

cc: electronic only
Corps, Jacksonville, Florida (Angela Dunn, Melissa Nasuti)

LITERATURE CITED

U.S. Fish and Wildlife Service. 2016. Biological Opinion for the Everglades Restoration Transition Plan, Phase 2 (ERTP-2016). South Florida Ecological Services Office; Vero Beach, Florida.

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, JACKSONVILLE DISTRICT
701 SAN MARCO BLVD
JACKSONVILLE, FL 32207-8175

Planning and Policy Division
Environmental Branch

11 December 2019

Mr. Larry Williams, Field Supervisor
U.S. Fish and Wildlife Service
1339 20th Street
Vero Beach, FL 32960

Dear Mr. Williams:

In accordance with provisions of Section 7 of the Endangered Species Act of 1973, as amended, the Jacksonville District, U.S. Army Corps of Engineers, (Corps), is hereby initiating consultation with the U.S. Fish and Wildlife Service (USFWS) concerning the Combined Operational Plan (COP). The purpose of the COP is to define operations for the constructed features of the Modified Water Deliveries (MWD) to Everglades National Park (ENP) and Canal 111 (C-111) South Dade Projects, while maintaining the congressionally authorized purposes of the Central and Southern Florida Project to include flood control; water supply for agricultural irrigation, municipalities and industry; regional groundwater control and prevention of saltwater intrusion; enhancement of fish and wildlife; and recreation.

The COP will result in a comprehensive integrated water control plan for the operation of water management infrastructure associated with the MWD and C-111 South Dade Projects in Miami Dade County. Implementation of the COP is anticipated to increase the availability of water deliveries from Water Conservation Area (WCA) 3A to ENP through Northeast Shark River Slough and improve hydrologic conditions in Taylor Slough, the Rocky Glades, and the eastern panhandle of ENP using the existing water budget. Water management operating criteria defined during development of the COP will be incorporated into an update to the 2012 WCAs, ENP, and ENP to South Dade Conveyance System Water Control Plan following completion of documentation for the National Environmental Policy Act (NEPA). Development of the COP is also being pursued to address the mandated Reasonable and Prudent Alternative of the July 22, 2016 Everglades Restoration Transition Plan Biological Opinion which requires the Corps to proceed as scheduled, and as allowable by law, for completing NEPA analysis for the COP in August 2020. As discussed at our September 18, 2019 Leadership Group meeting for the Everglades Restoration Transition Plan, the majority of the benefits that USFWS is seeking for the endangered Cape Sable Seaside Sparrow (CSSS), subpopulation Ax (CSSS-Ax), are being realized as a result of MWD Increment 2 Field Test. This includes raising the stage in the L-29 Canal to move water east away

from CSSS-Ax. COP will serve to further refine and optimize operations within WCA 3A, ENP and SDCS and make adjustments to the WCA 3 Rainfall Plan.

The Corps acknowledges the potential usage and occurrence of threatened and endangered species and/or critical habitat within the COP action area. The Corps is requesting formal consultation under ESA for the following species; the CSSS (Ammodramus maritimus mirabilis) and its designated critical habitat, the Everglade snail kite (Rostrhamus sociabilis plumbeus) and its designated critical habitat, and the wood stork (Mycteria americana). We request that the USFWS provide concurrence on the Corps species effect determinations as described in the enclosed Biological Assessment, provide a Draft Biological Opinion (BO) within 90 days of receipt of this letter for Corps' review and a Final BO within 135 days from receipt of this letter. The COP water control plan and adaptive management and monitoring plan has been included in the BA for reference.

If you have any questions or concerns please contact Ms. Melissa Nasuti by email Melissa.A.Nasuti@usace.army.mil or telephone 904-232-1368 regarding this consultation request.

Sincerely,

Angela E. Dunn
Chief, Environmental Branch

Enclosure

cc:
Mr. Donald Progulske, U.S. Fish and Wildlife Service, 1339 20th Street, Vero Beach, FL 32960
Mr. Miles Meyer, U.S. Fish and Wildlife Service, 1339 20th Street, Vero Beach, FL 32960
Mr. Kevin Palmer, U.S. Fish and Wildlife Service, 1339 20th Street, Vero Beach, FL 32960

Table 1. Status of Federally Threatened and Endangered Species with the Potential to occur within the COP Action Area and the Corps' Affect Determination (E: Endangered; T: Threatened; SA: Similarity of Appearance; CH: Critical Habitat, C: Candidate Species)

Common Name	Scientific Name	Status	May Affect Not Likely to Adversely Affect	May Affect	No Effect
Mammals	-	-	-	-	-
Florida panther	*Puma concolor coryi*	E	X	-	-
Florida manatee	*Trichechus manatus latirostris*	E, CH	X	-	-
Florida bonneted bat	*Eumops floridanus*	E	X	-	-
Birds	-	-	-	-	-
Cape Sable seaside sparrow	*Ammodramus maritimus mirabilis*	E, CH	-	X	-
Everglade snail kite	*Rostrhamus sociabilis plumbeus*	E, CH	-	X	-
Piping plover	*Charadrius melodus*	T	-	-	X
Red-cockaded woodpecker	*Picoides borealis*	E	-	-	X
Roseate tern	*Sterna dougallii*	T	-	-	X
Wood stork	*Mycteria americana*	T	-	X	-
Reptiles	-	-	-	-	-
American Alligator	*Alligator mississippiensis*	T, SA	X	-	-
American crocodile	*Crocodylus acutus*	T, CH	X	-	-
Eastern indigo snake	*Drymarchon corais couperi*	T	X	-	-
Gopher tortoise	*Gopherus polyphemus*	C	-	-	X
Invertebrates	-	-	-	-	-
Bartram's hairstreak butterfly	*Strymon acis bartrami*	E, CH	-	-	X

Common Name	Scientific Name	Status	May Affect Not Likely to Adversely Affect	May Affect	No Effect
Florida leafwing butterfly	*Anaea troglodyta floridalis*	E, CH	-	-	X
Miami blue butterfly	*Cyclargus thomasi bethunebakeri*	E	-	-	X
Schaus swallowtail butterfly	*Heraclides aristodemus ponceanus*	E	-	-	X
Stock Island tree snail	*Orthalicus reses (not incl. nesodryas)*	T	-	-	X
Plants	-	-	-	-	-
Crenulate lead plant	*Amorpha crenulata*	E	-	-	X
Deltoid spurge	*Chamaesyce deltoidea spp. deltoidea*	E	-	-	X
Garber's spurge	*Chamaesyce garberi*	T	-	-	X
Okeechobee gourd	*Cucurbita okeechobeensis ssp. okeechobeenis*	E	-	-	X
Small's milkpea	*Galactia smallii*	E	-	-	X
Tiny polygala	*Polygala smallii*	E	-	-	X
Big pine partridge pea	*Chamaecrista lineata var. keyensis*	E	-	-	X
Blodgett's silverbush	*Argythamnia blodgettii*	T	-	-	X
Cape Sable thoroughwort	*Chromolaena frustrata*	E, CH	-	-	X
Carter's small-flowered flax	*Linum carteri var. carteri*	E, CH	-	-	X
Everglades bully	*Sideroxylon reclinatum spp. austrofloridense*	T	-	-	X
Florida brickell-bush	*Brickellia mosieri*	E, CH	-	-	X
Florida bristle fern	*Trichomanes punctatum spp. floridanum*	E	-	-	X

Common Name	Scientific Name	Status	May Affect Not Likely to Adversely Affect	May Affect	No Effect
Florida pineland crabgrass	*Digitaria pauciflora*	T	-	-	X
Florida prairie-clover	*Dalea carthagenesis floridana*	E	-	-	X
Florida semaphore cactus	*Consolea corallicola*	E, CH	-	-	X
Pineland sandmat	*Chaemaesyce deltoidea pinetorium*	T	-	-	X
Sand flax	*Linum arenicola*	E	-	-	X

COMBINED OPERATIONS PLAN

BIOLOGICAL ASSESSMENT

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Appendix C.4 – Water Quality and Hydrology Monitoring Plan

Appendix C.5 – Water Quality and Hydrology Monitoring Plan South of S-331

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D.2 Introduction

The purpose of a Biological Assessment (BA) is to evaluate the potential effects of a Federal action on both listed species and those proposed for listing, including designated and proposed critical habitat, and determine whether the continued existence of any such species or habitat is likely to be adversely affected by the Federal action. The BA is also used in determining whether formal consultation or a conference is necessary. See 50 CFR 402.12(a). This is achieved by:

- Reviewing the results of an on-site inspection of the area affected by the Federal action to determine if listed or proposed species are present or occurs seasonally.
- Reviewing the views of recognized experts on the species at issue and relevant literature.
- Analyzing the effects of the Federal action on species and habitat including consideration of cumulative effects, and the results of any related studies.
- Analyzing alternative actions considered by the Federal agency for the proposed action.

In accordance with provisions of Section 7 of the Endangered Species Act (ESA) of 1973, as amended, the U.S. Army Corps of Engineers, Jacksonville District (USACE) via preparation of this BA is initiating consultation with the U.S. Fish and Wildlife Service (USFWS) regarding the Combined Operational Plan (COP). COP will incorporate constructed features of the Modified Water Deliveries (MWD) and C-111 South Dade Projects into the 2012 Water Control Plan.

D.2.1 Consultation Summary

Beginning in September of 2017 and throughout the Combined Operational Plan planning process, (USFWS) staff have attended COP Project Delivery Team (PDT) meetings, providing substantive comments informally through these venues. The Fish and Wildlife Coordination Act (FWCA; 16 U.S.C. 661 et seq., March 10, 1934, as amended 1946, 1958, 1978, and 1995) requires Federal agencies to consult with the USFWS regarding the impacts to fish and wildlife resources and the proposed measures to mitigate these impacts. Additional coordination authorities exist through the review process of the National Environmental Policy Act (NEPA) (NEPA; 42 U.S.C. 4321-4347, January 1, 1970, as amended 1975 and 1982) and the consultations required under the Endangered Species Act of 1973 (ESA; 7 U.S.C. 136, 16 U.S.C. 1532 ET SEQ. December 28, 1973). A Memorandum for Record (MFR) was signed by representatives from USACE and USFWS on October 3, 2017 and October 10, 2017 respectively, to document an informal understanding to utilize the COP NEPA review and ESA consultation process to complete coordination responsibilities under the FWCA. The October 2017 MFR indicated that the USFWS will continue to coordinate and consult with USACE through NEPA and the ESA to ensure impacts to fish and wildlife resources are adequately addressed via these two authorities. The Service will include comments relevant to the FWCA in the Service's response to the Corp's ESA coordination letter, where applicable. Formal comments have also been submitted through Planning Aid Letters (PALs) in accordance with the FWCA. Provided below is a brief consultation summary of correspondence exchanged to date.

On September 22, 2017 correspondence was provided to the USFWS indicating that USACE was beginning preparation of a NEPA assessment for COP. USACE invited the participation of Federal and State agencies, Native American Tribes, local agencies, interested parties and individuals in providing comments and identifying any issues or concerns. Scoping comments were accepted through October 21, 2017. The

USFWS provided no response to the NEPA scoping letter. The USFWS was asked at the beginning of the planning process to become a cooperating agency under NEPA in correspondence dated September 22, 2017. The USFWS declined cooperating agency status in a PAL dated November 13, 2017, stating that the Service prefers to continue its critical coordination with USACE as they have in the past as a consulting agency.

USACE has consulted with the USFWS by letter dated September 26, 2017 on federally listed threatened and endangered species under their purview that may be present in the action area. In correspondence dated October 31, 2017, the USFWS provided a revised list for COP. USACE provided subsequent email correspondence seeking clarification on the revised list due to the recent listing of several species. The USFWS provided concurrence on the revised list on November 27, 2017 via e-mail. Federally threatened and endangered species that may be encountered within or adjacent to the action area include the Florida panther (*Puma concolor coryi*), Florida population of West Indian Manatee (Florida manatee) (*Trichechus manatus*), Florida bonneted bat (*Eumops floridanus*), Cape Sable Seaside Sparrow (CSSS) (*Ammodramus maritimus mirabilis*), Everglade snail kite (*Rostrhamus sociabilis plumbeus*), piping plover (*Charadrius melodus*), red-cockaded woodpecker (*Picoides borealis*), roseate tern (*Sterna dougallii dougallii*), wood stork (*Mycteria americana*), American alligator (*Alligator mississippiensis*), American crocodile (*Crocodylus acutus*), Eastern indigo snake (*Drymarchon corais couperi*), gopher tortoise (*Goperus polyphemus*), Bartram's hairstreak butterfly (*Strymon acis bartrami*), Florida leafwing butterfly (*Anaea troglodyta floridalis*), Miami blue butterfly (*Cyclargus thomasi bethunebaker*), Schaus swallowtail butterfly (*Heraclides aristodemus ponceanus*), Stock Island tree snail (*Orthalicus reses* [not incl. *nesodryas*]), crenulate lead-plant (*Amorpha crenulata*), deltoid spurge (*Chamaesyce deltoidea ssp. deltoidea*), Garber's spurge (*Chamaesyce garberii*), Okeechobee gourd (*Cucurbita okeechobeensis ssp. okeechobeenis*), Small's milkpea (*Galactia smallii*), tiny polygala (*Polygala smallii*), Big Pine partridge pea (*Chamaecrista lineata var. keyensis*), Cape Sable thoroughwort (*Chromolaena frustrata*), Carter's small-flowered flax (*Linum carteri var. carteri)*, Everglades bully (*Sideroxylon reclinatum spp. Austrofloridense*), Florida brickell-bush (*Brickellia mosieri*), Florida bristle fern (*Trichomanes punctatum spp. floridanum*), Florida semaphore cactus (*Consolea corallicola*), sand flax (*Linum arenicola*), Florida pineland crabgrass (*Digitaria pauciflora*), Florida pineland sandmat (*Chaemaesyce deltoidea pinetorium*), and Florida prairie clover (*Dalea carthagenesis floridana*). Designated critical habitat includes the Florida manatee, CSSS, snail kite, American crocodile, Batram's hairstreak butterfly, Florida leafwing butterfly, Cape Sable thoroughwort, Carter's small-flowered flax, Florida brickell-bush, and Florida semaphore cactus.

USACE has also consulted with the USFWS by letter dated October 24, 2017 requesting written confirmation of concurrence on the use of a single environmental baseline for purposes of ESA consultation. The provided correspondence communicated that USACE had developed an existing conditions baseline (ECB) for purposes of alternative evaluation which represents conditions in place at the time of implementation of COP in 2019. NEPA requires that the lead Federal agency define a No Action Alternative or the conditions that will exist if a proposed action is not implemented. USACE proposed that there are no differences between planning assumptions identified in the 2019 ECB and the No Action Alternative; therefore a single baseline was anticipated to be modeled for the planning effort. Assumptions related to the 2019 ECB were fully documented and reviewed by the COP PDT. The USFWS responded in a PAL dated November 13, 2017 requesting consideration of the addition of the following items: (1) structure S-333 (S-333) expansion expedited by the South Florida Water Management District (SFWMD) and considered under the Central Everglades Planning Project (CEPP) (USACE 2014); (2) MWD Increment 2 (operational changes required under the July 2016 Everglades Restoration Transition Plan (ERTP) Biological Opinion (BO)) (USACE 2018); and (3) relaxation of the G-3273 Constraint. Clarification was provided by USACE in subsequent PDT meetings.

The expanded capacity at S-333 was subsequently added to the 2019 ECB, with operations consistent with the July 2018 operating permit issued by the Florida Department of Environmental Protection (FDEP) to the SFWMD. Increment 1.2 of the MWD Field Test is assumed for 2019 ECB since the associated operational criteria are compliant with the Reasonable and Prudent Alternative (RPA) from the 2016 ERTP BO (Increment 2 is also compliant with the RPA; however, the 2012 Water Control Plan is not), and the L-29 maximum operating limit of 7.8 feet National Geodetic Vertical Datum (NGVD) is consistent with both the 2008 Florida Department of Transportation (FDOT) Relocation Agreement and requirements to maintain the federally-authorized flood mitigation flood the 8.5 Square Mile Area (8.5 SMA). Increment 2 NEPA was also not completed nor approved by USACE South Atlantic Division when the existing conditions planning assumptions were identified. Furthermore, relaxation of the G-3273 constraint is already included within MWD Increment 1.1 and 1.2 operations.

USACE also consulted with the USFWS seeking input on potential performance metrics and ecological planning tools to evaluate environmental effects during the planning process for COP. The USFWS provided concurrence on the suggested metrics in the PAL dated November 13, 2017 and suggested the use of additional metrics to be utilized in coordination with the U.S. Geological Survey (USGS).

The 2016 ERTP BO requires USACE to proceed as scheduled, and as allowable by law, for completing NEPA analysis on COP in 2019 due to a jeopardy opinion on the CSSS. The 2016 ERTP BO (page 185) included recognition that "The Service understands that implementing each of the actions listed in section 7.1.2 is subject to various contingencies, including real estate acquisitions by DOI and the Corps, timely completion of several ongoing and planned construction projects, and complying with NEPA, some of which the Corps does not control (e.g., non-Corps land acquisition, tribal consultation, state Coastal Zone Management Act evaluation). These actions must proceed in accordance with applicable Federal laws and regulations, and are subject to the administrative and Congressional budget process, appropriations, the Federal Acquisition Regulations and Competition in Contracting Act requirements, and the actions of third parties, which may delay or otherwise require changes to their execution." In correspondences dated August 10, 2018 USACE requested that the 2016 ERTP BO be revised to reflect the anticipated date for COP completion of May 25, 2020. USFWS provided correspondence on September 7, 2018, confirming the new date. USACE requested a second amendment to the 2016 ERTP BO via correspondence on September 30, 2019 noting that the anticipated date for COP completion is August 2020. USFWS provided correspondence on October 9, 2019 confirming the new date.

A full consultation history on water management activities to protect the CSSS is contained within the 2010 ERTP BA (USACE 2010), 2010 ERTP BO (USFWS 2010), the 2011 ERTP FEIS (USACE 2011), the 2015 ERTP Supplemental BA (USACE 2015), and the 2016 ERTP BO (USFWS 2016), and is hereby incorporated by reference.

D.2.2 Study Area

The water management operating criteria relating to the 2012 Water Control Plan affects an area within the Central & Southern Florida (C&SF) Project located in South Florida and includes portions of several counties, as well as Water Conservation Area (WCA) 3, Everglades National Park (ENP), Big Cypress National Preserve (BCNP), and adjacent areas. The MWD Project is a modification of the C&SF Project. Features of the MWD Project are located in Miami-Dade County, including portions of ENP and adjacent areas (**Figure D.2-1**). The 1992 MWD General Design Memorandum (GDM) and Final EIS defines the project boundary as Shark River Slough (SRS) and that portion of the C&SF Project north of S-331 to include WCA 3. The C-111 South Dade Project is situated within the C-111 basin which includes roughly 100

square miles of mostly agricultural lands in the Homestead/Florida City area. The C-111 South Dade Project adjoins ENP to the west, and discharges to Taylor Slough, the eastern panhandle of ENP, Florida Bay, Manatee Bay and Barnes Sound. The major project components of the MWD and C-111 South Dade Projects are shown in (**Figure D.2-1**).

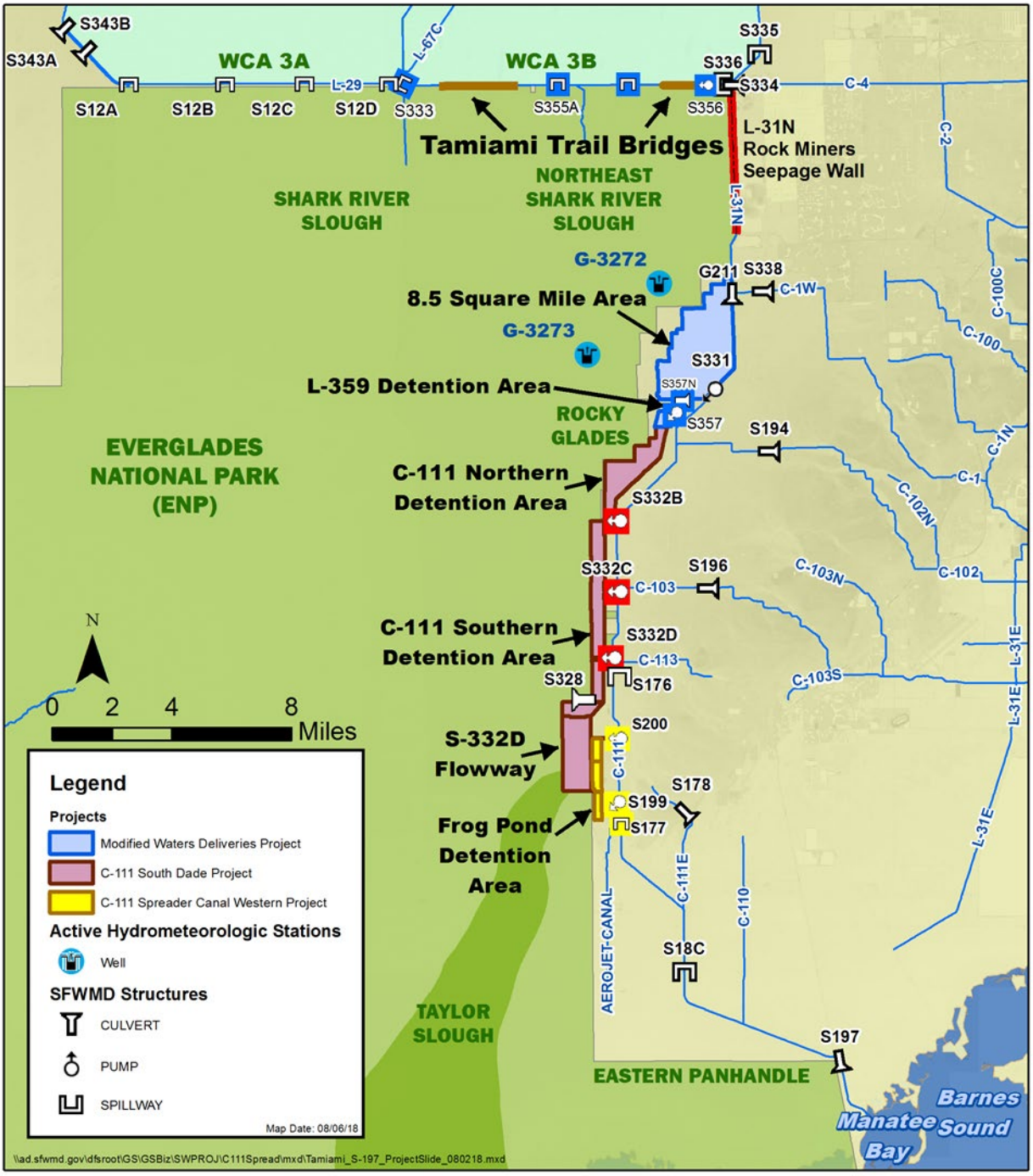


Figure D.2-1. Map of study area.

D.2.3 Project Description

The COP is an integrated operational plan for two modifications of the C&SF project – known as MWD to ENP and the C-111 South Dade Projects. The purpose of COP is to define the water management operations for the WCA 3A and WCA 3B outlets, structures in the L-31N and the C-111 basins constructed as part of the C&SF Project and the recently constructed components of the MWD and C-111 South Dade Projects. The COP water management operations will be consistent with their respective project purposes as defined by the authorizing legislation and further refined by subsequent GDMs, general reevaluation reports (GRR) and limited reevaluation reports (LRR) completed for the MWD and C-111 South Dade Projects. COP balances ecological restoration objectives of the MWD and C-111 South Dade completed infrastructure by redistributing the existing WCA 3A and ENP water budget, while remaining forward compatible with future expected flow increases. The proposed operations will also be consistent with the original purposes of the C&SF Project to provide flood control; water supply for agricultural irrigation, municipalities and industry, and ENP; regional groundwater control and prevention of saltwater intrusion; enhancement of fish and wildlife; and recreation.

D.2.3.1 Project Authority

A minimum schedule of water deliveries from the C&SF Project to ENP was authorized by Congress in 1970 in PL 91-282. Section 1302 of the Supplemental Appropriations Act of 1984 (PL 98-181), passed in December 1983, authorized the USACE, with the concurrence of the National Park Service (NPS) and SFWMD, to deviate from the minimum delivery schedule for two years in order to conduct an Experimental Program of water deliveries to improve conditions within ENP. Section 107 of PL 102-104 amended PL 98-181 to allow continuation of the Experimental Program until modifications to the C&SF Project, authorized by Section 104 of the ENP Protection and Expansion Act of 1989 (PL 101-229), were completed and implemented. PL 101-229 eventually led to the MWD to ENP Report and project that was authorized by PL 101-229 in 1989 (USACE 1992). The following stated objectives of the MWD Project were intended to take steps to restore the natural hydrologic conditions within ENP, to the extent practicable, given the identified constraints:

i. Timing: Changing the schedule of water deliveries so that it fluctuates in consonance with local meteorological conditions, including providing for long-term and annual variation in ecosystem conditions in the Everglades;

ii. Location: Restoring WCA 3B as a functioning component of the Everglades hydrologic system and restoration of water deliveries to North East Shark River Slough (NESRS), the center of the historic SRS;

iii. Volume: Adjusting the magnitude of water discharged to ENP to minimize the effects of too much or too little water.

The MWD to ENP GDM and Final EIS were published in July 1992. The MWD Final EIS includes a discussion of the location, capacity, and environmental impacts for the proposed structural modifications, which included structures S-345A, B and C; S-349A, B and C; S-355A and B; S-334 modification, removal of the L-67 Extension Levee and borrow canal filling; and a levee and canal system for flood mitigation in the developed East Everglades area (also referred to as the 8.5 SMA). The levee and canal system included two pumping stations, S-356 and S-357. The MWD recommended plan provides a system of water deliveries to ENP across the full width of the historic SRS flow-way. The Canal-111 (C-111) South Dade County 1994 Integrated GRR and EIS was published in May 1994. This report described a conceptual plan

for five pump stations and levee-bounded retention/detention areas to be built west of the L-31N Canal, between the proposed S-332B and S-332D pump stations, to control seepage out of ENP while providing flood mitigation to agricultural lands east of C-111 Canal. Features of the MWD and C-111 South Dade projects, including amendments to the original project components, are described in Section 1.3 (Project Background) of the COP EIS.

D.2.3.2 Project Objectives

The following lists of COP planning objectives are based on the authorizing legislation and prior planning reports for each project. Objectives and constraints may be modified based on identification of new problems and opportunities, interagency input, and public scoping.

1. Improve water deliveries (timing, location, volume) into ENP and take steps to restore natural hydrologic conditions in ENP given current C&SF infrastructure and features expected to be completed by the time of implementation, to the extent practicable by
    a. Changing schedule of water deliveries so that it fluctuates in consonance with local meteorological conditions, including providing for long term and annual variation in ecosystem conditions in the Everglades (Timing) (P.L. 101-229, Section 101b)
    b. Restoring NESRS as a functioning component of the Everglades hydrologic system (Location) (P.L. 101-229, Section 101b)
    c. Adjusting the magnitude of water discharged to ENP to minimize effects of too much or too little water (Volume) (1992 MWD GDM, Section 44)
2. Maximize progress toward restoring historic hydrologic conditions in the Taylor Slough, Rocky Glades, & eastern Panhandle of ENP.
3. Protect the intrinsic ecological values associated with WCA-3A and ENP.
4. Minimize the damaging freshwater flows to Manatee Bay/Barnes Sound through the S197 structure and increase flows through Taylor Slough and coastal creeks (1994 C-111 GRR, Section 5.2)
5. Include consideration of cultural values and tribal interests & concerns within WCA-3A and ENP.

D.2.3.3 Proposed Action

The formulation of COP was governed by the MWD and C-111 South Dade Project objectives and constraints (COP EIS Section 1.6), and lessons learned from a series of incremental field tests conducted under the authority of the MWD Project (i.e. Increment 1, Increment 1.1 and 1.2, and Increment 2) to raise the L-29 Canal maximum operating limit for the purpose of increasing flows to NESRS in ENP. The alternative formulation process was a five step process that can best be described as the Initial Array, Round 1, Round 2, Round 3, and Round 3 Optimization. The formulation process was a collaborative multi-agency and public effort. Regional hydrologic modeling was performed to identify the Preferred Plan (Alternative Q+ (ALTQ+)) based on evaluation of system conditions. COP is the last step to implement operational changes to convey water from WCA 3A to the ENP using the constructed features of the pre-CERP (Comprehensive Everglades Restoration Program) Foundation Projects (i.e. MWD and C-111 South Dade Project) and would result in a change to the 2012 WCAs, ENP, and ENP-South Dade Conveyance System (SDCS) Water Control Plan. COP is also being pursued to address the mandated RPA of the July

22, 2016 ERTP BO and subsequent amendments that require USACE to proceed as scheduled, and as allowable by law, for completing NEPA analysis for the COP by August of 2020.

The proposed action is ALTQ+ that is largely based on the Round 3 Alternative Q (ALTQ) with minor tweaks based on sensitivity runs performed. In general, ALTQ+ meets all the project objectives and does not violate project constraints. The main component of ALTQ+ that improves water deliveries to ENP is the Tamiami Trail Flow Formula (TTFF). The TTFF replaces the 1985 WCA 3A Rainfall Plan. The TTFF uses information from water stages (WCA 3A and NESRS), rainfall (historical median WCA 3A and BCNP inflows with forecast adjustments), potential evapotranspiration (historical median), and recent structure flows to predict upcoming weekly flow target volumes across Tamiami Trail.

To facilitate increased flows out of WCA 3A, the L-29 canal is operated up to 8.5 feet, NGVD which allows for improved water deliveries to ENP via NESRS. However, the operating canal stages between 8.3 and 8.5 feet, NGVD are limited to 90 days per water year (May 1 to April 30), which is the interim FDOT constraint until Tamiami Trail Next Steps construction is completed. In addition, canal stages are limited by continued adherence 8.5 Square Mile Area (SMA) flood mitigation criteria. Outside the 90-day FDOT limit, the L-29 canal level will be maintained below 8.3 feet, NGVD subject to downstream constraints.

The 2008 MWD Tamiami Trail Limited Re-evaluation Report (LRR) included recommendations to build a one mile long bridge in the project area's eastern segment and raise the headwater stage constraints in the L-29 Borrow Canal by one foot from 7.5 feet, NGVD to 8.5 feet, NGVD, which required road mitigation on parts of Tamiami Trail (U.S. Highway 41) in the action area, located between S-333 on the west and S-334 on the east. To ensure the safety and stability of the roadway sub base infrastructure along this segment of Tamiami Trail (U.S. Highway 41), operational constraints [referenced within Section 6 (Recommended Plan) of the 2008 Tamiami Trail LRR] were set forth within the "Contract Between the United States of America and FDOT for Relocation, Rearrangement, or Alteration of Facilities Modified Water Deliveries to Everglades National Park Project (Relocation Agreement)") dated September 25, 2008. FDOT allowed USACE to use a new standard for the Tamiami Trail roadway (adopted in the March 2008 FDOT Flexible Pavement Design Manual) thereby reducing the required separation (Design Base High Water Clearance) between the Design High Water (DHW) and the bottom of the road base. Operational constraints as outlined within the Relocation Agreement dated September 25, 2008 are minimum protective standards that are included in ALTQ+. In coordination with FDOT, USACE has expanded hydrologic monitoring of water levels along the section of Tamiami Trail that is of concern. Data collected in accordance with the monitoring plan developed in consultation with FDOT will help to inform L-29 canal operations in COP.

The requirements of the Relocation Agreement, including any subsequent amendments to this agreement between USACE and FDOT, shall remain unchanged until full completion of Tamiami Trail Next Steps roadway construction, currently anticipated for late 2022 or early 2023. ALTQ+ includes the capability to further extend and/or remove the cumulative duration criteria for operating the L-29 Canal above 8.3 feet NGVD (referenced as the FDOT roadway constraint), while continuing to adhere to the maximum operating stage limit of 8.5 feet NGVD. Implementation of this change would not occur without: (1) written approval from FDOT to remove the L-29 Canal constraint identified in **Appendix A** (**Water Control Plan**), based on a joint evaluation of monitoring data by the USACE and the FDOT (this data evaluation is ongoing with the MWD Increment 2 field test); (2) demonstration of the capability of the completed MWD Project components to maintain flood mitigation requirements for the 8.5 SMA under the raised L-29 Canal maximum operating limit of up to 8.5 feet, NGVD; and (3) consideration of increased low-water stages within WCA 3A, including along the western L-29 Canal between S-12A and S-333. The requirement

for all three pre-conditions to be met may preclude these operations during the initial implementation period of COP, since additional inflows of treated water to WCA 3A from the upstream Lake Okeechobee and EAA basins and/or additional flood mitigation requirements may be necessary.

South Dade canal operations for reaches along the L-31N (south of S-331) and C-111 Canals were generally lowered under ALTQ+ compared to the long-term operational paradigms prescribed within the previous Water Control Plans under the Interim Operational Plan (IOP) (2002-2012) and ERTP (2012-2015), which preceded the MWD incremental field tests starting in 2015, to simultaneously promote both increased deliveries to Taylor Slough and the hydraulic ridge and reduced flood risk for the adjacent agricultural and urban areas. Extensive analyses during the COP iterative modeling rounds, including specifically crafted sensitivity simulations, demonstrated there is no significant trade-off of ecological performance benefits within ENP associated with the lowering of the normal canal operating ranges with COP. ALTQ+ promotes increased overland flow to Florida Bay and reduces the use of the S-197. The seasonal closures for the S-12A, S-12B, S-343A and S-343B remain unchanged from the 2016 ERTP BO. However, ALTQ+ includes removal of the seasonal closures at S-344 and includes limited adjustments to the S-332D seasonal pump restrictions. Lifting of S-344 closure dates and extending S-332D full pumping by an additional month, from November 30 to December 31, were based on coordination with the USFWS.

ALTQ+ includes additional operational flexibility by inclusion of an Extreme High Water Line (EHWL) for water management operations when extreme high water levels in WCA 3A exist. This operational flexibility is not expected to be triggered frequently and is intended to be available if needed to help reduce risks to the WCA 3A perimeter levee system, a population at risk of 70,600 people, hurricane evacuation routes, and wildlife and tree islands from extreme high water conditions. The EHWL ranges from 11.0 to 12.0 feet, NGVD. When WCA 3A water levels are above the EHWL, this will trigger a thorough evaluation of the C&SF system conditions. The information will be used to decide whether or not to implement all actions authorized by the EHWL which includes routing water from WCA 3A through the SDCS.

Reference **Appendix A** for a full description of the Proposed Action (ALTQ+) that will be included in the 2020 Water Control Plan.

A monitoring plan has been developed for COP. The COP Adaptive Management and Monitoring Plan (AMMP) includes (1) Part 1 Adaptive Management and Ecological Monitoring Plan; (2) Part 2 Water Quality Monitoring Plan; (3) Part 3 Hydrometerological Monitoring Plan, and (4) Part 4 Cultural Resources Monitoring Plan. The COP AMMP (**Appendix C**) was developed with the primary objective of identifying the monitoring necessary to inform decision-makers, COP partner agencies, and the public on progress towards achieving restoration success, as well as address uncertainties related to project performance. The USACE, SFWMD, and ENP will establish an interagency collaborative forum (referenced within the COP AMMP as the "PDT+") that succeeds the COP interagency PDT, consisting of the COP implementing agencies, oversight agencies, and stakeholder groups that will meet 1-2 times per year during COP implementation. Additional technical sub-teams will also be established to oversee hydrologic monitoring, coordinate data evaluations, and prepare data reports, consistent with the commitments identified in the COP AMMP. Established meetings (e.g., WCA 3 Periodic Scientists Calls (PSCs)) may also support evaluation of the COP AMMP and/or provide additional forums for periodic updates on the monitoring and assessment results.

D.2.4 Evaluation Tools and Model Assumptions

The following provides a summary of the tools used to determine potential effects to federally listed threatened and endangered species. Model assumptions are also described.

D.2.4.1 Evaluation Tools

In order to achieve the action objective, USACE in conjunction with the project team, identified a list of performance measures for purposes of evaluating the systems response to alternative plans (**Table D.2-1**). Project performance measures were identified as being able to evaluate a project objective(s) and are quantitative tools that have numerical targets related to restoration objectives. Several of the project performance measures for the planning effort are derived from those performance measures approved for use in the Comprehensive Everglades Restoration Plan (CERP) by Restoration, Coordination and Verification (RECOVER). RECOVER is an interagency and interdisciplinary scientific and technical team that provides essential support to the CERP. RECOVER performance measures identify hydrologic and ecological indicators expected to respond to implementation of CERP and are developed from conceptual ecological models (CEMS) that identify the major anthropogenic drivers and stressors on natural systems, the ecological effects of these stressors, and the best biological attributes or indicators of these ecological responses. Ecological planning tools developed by the Joint Ecosystem Modeling group (https://www.jem.gov) were also identified to be used for purposes of evaluating habitat suitability for fish and wildlife resources (**Table D.2-2**) in addition to metrics developed under ESA consultation for the ERTP from the 2016 BO. Regional hydrologic models applied as the primary tools include the South Florida Regional Simulation Model Glades-LECSA Implementation (RSM-GL).

The project performance measures, ecological planning tools, and 2016 ERTP BO metrics were used in evaluating potential effects to federally listed species in **Section D.2.6** (**Effect Determinations**). **Table D.2-1** and **Table D.2-2** provides a description of the performance measures and ecological planning tools.

Table D.2-1. COP performance measures.

Area	Performance Measure	Description
WCA 3 & ENP	Inundation Patterns • Percent Period of Record (PPOR) of Inundation	Above Ground Water Levels - Measure of the duration of inundation over the period of record within WCA 3 and ENP. Desired restoration condition is to restore pre-drainage patterns of multi-year hydroperiods. Target: based on Natural System Model (NSM)*.
WCA 3 & ENP	Hydrologic Surrogate for Soil Oxidation • Drought Intensity Index	Below Ground Water Levels - Measure of cumulative drought intensity below ground to reduce exposure to peat within WCA 3 and ENP. Desired restoration condition is to restore processes that result in soil accretion. Target: based on NSM.

Area	Performance Measure	Description
ENP (Northeast Shark River Slough)	Dry Events in Sh3ark River Slough • Number of Dry Events • Duration of dry Events • Percent Period of Record (PPOR) of Dry Events	Below Ground Water Levels - Measure of number of times and mean duration in weeks that water drops below ground in NESRS. Desired restoration condition is to restore pre-drainage patterns of multi-year hydroperiods. Target: based on NSM.
WCA 3 & ENP	Slough Vegetation Suitability • Hydroperiod • Drydown • Dry Season Average Depth • Wet Season Average Depth	Above & Below Ground Water Levels - Measure to evaluate the hydrologic suitability for vegetation communities within WCA 3A and ENP. Desired restoration condition is to restore pre-drainage water patterns suitable for white water lily and slim spikerush. Target: based on NSM.
Florida Bay	Southern Coastal Systems • Dry Season Regime Overlap • Wet Season Regime Overlap • Dry Season High Salinity • Wet Season High Salinity	Salinity - Measure to evaluate suitability for flora and fauna in Florida Bay based on salinity envelopes. Target: paleo-adjusted NSM.

* Several of the performance measure targets listed within this table are based on output from the NSM which simulates the response of a pre-drained Everglades. Additional documentation of the NSM is available at the following web location: https://www.sfwmd.gov/science-data/nsm-model#level7.

Table D.2-2. COP ecological planning tools.

Tool	Description
Marl Prairie Habitat Suitability and CSSS Helper	The CSSS build their nests on the ground and up to six inches (about 17 centimeters) above the ground in mixed marl prairies. To increase nesting success, these short-hydroperiod prairies must remain mostly dry during the nesting season (March through July). CSSS MarlPrairie is a spatially explicit modeling tool that simulates hydrologic suitability of marl prairie habitat based on CSSS survey presence data thresholds. CSSS MarlPrairie scores specifically target hydrologic indicators of suitable marl prairies inhabited by the CSSS. For more details about the model, please see Pearlstein et al 2016. The CSSS Viewer was developed to estimate and evaluate water levels and water depths in CSSS habitat. The CSSS Viewer calculates: (1) the percent area of each CSSS subpopulation that is dry; (2) the percent area having water depth less than or equal to six inches of water; and (3) the percent area that has been dry for 90 days

Tool	Description
	or more, each day by subpopulation areas. For more details about the model please see Beerens et al 2016.
Apple Snail	The Everglade snail kite has an almost exclusive diet of freshwater apple snails (*Pomacea paludosa*). The persistence of these apple snails depends largely on hydrologic regime and temperature. This size-structured population model simulates the response of apple snails to a range of water conditions that include timing, frequency, and duration. For more details about the model please see Darby et al 2015.
WADEM	Wader Distribution and Evaluation Modeling (WADEM) predicts how wading birds respond to the changes in hydrology that will occur with Everglades ecosystem restoration. It can predict Great Egret, White Ibis, and Wood Stork foraging distributions across changing habitat conditions based on their selection of prey resources (defined by daily – multi-annual hydrologic variables). For more details about the model please see Beerens et al. 2015a and Beerens et al. 2015b.
Small Fish	The density of small fishes (standard length < 8 cm) in the Everglades is highly dependent on variation in hydrological conditions. Based on 10-year time series data (1996-2006), Trexler and Goss (2009) parameterized a logistic population growth model to predict small fish densities based on the time since the end of the most recent drying event.
Alligator Suitability	Alligators are dependent on spatial and temporal patterns of water fluctuations that affect courtship and mating, nesting, and habitat use. Water management practices and other anthropogenic changes to the Everglades region have affected alligators, which historically were abundant in peripheral marshes of the Everglades and are now most abundant in central sloughs. The alligator ecological planning tool models habitat suitability annually for five components of alligator production: (1) land cover suitability; (2) breeding potential (female growth and survival from April 16 of the previous year - April 15 of the current year); (3) courtship and mating (April 16 – May 31); and (4) nest building (June 15 – July 15), and egg incubation (nest flooding from July 01 – September 15). For more details, please see Shinde et al. 2013 and RECOVER 2014.
Everglades Landscape Vegetation Succession (ELVeS)	The Everglades Landscape Vegetation Succession model (ELVeS) is a spatially-explicit simulation of vegetation community change over time in response to changes in environmental conditions. The model uses empirically-based probabilistic functions of vegetation community niche space and temporal lags to evaluate expected community response within the model's domain.

The following provides a brief description of the performance indicators used to evaluate alternative plans from the 2016 ERTP BO.

Everglade Snail Kite

A. July 2016 ERTP BO ERTP Reinitiation Trigger (Dry Season High Water):

If water levels rise above 9.2 feet, NGVD at gauge 3AS3W1 by April 15 in 2 consecutive years as a result of ERTP operations, incidental take will be exceeded.

B. July 2016 ERTP BO Reinitiation Trigger (Wet Season High Water):

If water levels rise above 10.5 feet NGVD at gauge 3AS3W1 for 60 consecutive days in 2 single years as a result of ERTP operations, incidental take will be exceeded.

C. July 2016 ERTP BO Reinitiation Trigger (Recession Dry Season Amplitude):

Incidental take will be exceeded if stages in WCA 3A, as measured by the gauge(s) closest to active kite nesting (as determined by the USFWS) recede by more than 1.7 feet from January 1 through May 31 or the onset of the wet season, whichever is sooner.

Wood Stork and Wading Birds

A. July 2016 ERTP BO Reinitiation Trigger (Breeding Season Water Depths):

Allowable incidental take will be exceeded if operations from implementing the RPA results in water depths greater than 16 inches (41 cm) from March 1 through May 31 throughout WCA 3A for two consecutive years as measured by the two gauge average (based upon a ground surface elevation of 8.4 feet NGVD) at gauges 3A-3 and 3A-4.

CSSSS

A. July 2016 ERTP BO CSSS RPA Target: Dry Nesting Days

To produce multiple broods each year, the CSSS requires at least 90 consecutive dry days (water below ground surface) during the nesting season (March 1 – July 15). USACE will manage water levels in a manner aimed at meeting the following:

> Subpopulation A - At least 24,000 acres of suitable habitat within and adjacent to CSSS subpopulation A must have 90 consecutive dry days between March 1 and July 15 (CSSS breeding season) every year.
>
> Subpopulations B through F – At least 40 percent of each designated CSSS critical habitat unit must have 90 consecutive dry days between March 1 and July 15 (CSSS breeding season) every year.

B. Discontinuous Hydroperiod

The marl prairie habitat that the CSSS requires for its survival and recovery persists under a hydrologic regime of 90 – 210 wet days (water above ground; discontinuous). In order to maintain and restore a sufficient area of suitable marl prairie habitat for each CSSS subpopulation, USACE will manage water levels in a manner aimed at meeting the following:

> Subpopulation A - At least 24,000 acres of suitable habitat within and adjacent to CSSS subpopulation A must show a 4-year running average discontinuous hydroperiod range of 90-210 days, with no 2 consecutive years failing to meet this target.
>
> Subpopulations B though F – At least 40 percent of each designated CSSS critical habitat unit must show a 4-year running average discontinuous hydroperiod range of 90-210 days, with no 2 consecutive years failing to meet this target.

D.2.4.2 Model Assumptions

Species were evaluated based on the existing condition (ECB19RR). The existing condition is intended to represent conditions assumed in place at the time of implementation of the COP Water Control Plan in 2020. This base condition, referred to as ECB19RR, included the following: (1) MWD Increment 1.1 and 1.2 (operational changes required under the July 2016 ERTP BO and in response to new information gained during the 2016 Temporary Emergency Deviation); (2) existing C&SF project infrastructure and Regulation Schedules (including 2008 Lake Okeechobee Regulation Schedule); (3) MWD Tamiami Trail Modifications 1-mile bridge and raised roadway; (4) Tamiami Trail Next Steps 2.6 mile Western Bridge; (5) full construction of C-111 South Dade to include Contracts 8, 8A and 9; (6) 8.5 SMA project features to include C-358 and S-357N; (7) Miami-Dade Limestone Products Association (MD-LPA) 5 mile Seepage Cutoff wall along L-31 North; (8) current permitted operations for the SFWMD C-111 Spreader Canal project components (includes G-737 and S-199/S-200 at expanded 300 cfs each); and (9) the expanded capacity at S-333 completed by the SFWMD component of the CEPP, with operations as prescribed by the July 2018 permit issued by FDEP to SFWMD; (10) the DOI plug installed at the junction of old Tamiami Trail Roadway and ENP Shark Valley Tram Road south of WCA 3A; and (11) assuming operations of the S-152, Decompartmentalization (Decomp) Physical Model. **Appendix B** provides a summary of the planning assumptions related to ECB19RR.

Three rounds of hydrologic modeling were conducted during plan formulation efforts for COP, consistent with the hydrologic modeling strategy that was vetted through the COP interagency PDT. As discussed in **Section D.2.3.3**, the proposed action is ALTQ+ which is largely based on Round 3 ALTQ with minor tweaks based on sensitivity runs performed. ALTQ+ was not modeled; however, hydrologic model output from ALTQ and the sensitivity runs on ALTQ carried forward to develop ALTQ+, were used to evaluate the potential effects of ALTQ+ on federally listed species discussed in **Section D.2.6**. The additional effects of ALTQ+ are expected to be similar compared to the overall changes in the baseline conditions observed under the current WCP.

ALTQ+ includes the following additions, compared against the modeling simulations of ALTQ conducted during the Round 3 modeling:

1. Capability to further extend and/or remove the 90-day annual cumulative duration limitation for operating the L-29 Canal above 8.3 feet, NGVD (referenced as the FDOT roadway constraint),

while continuing to adhere to the maximum operating stage limit of 8.5 feet, NGVD (included in RSM-GL Round 3 sensitivity run SRQ1)

2. Removal of seasonal closures for S-344 (included in RSM-GL Round 3 sensitivity run SRQ4)
3. Removal of seasonal pumping capacity restriction for S-332D during the month of December (included in RSM-GL Round 3 sensitivity run SRQ4, which additionally removed S-332D seasonal pumping capacity restrictions during January through 14 July)
4. Additional operational flexibility within the COP Water Control Plan to address uncertainties identified in the COP AMMP regarding: (a) water quality inflows to SRS (included in RSM-GL Round 3 sensitivity run SRQ2 and SRQ3); and (b) TTFF dry season operations for SRS (dry season field test criteria developed based on technical evaluation of RSM-GL ALTO versus ALTQ hydrologic responses within WCA 3A and ENP)
5. Operational criteria and operational flexibility developed by COP Water Management sub-team

   (and vetted through the COP PDT), as needed to effectively translate the operational intent and operational priorities established with the ALT Q+ Preliminary Preferred Plan for inclusion in the COP Water Control Plan (the ALTQ+ table specifically identified which structures would require "further details to be developed thru the Operational Subteam").

A description of general hydrologic performance is provided below to characterize potential changes in stages throughout WCA 3 and ENP for ALTQ relative to ECB19RR and for those sensitivity runs (SRQ1, SRQ2, SRQ3, and SRQ4) that were used to inform the development of ALTQ+.

D.2.4.2.1 Water Conservation Area 3

The cyclic analysis of the 3-gauge average of the stages at Gauges 3A-28, 3A-3, and 3A-4 for ALTQ simulations is shown in **Figure D.2-2**. The labels for the plotted traces indicate the probability exceedance percentiles for 5%, 10%, 25%, 50% (median value), 75%, 90%, and 95%. The maximum, minimum and average stages for each Julian calendar day are also shown in the figure. Comparison of stages corresponding to 10%, 50%, and 90% exceedance probability percentiles can be found in **Figure D.2-4**, **Figure D.2-5**, and **Figure D.2-6,** respectively. It should be noted that ALTQ simulations did not include operational rules associated with EHWL. Reference **Section D.2.3.3** and **Appendix A** for further information on the conditions in which the EHWL would be implemented. Simulated daily WCA 3A stages for the entire 41-year POR is shown in **Figure D.2-3**. As indicated in the figure, EHWL is expected to be exceeded infrequently and the modeling results would not be significantly altered by the decision to not explicitly model the EHWL operations for the COP alternatives, Including ALT Q. The simulated stages for ECB19RR is included in the graphs for comparison purposes. The existing condition model simulation (ECB19RR) for the study area similarly did not include the operational rules for the Increment 1.1/1.2 High Water Line (similar intent as the EHWL, but at a slightly lower WCA 3A elevation) as a part of WCA 3A regulation schedule.

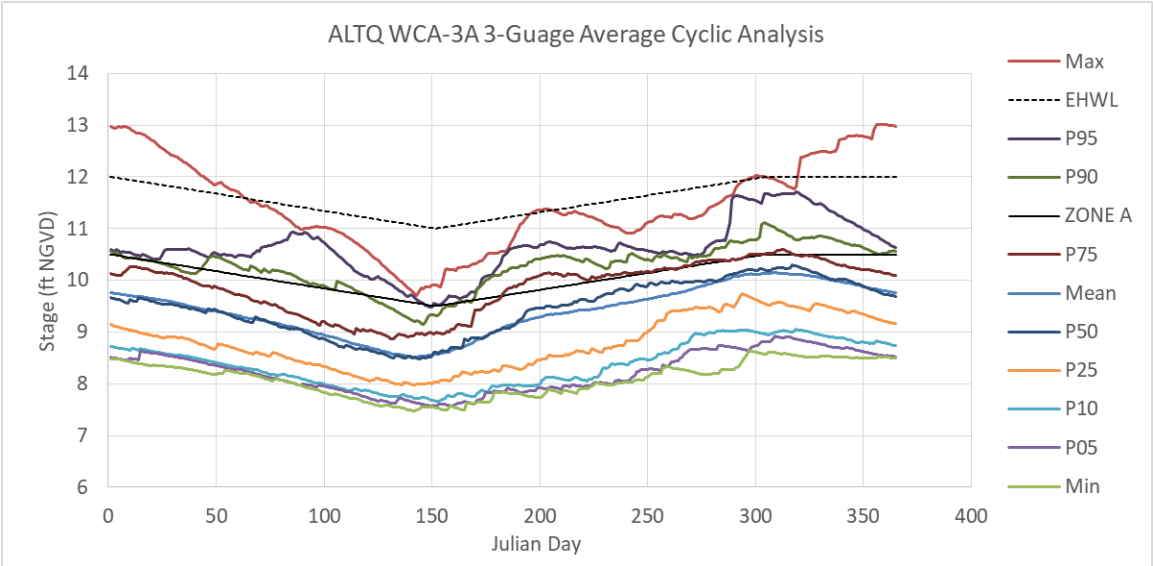


Figure D.2-2. Cyclic Analysis of the WCA 3A 3-gauge average for ALTQ.

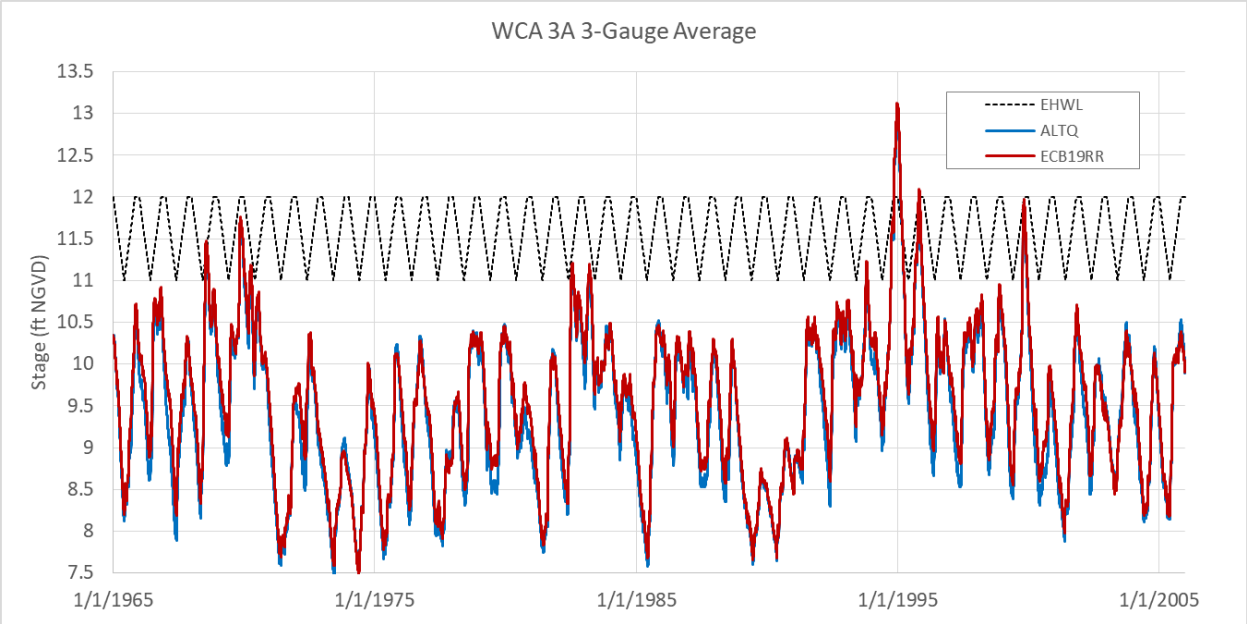


Figure D.2-3. Extreme High Water Line and simulated WCA 3A stages.

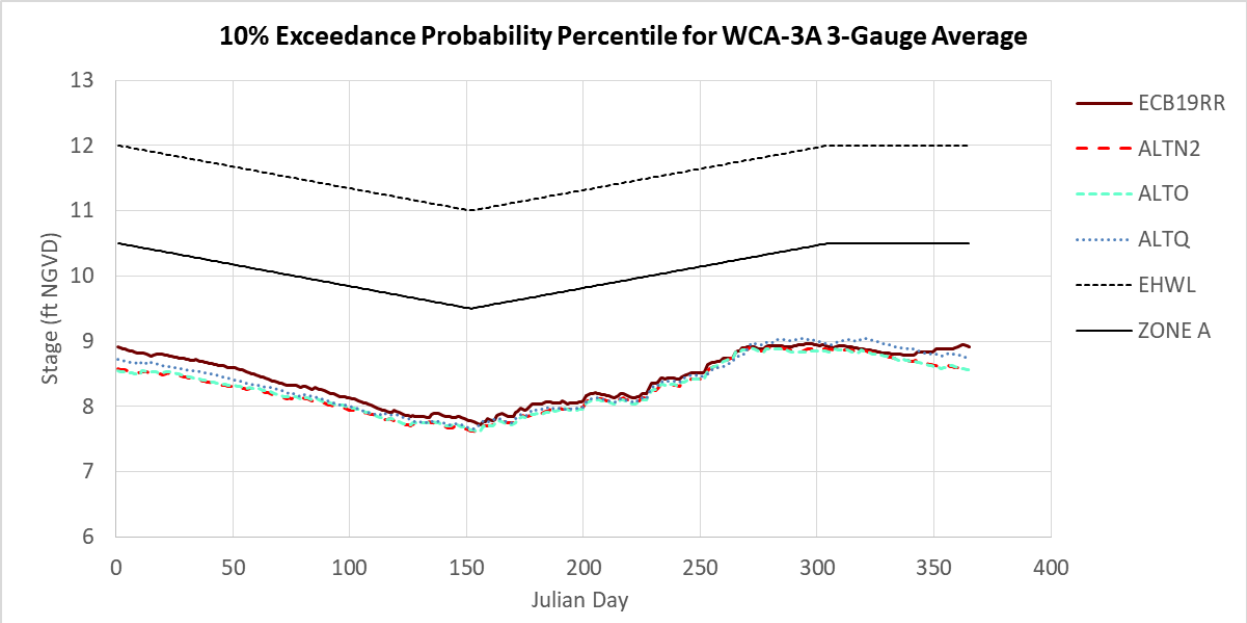


Figure D.2-4. 10% Exceedance Probability Percentile for WCA 3A 3-Gauge Average.

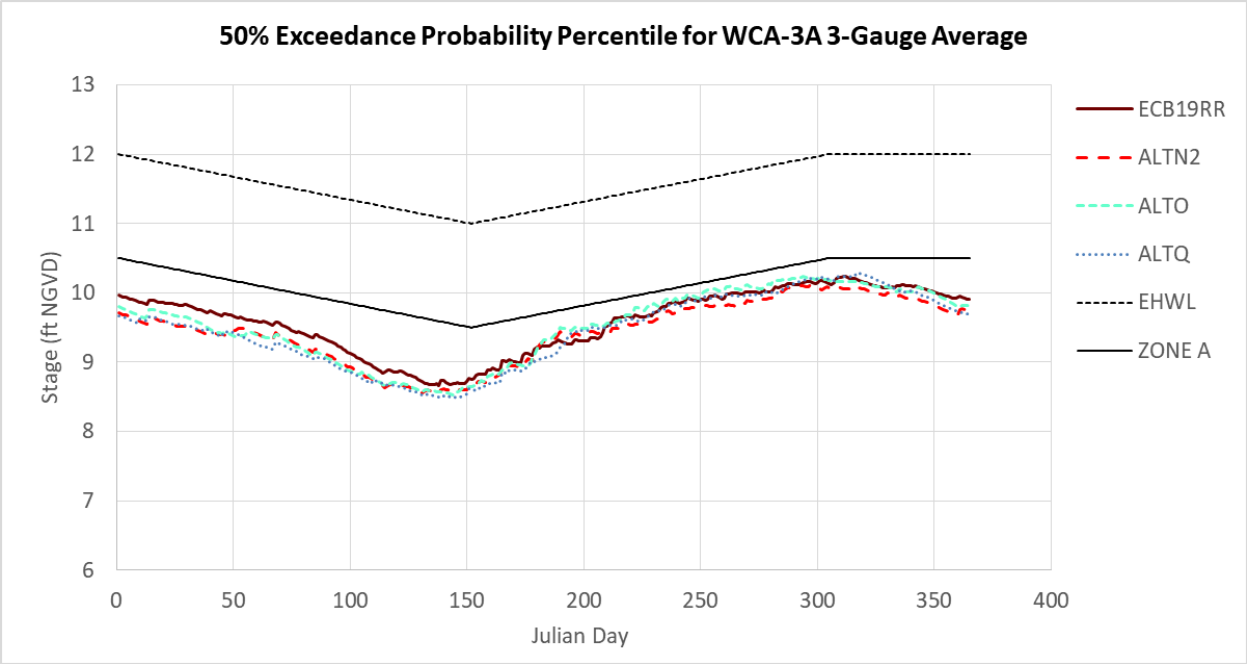


Figure D.2-5. 50% Exceedance Probability Percentile for WCA 3A 3-Gauge Average.

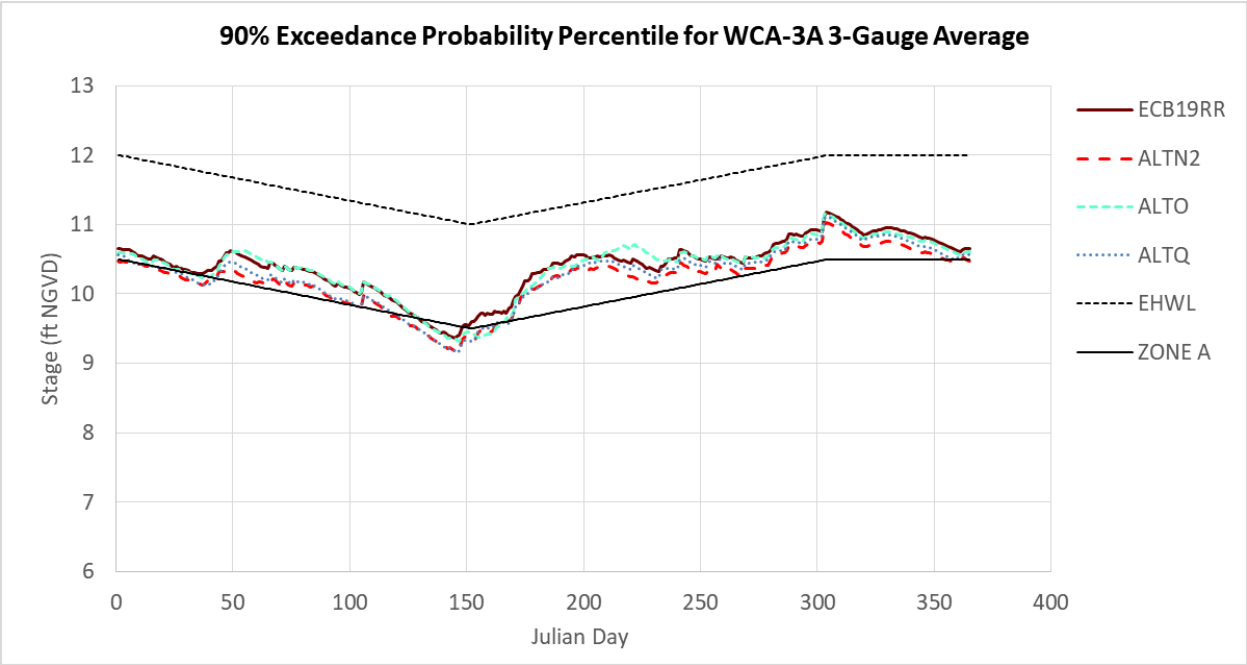


Figure D.2-6. 90% Exceedance Probability Percentile for WCA 3A 3-Gauge Average.

As the ponding depth duration curves and hydroperiod duration comparisons (**Figure D.2-7** and **Figure D.2-10**) indicate, a slight decrease in stages is expected under ALTQ in comparison to ECB19RR for east central WCA 3A. The average annual extent of reduced hydroperiods can be seen in **Figure D.2-7**. The reduction in depths become more pronounced under drier conditions, with virtually unchanged stages under extremely wet conditions. As presented in **Figure D.2-8** and **Figure D.2-9**, considerably shorter hydroperiods in east-central WCA 3A are expected during extreme dry years, versus the similar hydroperiods with ECB19RR during extreme wet years under ALTQ. ALTQ+ includes capability to further extend and/or remove the cumulative duration criteria for operating the L-29 Canal above 8.3 feet NGVD (referenced as the FDOT roadway constraint), while continuing to adhere to the maximum operating stage limit of 8.5 feet NGVD. Round 3 sensitivity run simulation SRQ1 included removal of 90-day annual cumulative duration limitation for operating the L-29 Canal above 8.3 feet, NGVD. Differences in average annual hydroperiods for SRQ1 with respect to ECB19RR, and ALTQ are provided in **Figure D.2-11**. As seen in the figure the hydrologic effect of ALTQ+ on WCA 3A is expected to be very similar to that of ALTQ. The comparison of the modeling results provided in **Figure D.2-12** and **Figure D.2-13** indicate that similar responses to are expected even during extreme dry (1989) and extreme wet years (1995). Depth duration curves shown in **Figure D.2-10** indicate the hydrologic conditions very similar to ALTQ are expected under ALTQ+ for east central WCA 3A. Similar depths are expected for the entire range of expected stages at Gauge WCA_3A-3.

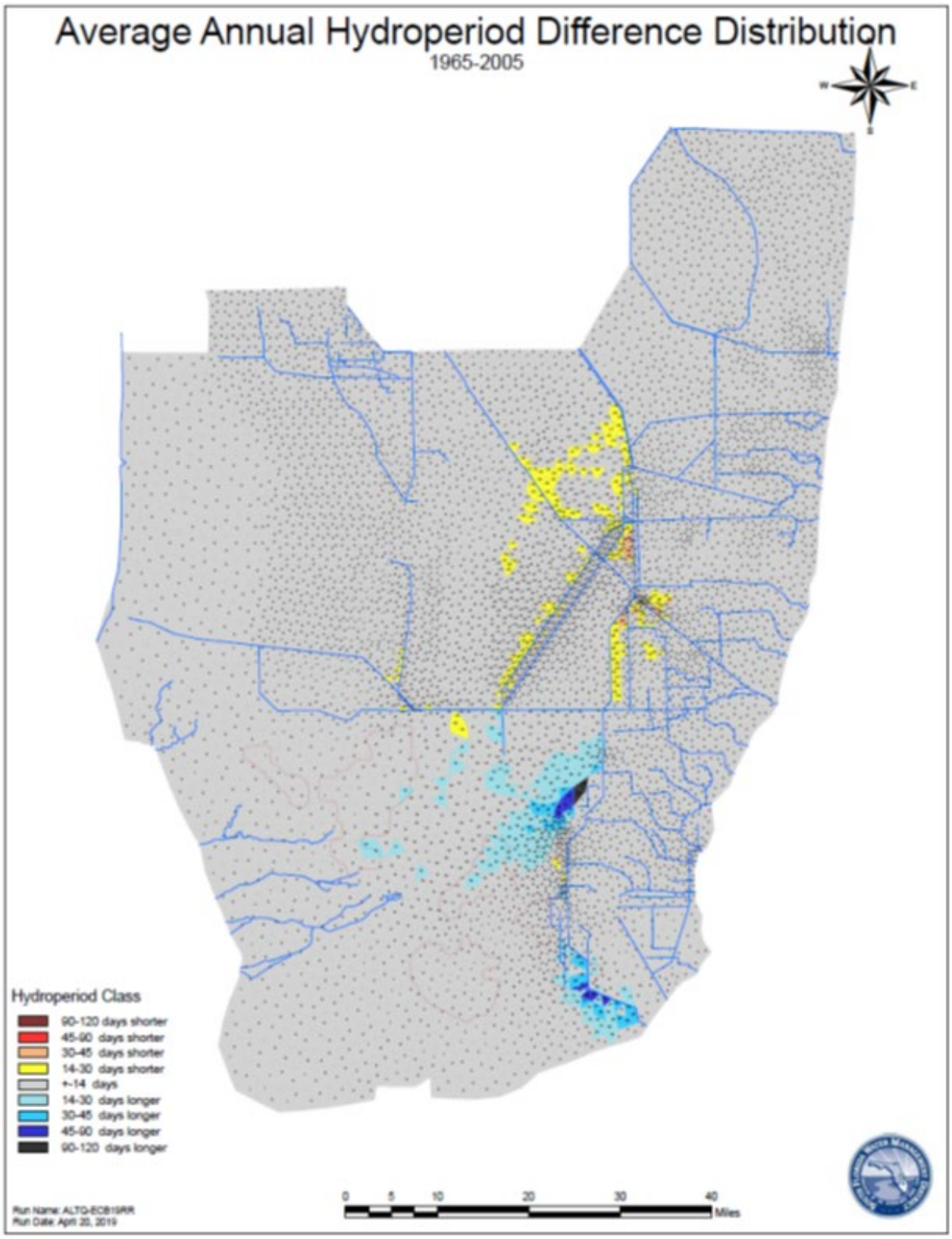


Figure D.2-7. Difference in average annual hydroperiods for ALTQ and ECB19RR.

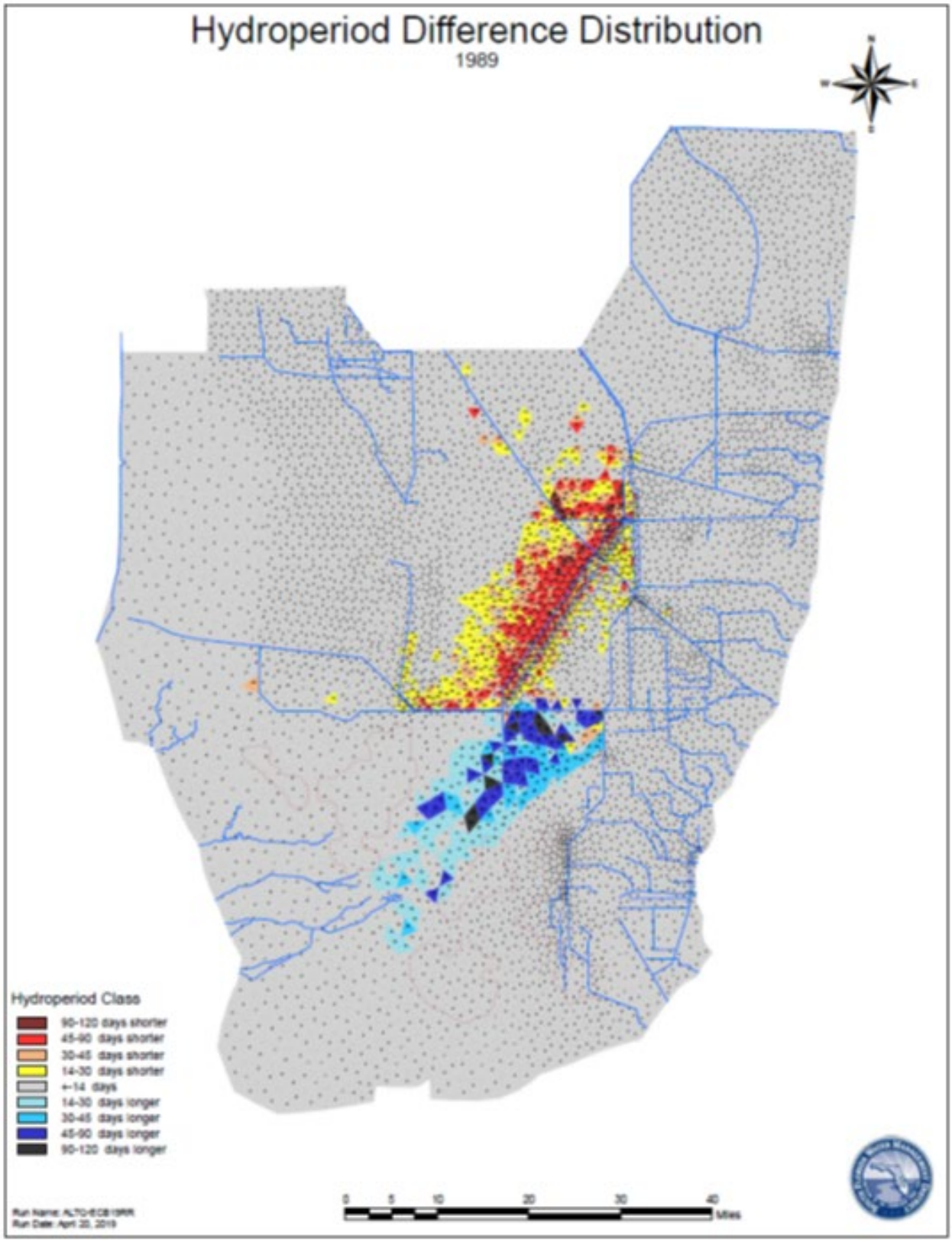


Figure D.2-8. Difference in 1989 (dry year) hydroperiods for ALTQ and ECB19RR.

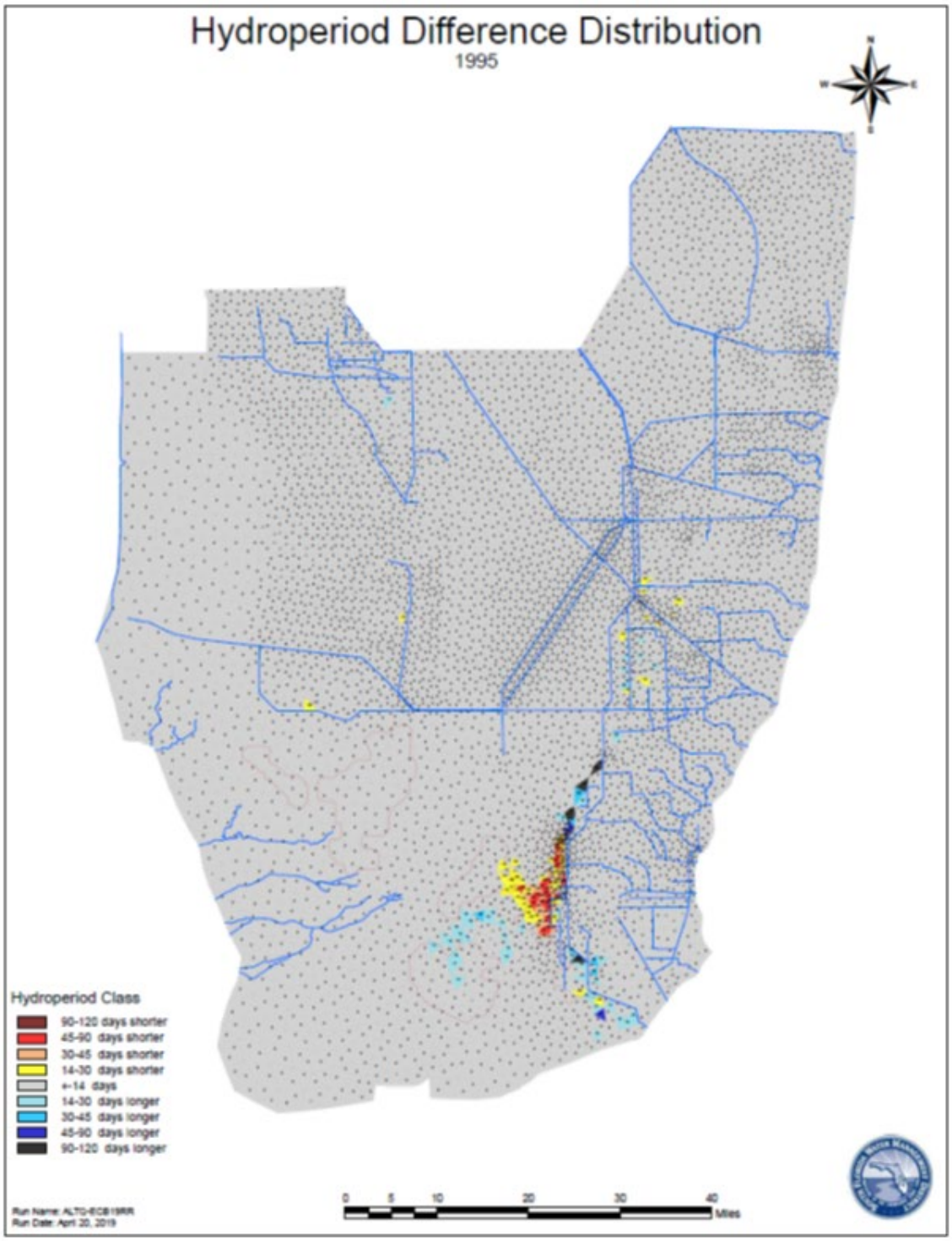


Figure D.2-9. Differences in 1995 (wet year) hydroperiods for ALTQ and ECB19RR.

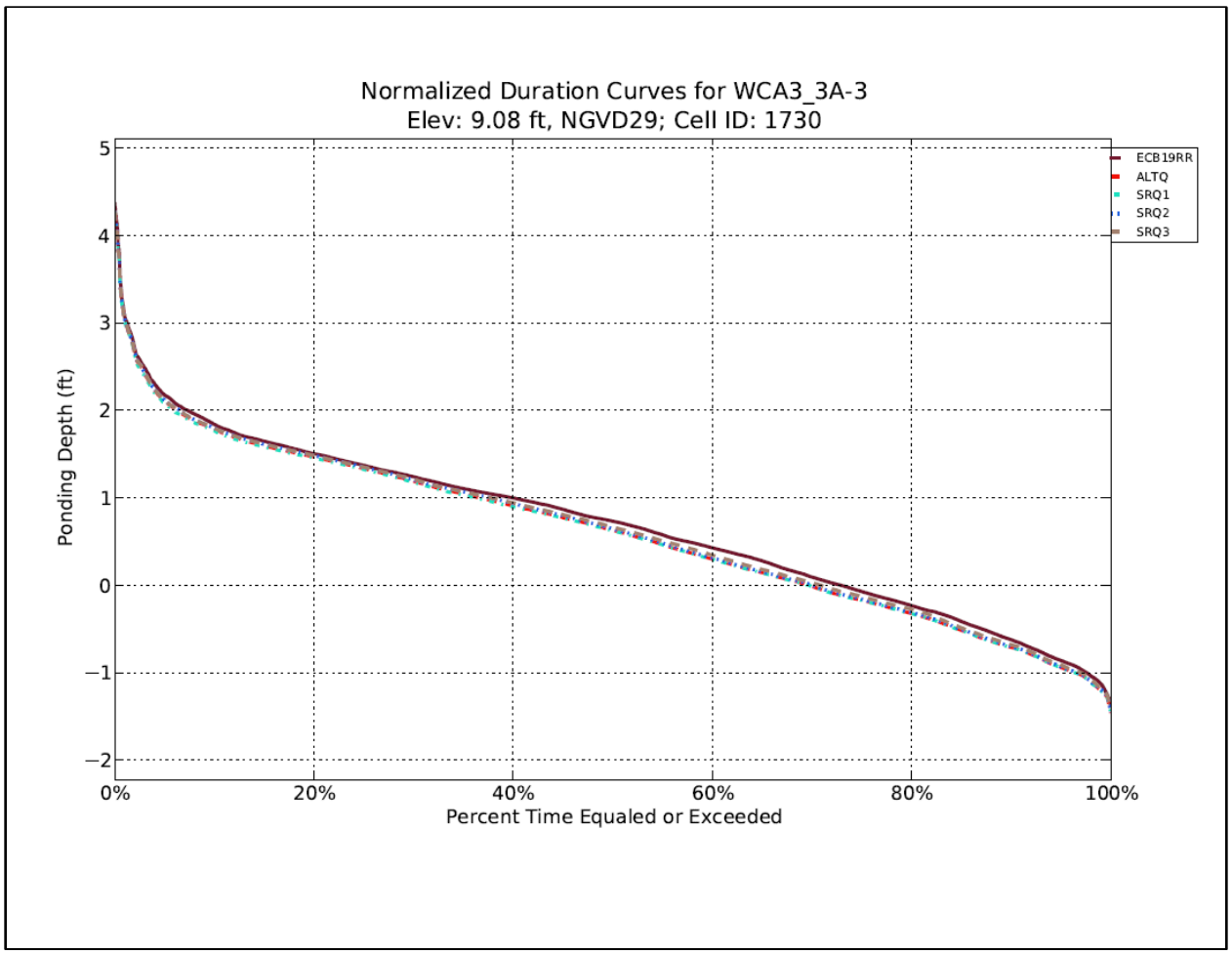


Figure D.2-10. Depth duration curves for gauge WCA_3A-3 (east-central WCA 3A).

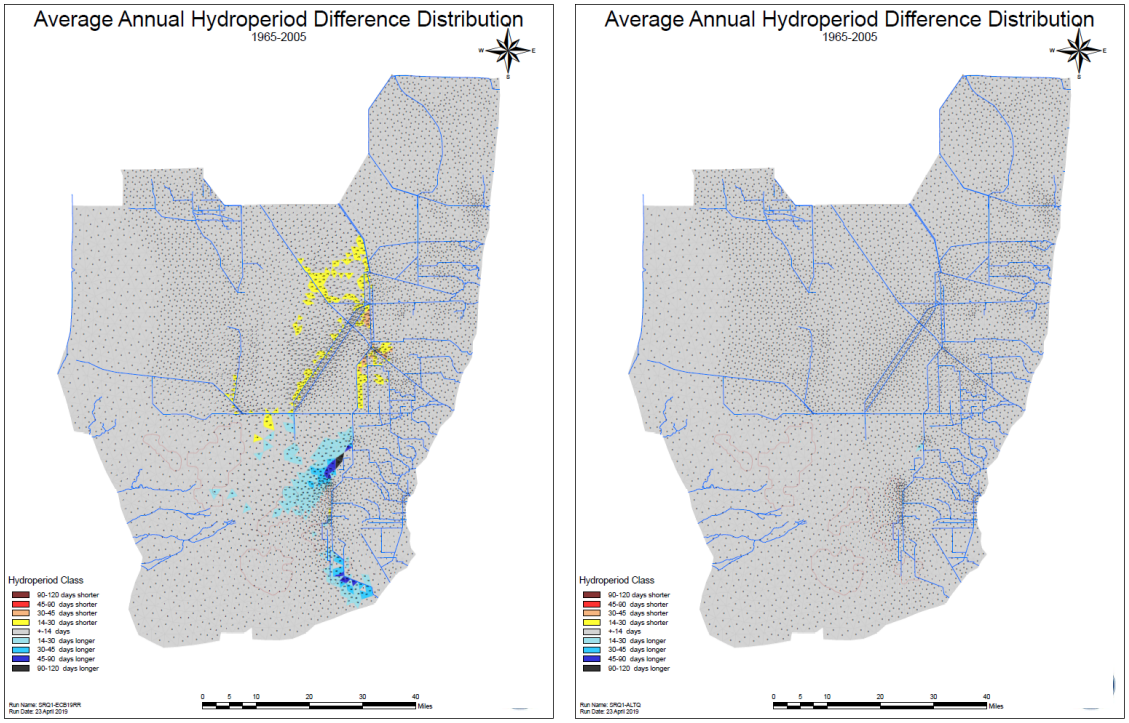


Figure D.2-11. Differences in average annual hydroperiods for SRQ1 with respect to (a) ECB19RR, and (b) ALTQ.

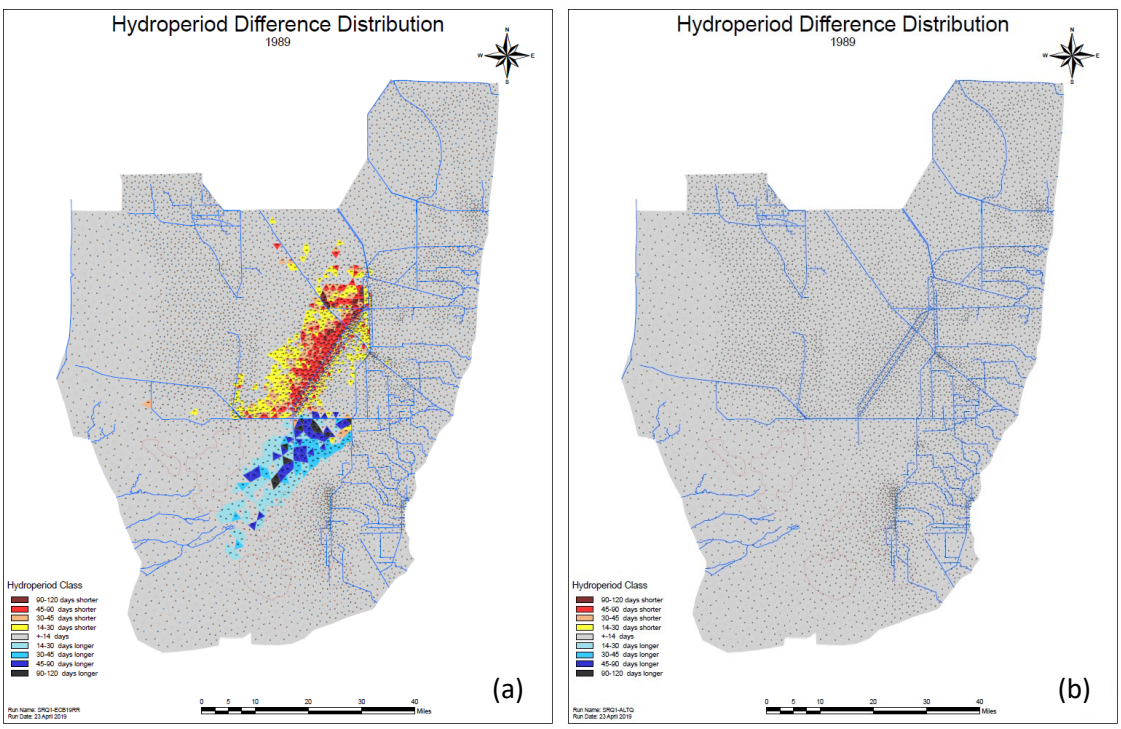


Figure D.2-12. Differences in 1989 (dry year) hydroperiods for SRQ1 with respect to (a) ECB19RR, and (b) ALTQ.

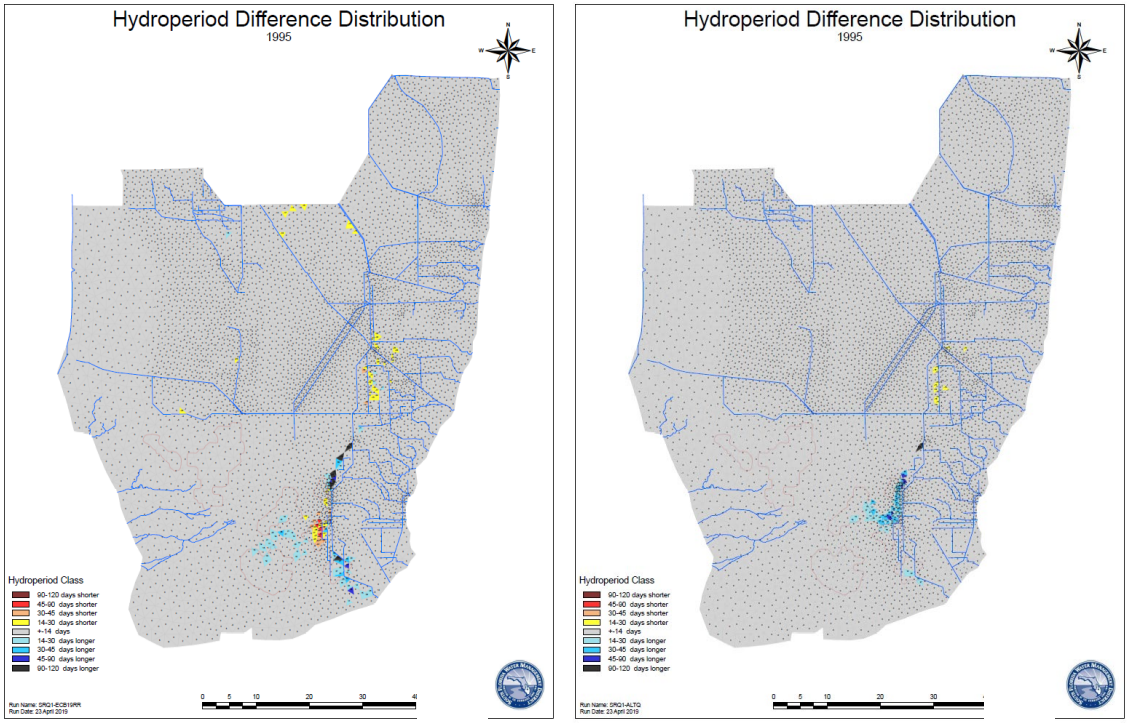


Figure D.2-13. Differences in 1995 (wet year) hydroperiods for SRQ1 with respect to (a) ECB19RR, and (b) ALTQ.

As the ponding depth duration comparison shown in **Figure D.2-14** indicates, a minor to moderate decrease in the stages is expected under ALTQ in comparison to ECB19RR conditions for central WCA 3A. The difference in 41-year average of simulated depths indicate less than 0.25 feet of decrease in long-term averages for central WCA 3A. The reduction in stages become more pronounced under drier conditions, with virtually unchanged stages under extremely wet conditions. As presented in **Figure D.2-8** and **Figure D.2-9**, considerably shorter hydroperiods in central WCA 3A are expected during extreme dry years, versus the similar hydroperiods during extreme wet years. Hydrologic conditions very similar to ALTQ are expected under ALTQ+ for central WCA 3A (**Figure D.2-11**, **Figure D.2-12**, and **Figure D.2-13**). Depth duration curves shown in **Figure D.2-14** indicate the similar depths are expected for the entire range of expected stages at Gauge WCA_3A-4 for ALTQ+.

The stages in southern WCA 3A are expected to be slightly to moderately lower under ALTQ than the ECB19RR conditions (**Figure D.2-15**). As the hydroperiod comparison maps provided in **Figure D.2-11**, **Figure D.2-12**, and **Figure D.2-13** indicate, hydrologic conditions in southern WCA 3A under ALTQ+ are expected to be very similar to ALTQ with no significant change. Depth duration curves shown in **Figure D.2-15** indicate the similar depths are expected for the entire range of expected stages at Gauge WCA_3A-28 for ALTQ+.

ALTQ+ includes removal of the seasonal closures at S-344 per the 2016 ERTP BO. S-344 may discharge, up to the design capacity of 135 cfs, from WCA 3A to BCNP when WCA 3A is in Zone A of the WCA 3A Regulation Schedule. The annual average volume through the S-344 structure was simulated to be 6,000 acre feet for the SRQ4 sensitivity run, versus 7,000 acre feet for ECB19RR. The difference in the simulated S-344 volumes is less than 1% of the total deliveries from WCA 3A. Therefore, no significant differences in ALTQ+ over that of ALTQ is expected for WCA 3A with respect to S-344.

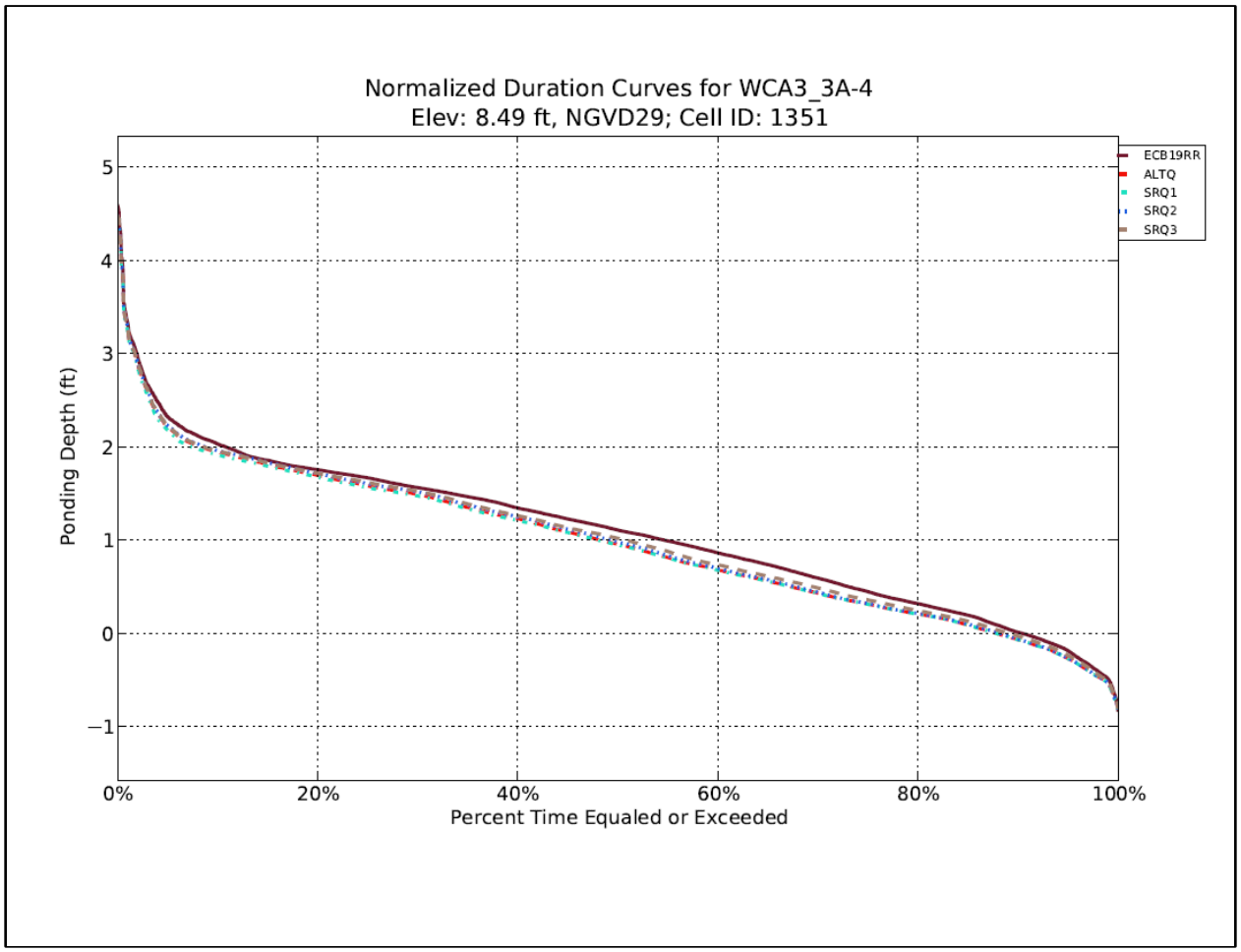


Figure D.2-14. Depth duration curves for gauge WCA_3A-4 (central WCA 3A).

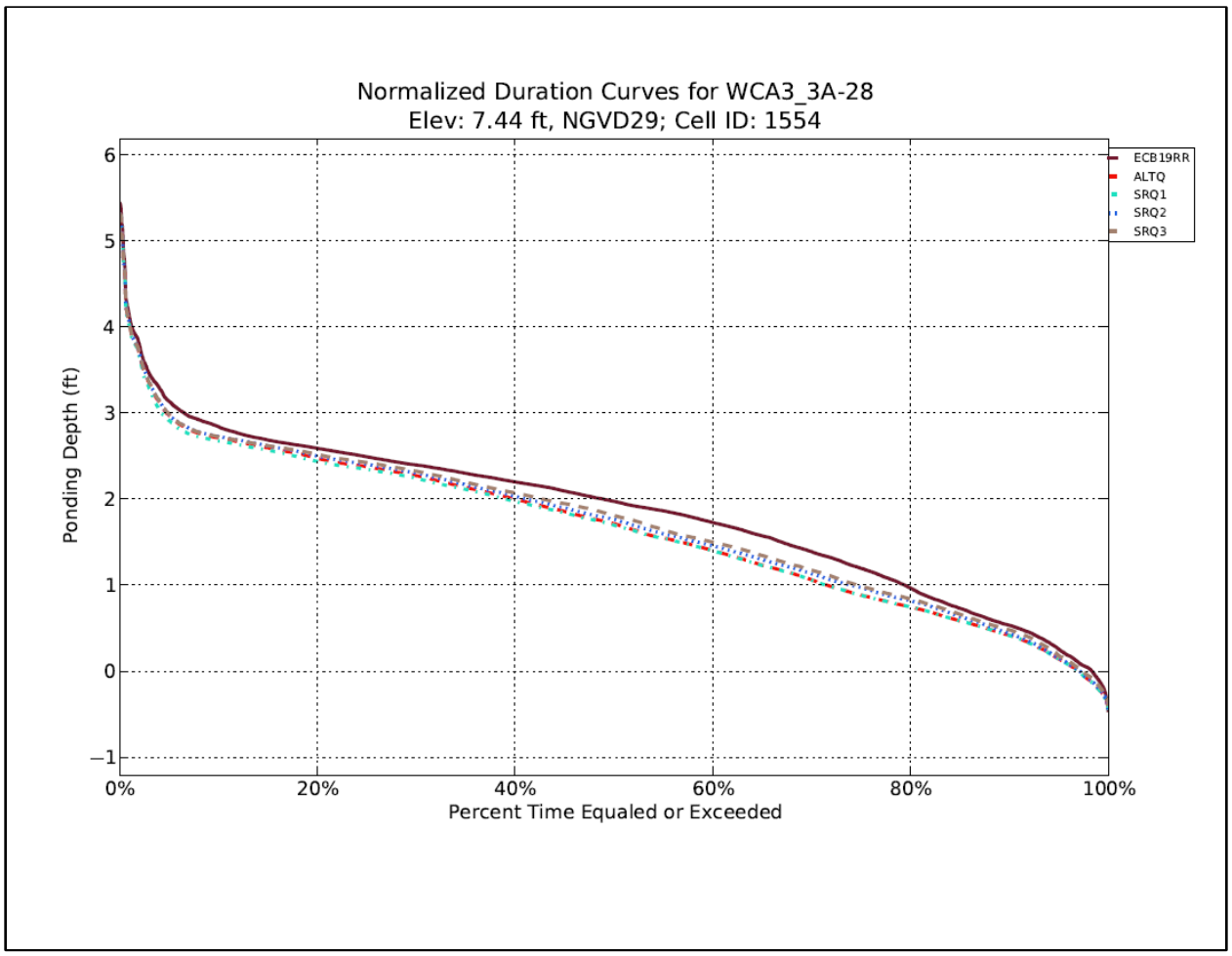


Figure D.2-15. Depth duration curves for gauge WCA_3A-28 (southern WCA 3A).

Reduction in stages are expected for WCA 3B under ALTQ relative to ECB19RR conditions. The comparison of hydroperiods for the Gauge WCA3_3B-71 as the representative of the hydrological conditions in the WCA 3B (**Figure D.2-16**) indicate minor to moderate reduction in ponding depths for this gauge. While minor to moderate adverse effect are expected in the southern and central WCA 3B, moderate adverse effects are expected in northern WCA 3B. As the hydroperiod comparison maps provided in **Figure D.2-11**, **Figure D.2-12**, and **Figure D.2-13** indicate, hydrologic conditions in WCA 3B under ALTQ+ are expected to be very similar to ALTQ with no significant change. Depth duration curves shown in **Figure D.2-16** indicate the similar depths are expected for the entire range of expected stages at Gauge WCA_3B-71 for ALTQ+.

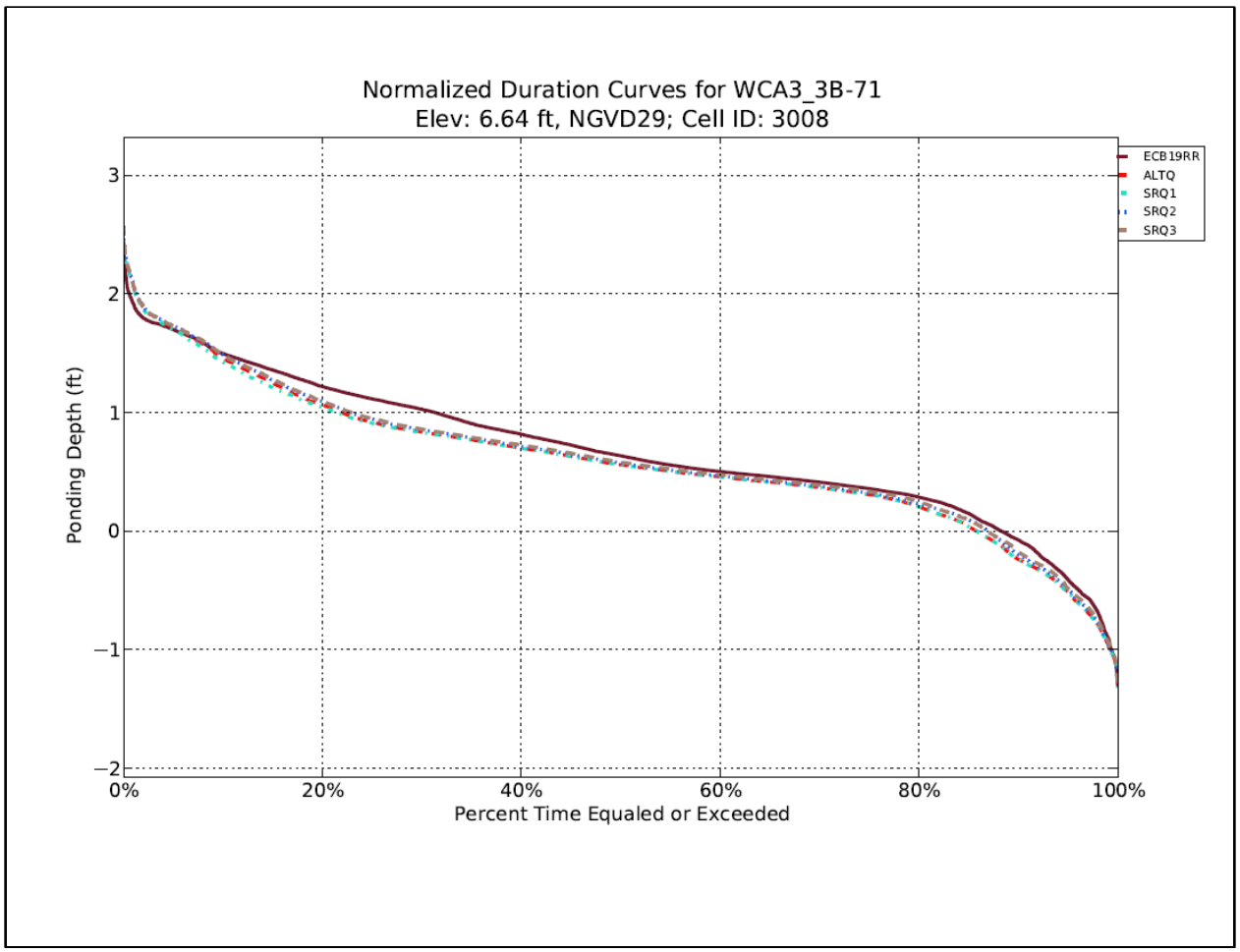


Figure D.2-16. Depth duration curves for gauge WCA_3B-71 (WCA3B)

D.2.4.2.2 ENP

A table comparing the deliveries to ENP under ALTQ and ECB19RR conditions is provided **Table D.2-3**. The summation of average monthly discharges for the S-12s, S-333, and S-333N was used to estimate the deliveries to the ENP from WCA 3A. Total deliveries to ENP additionally accounts for S-356 flows and discounts S-334 flows to estimate the total volumes delivered to ENP. As seen in the table, a year-round improvement in deliveries to ENP is expected for ALTQ over ECB19RR. The hydrologic conditions in the greater ENP under ALTQ+ is expected to be similar to what is simulated for ALTQ.

Table D.2-3. Mean Monthly total deliveries and deliveries from WCA 3A to ENP for ALTQ/ALTQ+ and ECB19RR.

Month	Deliveries to ENP - ALTQ	Deliveries to ENP from WCA 3A - ALTQ	Deliveries to ENP - ECB19RR	Deliveries to ENP from WCA 3A - ECB19RR
	acre-feet	acre-feet	acre-feet	acre-feet
Jan	3,033	2,517	1,925	1,518
Feb	2,541	2,132	1,666	1,295

Month	Deliveries to ENP - ALTQ	Deliveries to ENP from WCA 3A - ALTQ	Deliveries to ENP - ECB19RR	Deliveries to ENP from WCA 3A - ECB19RR
Mar	2,176	1,869	1,587	1,275
Apr	1,781	1,550	1,319	1,106
May	1,443	1,225	1,118	888
Jun	1,690	1,350	1,471	1,171
Jul	2,651	2,260	2,452	2,162
Aug	3,219	2,669	2,946	2,620
Sep	3,362	2,755	3,172	2,802
Oct	4,090	3,389	3,869	3,476
Nov	4,267	3,572	3,340	2,920
Dec	3,583	2,959	2,179	1,706

The main reason for the observed differences in modeled ALTQ and ECB19RR deliveries to ENP from WCA 3A is the implementation of the TTFF. To compare the effects of simulation scenarios on the monthly deliveries, a cyclic analysis of the total monthly deliveries for the 41-year simulation period was conducted. The results of the analysis corresponding to 10%, 50%, and 90% percentiles are provided in **Figure D.2-17**, **Figure D.2-18**, and **Figure D.2-19**, respectively. The figures indicate that the more pronounced improvements in the deliveries to ENP is expected under dry conditions. For all three presented exceedance percentiles, the dry season months experience higher increases in deliveries under ALTQ, with more drastic improvement for 10% percentile representing extreme dry conditions (**Figure D.2-17**).

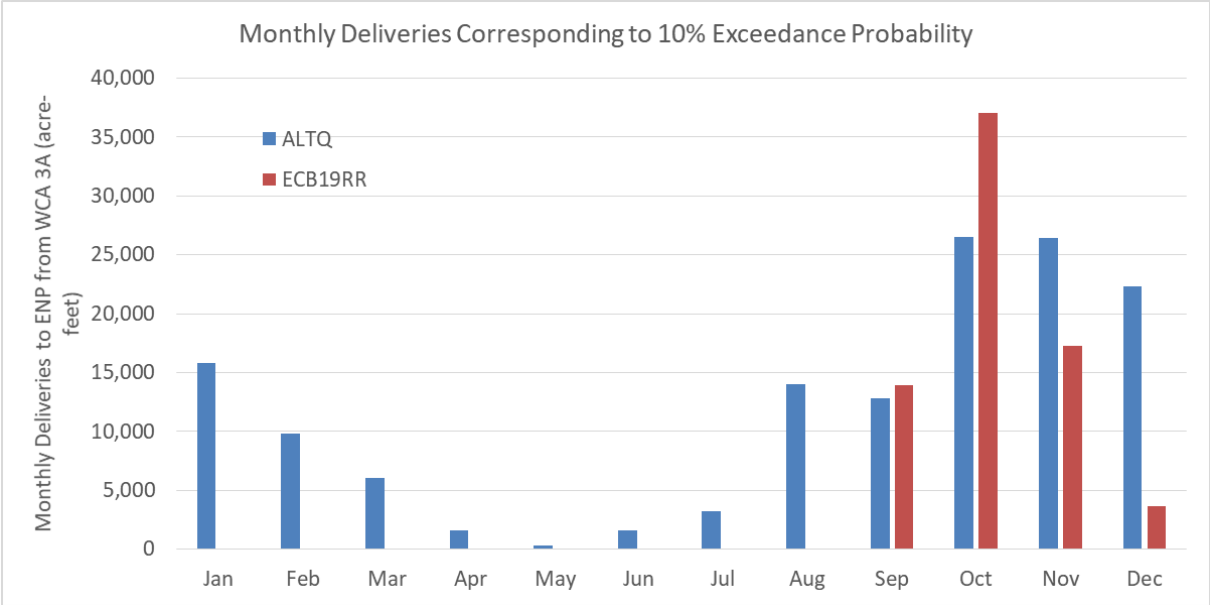


Figure D.2-17. Monthly deliveries to the ENP from WCA 3A corresponding to 10% exceedance probability percentile.

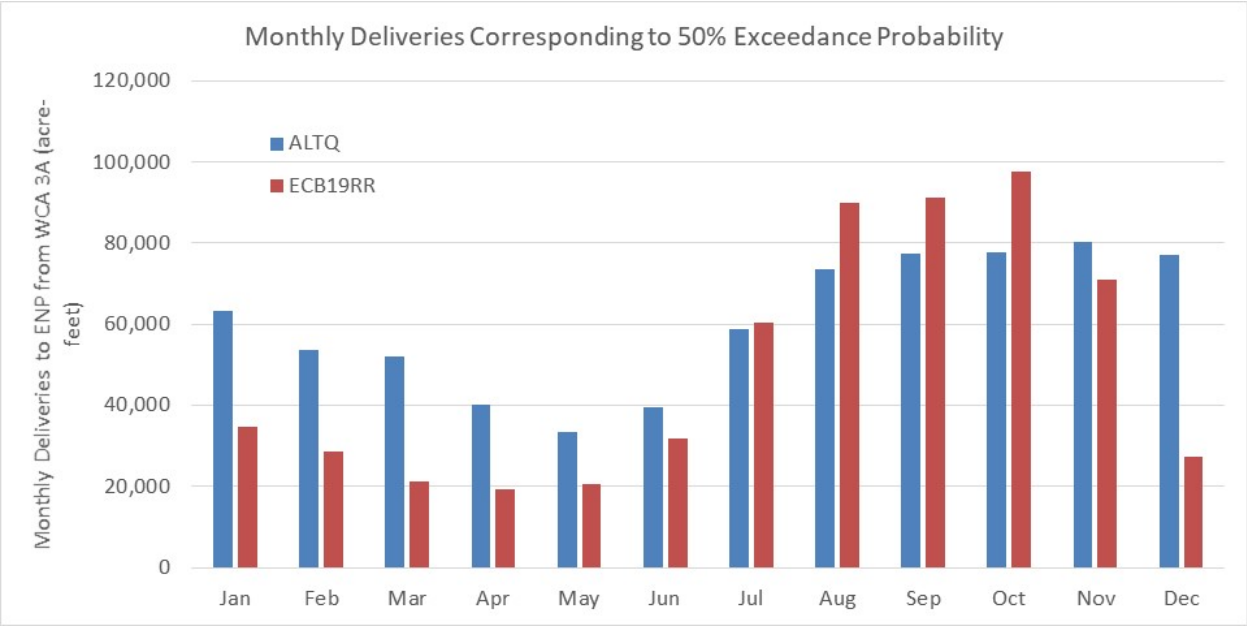


Figure D.2-18. Monthly deliveries to the ENP from WCA 3A corresponding to 50% exceedance probability percentile.

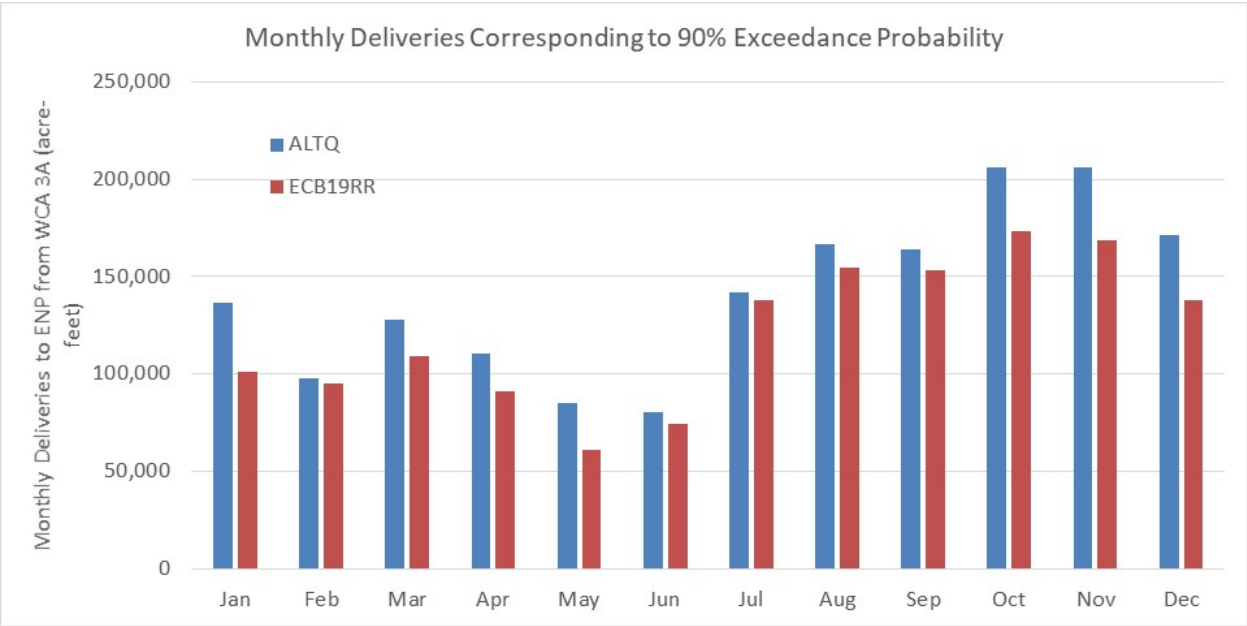


Figure D.2-19. Monthly deliveries to the ENP from WCA 3A corresponding to 90% exceedance probability percentile.

The removal of the L-29 Canal FDOT constraint (SRQ1) results in an average annual flow volume increase into the L-29 Canal of approximately 50,000 acre feet, approximately a 7% increase. Total inflows to NESRS (Transect 18) were increased by 43,000 acre feet, with approximately two-thirds of this increase occurring during the wet season months of June to October. The TTFF limits the additional increased flows from WCA 3A to ENP based on a system-wide balance given consideration of hydrologic stage conditions in both areas, and no significant changes to hydroperiods or depths within ENP were observed with the SRQ1 simulation.

D.2.4.2.2.1 Western Shark River Slough

The average stage differences for the 41-year simulation period indicated that the long term stage average for western SRS under ALTQ will slightly decrease relative to ECB19RR conditions based on gauges at Gauges ENP_NP-34, ENP_NP-201, and ENP_NP-205 (**Figure D.2-20, Figure D.2-21,** and **Figure D.2-22**). The comparison of simulated hydroperiods at ENP_NP-201 gauge indicated a moderate increase for dry conditions, and a moderate decrease in ponding depths for moderately wet conditions **Figure D.2-8** and **Figure D.2-9**. As the hydroperiod comparison maps provided in **Figure D.2-11**, **Figure D.2-12**, and **Figure D.2-13** indicate, hydrologic conditions in western SRS under ALTQ+ are expected to be very similar to ALTQ with no significant change. Depth duration curves shown in **Figure D.2-20**, **Figure D.2-21**, and **Figure D.2-22** indicate that similar depths are expected for the entire range of expected stages at Gauges ENP_NP-34, ENP_NP-201, and ENP_NP-205 for ALTQ+.

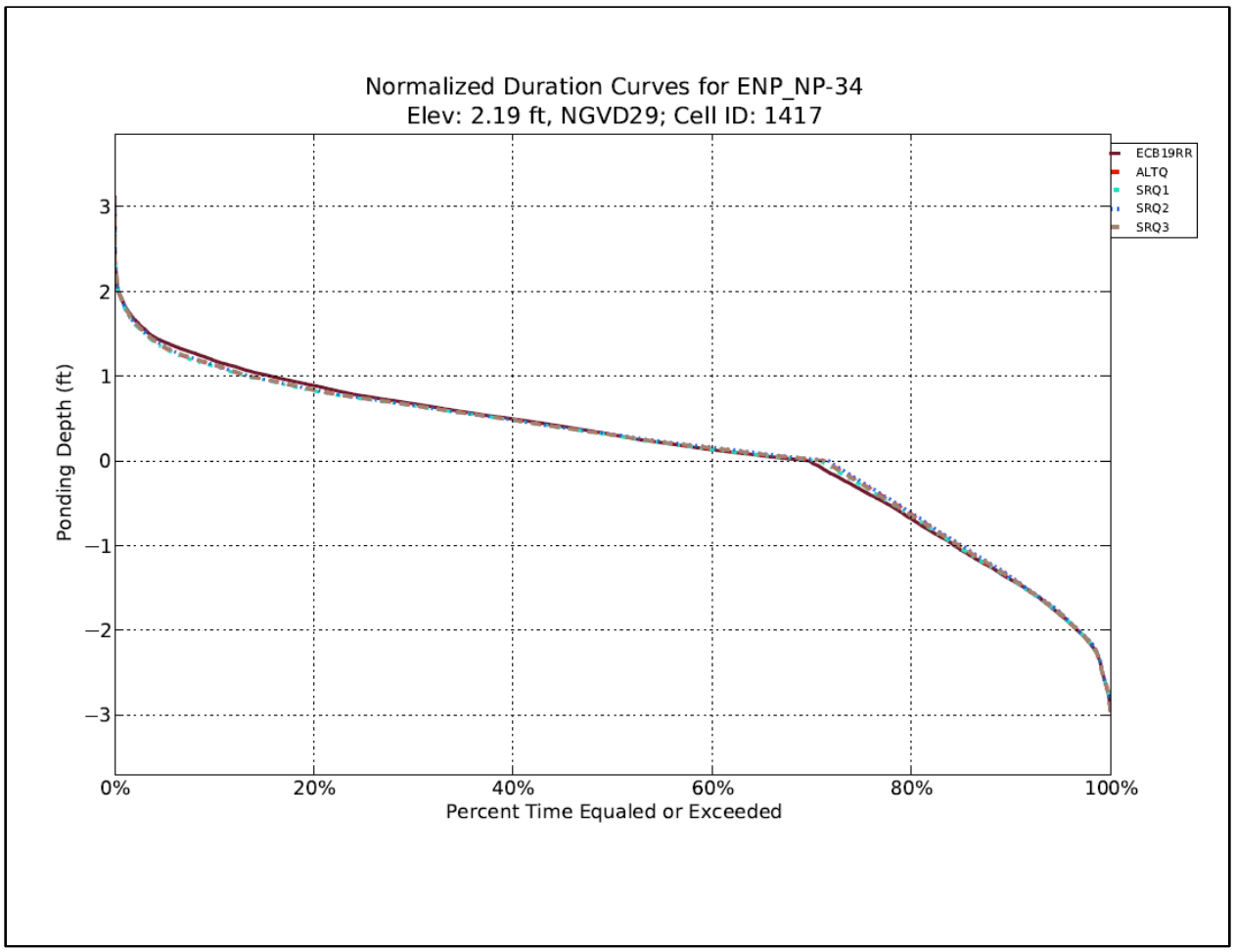


Figure D.2-20. Depth duration curves for gauge ENP_NP-34 (Western Shark River Slough)

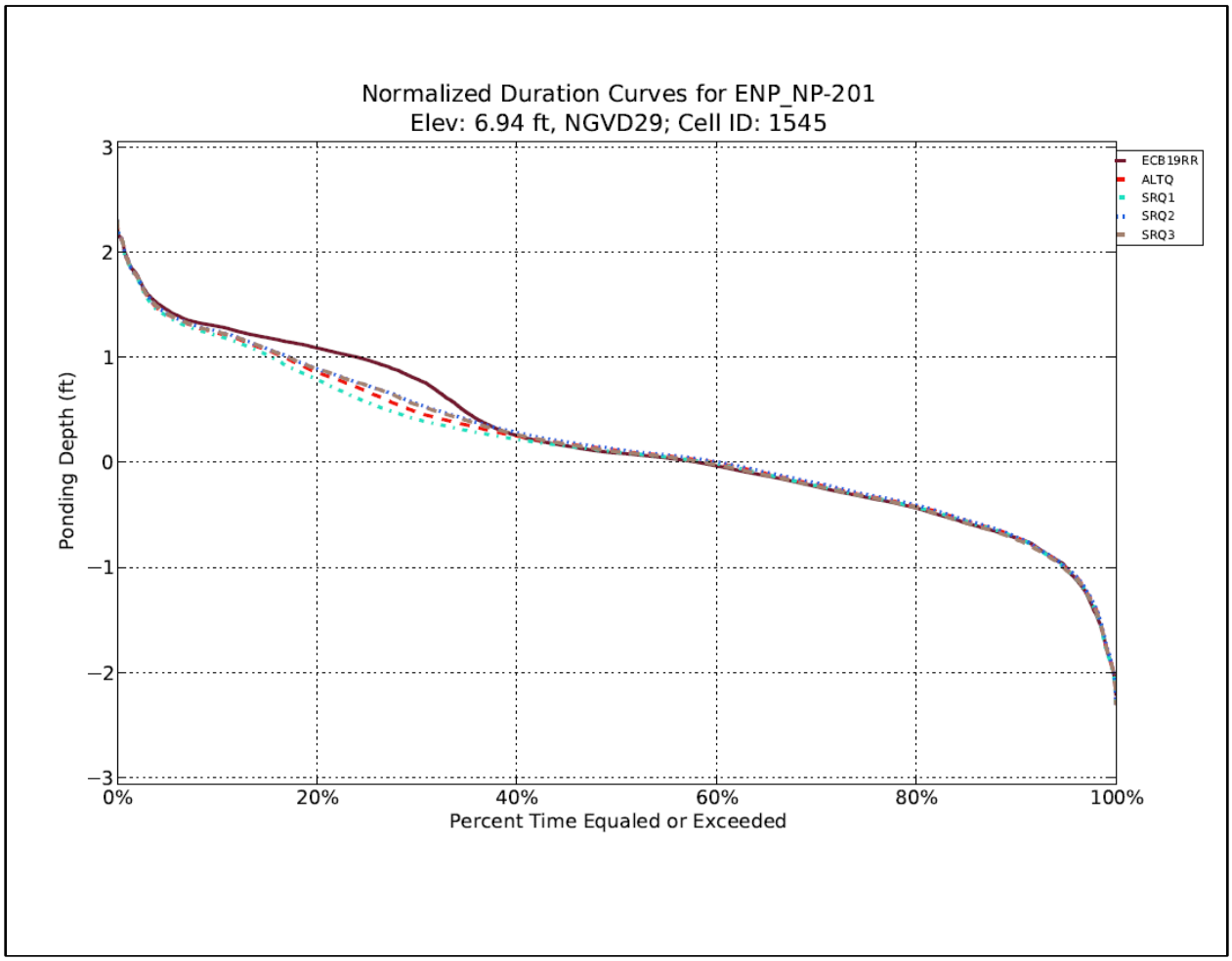


Figure D.2-21. Depth duration curves for Gauge ENP_NP-201 (Western SRS)

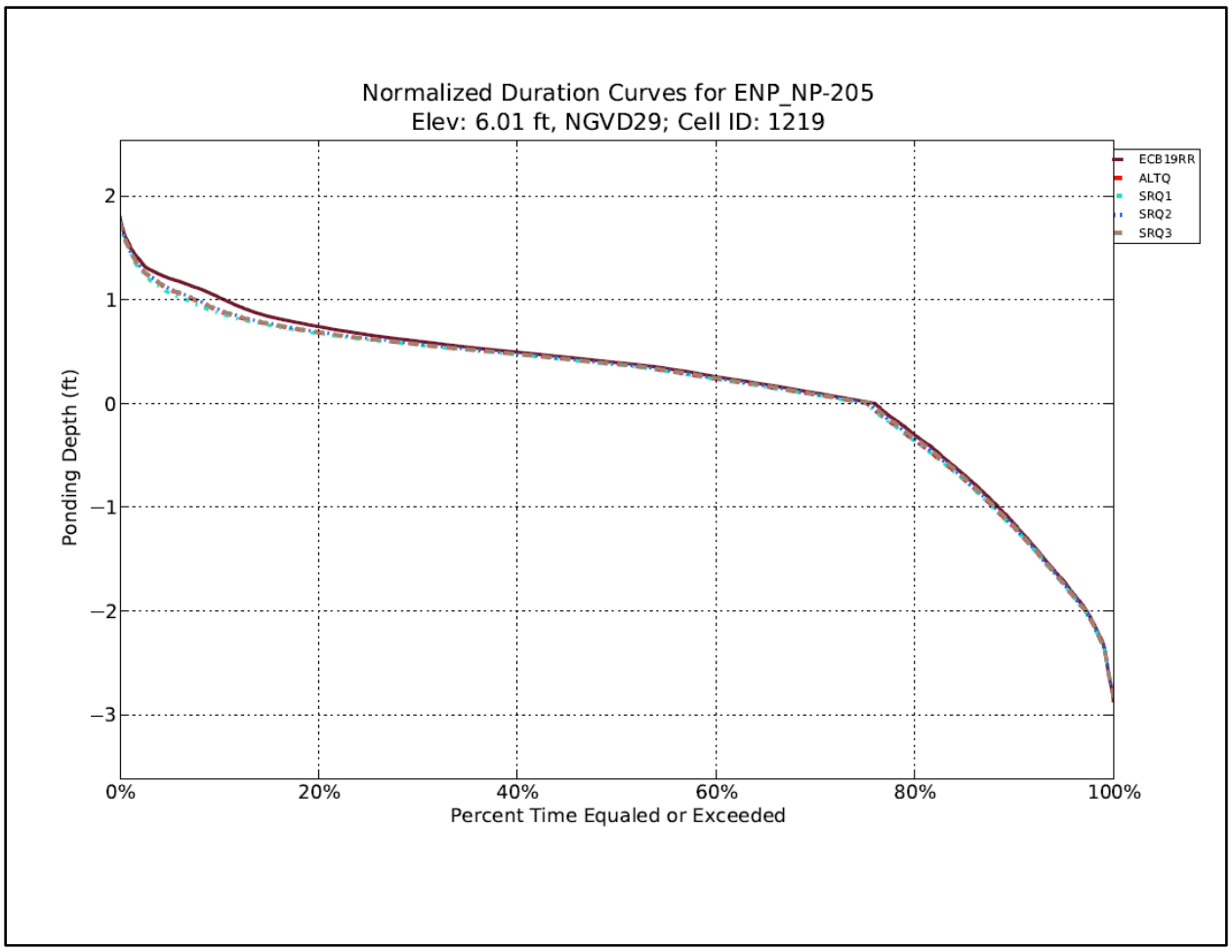


Figure D.2-22. Depth duration curves for Gauge ENP_NP-205 (Western SRS)

D.2.4.2.2.2 Northeast Shark River Slough

The average stage differences for the 41-year simulation period indicated a moderate to major increases in NESRS under ALTQ relative to ECB19RR conditions (**Figure D.2-23**). As shown in the duration curves for the Gauge ENP_G3273 (**Figure D.2-24**) and NESRS1 (**Figure D.2-25**), higher stages are expected for all stage levels. As the hydroperiod comparison maps provided in **Figure D.2-11**, **Figure D.2-12**, and **Figure D.2-13** indicate, hydrologic conditions in NESRS under ALTQ+ is expected to be very similar to ALTQ with no significant change. Depth duration curves shown in **Figure D.2-24**, and **Figure D.2-25** indicate that similar depths are expected for the entire range of expected stages at Gauges 3273 and ENP_NESRS1 for ALTQ+.

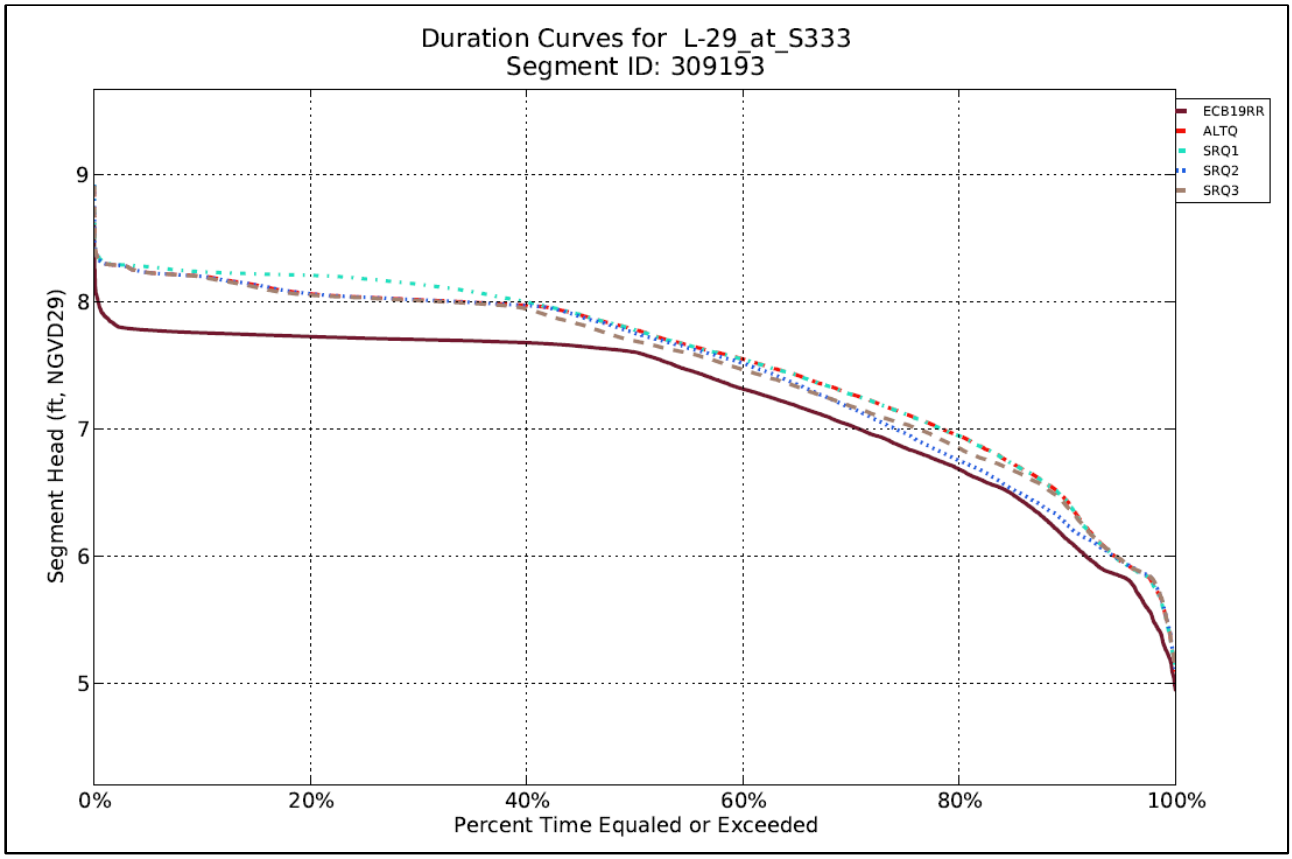


Figure D.2-23. Canal stage duration curves for L-29 Canal at -S333.

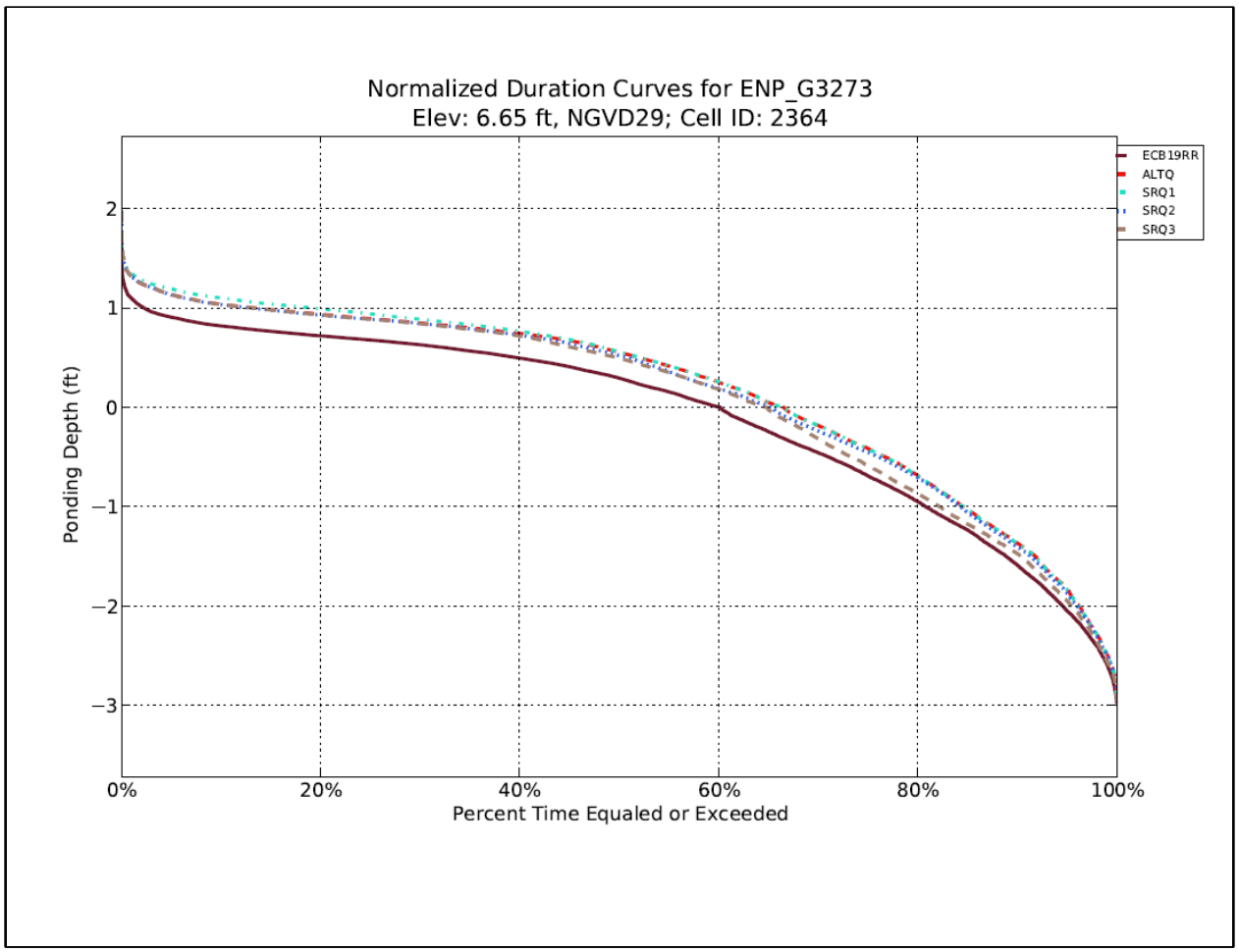


Figure D.2-24. Depth duration curves for Gauge G-3273 (NESRS).

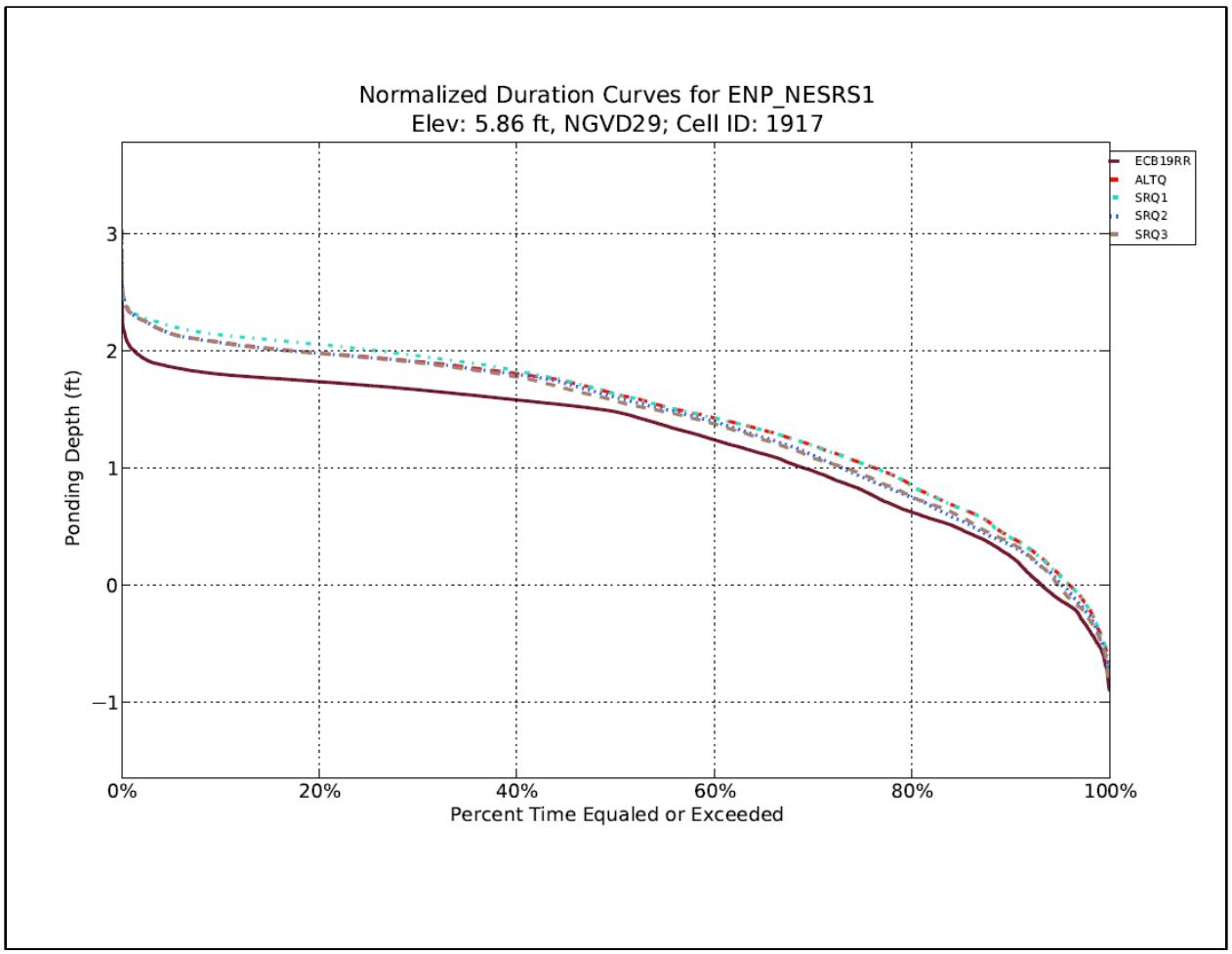


Figure D.2-25. Depth duration curves for Gauge ENP_NESRS1 (NESRS)

D.2.4.2.2.3 Taylor Slough

The average stage differences for the 41-year simulation period indicate a slight improvement in the hydrologic conditions of the Taylor Slough under ALTQ relative to ECB19RR conditions as simulated at Gauge ENP_NP-TSB (**Figure D.2-26**). Hydrologic conditions very similar to ALTQ with minor improvement are expected under ALTQ+. The main difference between ALTQ and ALTQ+, expected to effect the Taylor Slough, is the removal of seasonal pumping capacity restriction for S-332D during the month of December. The removal of restrictions for the month of December was not explicitly modeled. However, the results for SRQ4, which included removal of seasonal restrictions for S-332D, indicated average December flow rates of 217.7 cubic feet per second (cfs), which is approximately 10% higher than the simulated average December flow rates for ALTQ (197.8 cfs). The average monthly flow rate through S-332D is 132.4 cfs for ECB19RR. Therefore, the hydrologic conditions in Taylor Slough under ALTQ+ is expected to experience a slight improvement relative to ECB19RR conditions.

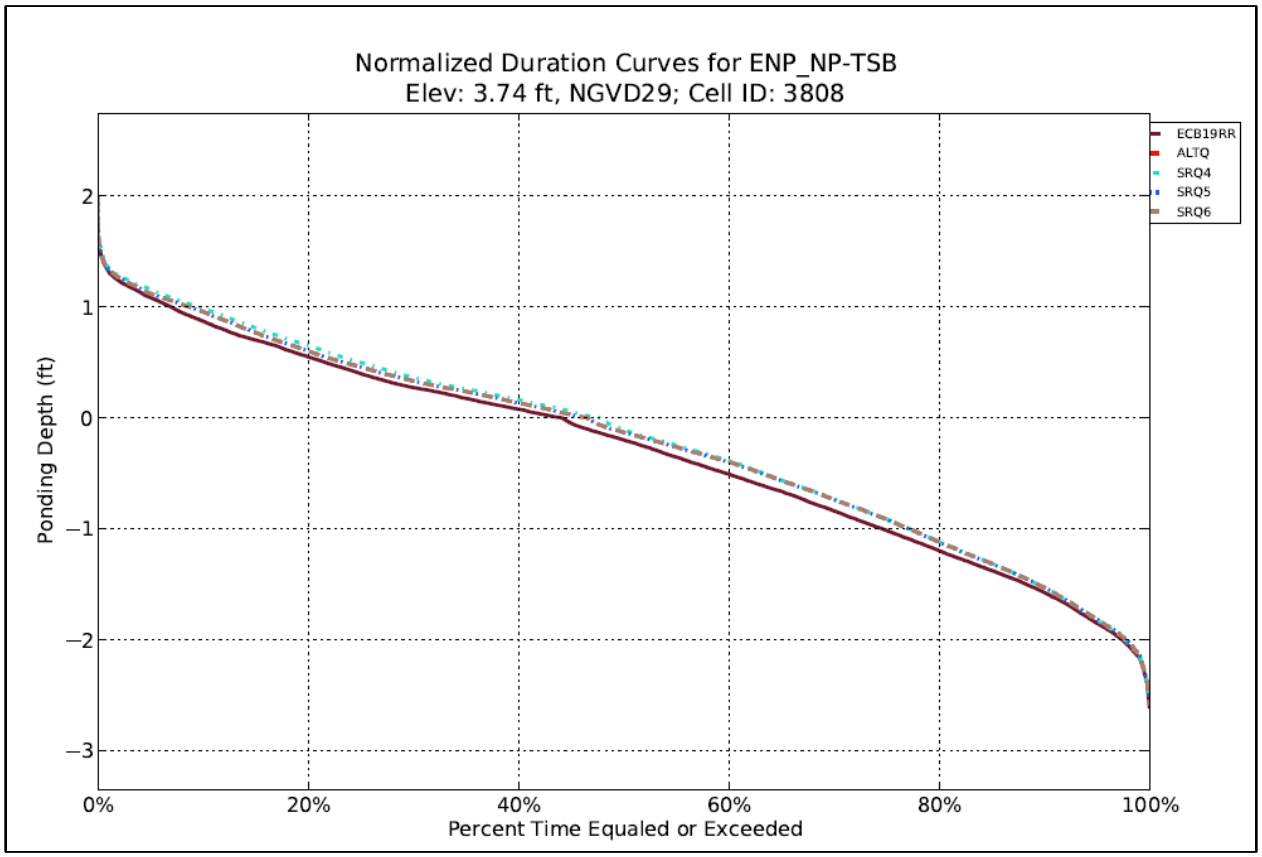


Figure D.2-26. Depth duration curves for Gauge ENP_NP-TSB (Taylor Slough).

D.2.5 Description of Existing Conditions, Listed Species and Designated Critical Habitat

The following provides a description of existing conditions and listed species, including their critical habitat within the study area.

D.2.5.1 Affected Environment

The COP is an integrated operational plan for two modifications of the C&SF project known as MWD to ENP and the C-111 South Dade Projects. The purpose of COP is to define the water management operations for the WCA 3A and WCA 3B outlets, structures in the L-31N and the C-111 basins constructed as part of the C&SF Project and the recently constructed components of the MWD and C-111 South Dade Projects. The 2019 COP Draft EIS provides a full description of the affected environment within the action area and is incorporated by reference into this document. The information will be available for review at http://www.saj.usace.army.mil/About/Divisions-Offices/Planning/Environmental-Branch/Environmental-Documents/ and is hereby incorporated by reference.

D.2.5.1.1 Vegetative Communities

The Everglades landscape is dominated by a complex of freshwater wetland communities that includes open water sloughs and marshes, dense grass- and sedge-dominated marshes, forested islands, and wet marl prairies. The primary factors influencing the distribution of dominant freshwater wetland plant

species of the Everglades are soil type, soil depth, and hydrological regime (USFWS 1999). These communities generally occur along a hydrological gradient with the slough/open water marsh communities occupying the wettest areas (flooded more than nine months per year), followed by sawgrass marshes (flooded six to nine months per year), and wet marl prairie communities (flooded less than six months per year) (USFWS 1999). The freshwater wetlands of the Everglades eventually grade into inter-tidal mangrove wetlands and subtidal seagrass beds in the estuarine waters of Florida Bay.

Development and drainage over the last century have dramatically reduced the overall spatial extent of freshwater wetlands within the Everglades, with approximately half of the pre-drainage 1.2 million hectares of wetlands being converted for development and agriculture (Davis and Ogden 1997). Alteration of the normal flow of freshwater through the Everglades has also contributed to conversions between community types, invasion by exotic species, and a general loss of community diversity and heterogeneity. Vegetative trends in ENP have included a substantial shift from the longer hydroperiod slough/open water marsh communities to shorter hydroperiod sawgrass marshes (Davis and Ogden 1997; Armentano et al. 2006). In addition, invasion of sawgrass marshes and wet prairies by exotic woody species has led to the conversion of some marsh communities to forested wetlands (Gunderson et. al. 1997).

Vegetative communities of the WCAs have suffered from both over drainage and prolonged periods of inundation associated with the stabilization of water levels (USACE 1999). Many areas of WCA 3A still contain relatively good wetland habitat consisting of a complex of tree islands, sawgrass marshes, wet prairies, and aquatic sloughs. Water lilies (*Nymphaea alba*) were originally widespread in sloughs throughout many areas of WCA 3A (McVoy et al. 2011). Reduced freshwater inflow and drainage by the Miami Canal have overdrained the northern portion of WCA 3A, resulting in increased fire frequency and the associated loss of tree islands, wet prairie and aquatic slough habitat. Northern WCA 3A is currently dominated largely by mono-specific sawgrass stands with large areas of shrubs and monotypic cattail. In addition, northern WCA 3A lacks the diversity of communities that exists in southern WCA 3A. In southern WCA 3A, Wood and Tanner (1990) documented the trend toward deep water lily dominated sloughs due to impoundment. In approximately 1991, the hydrology of southern WCA 3A shifted to the deeper water and extended hydroperiods of the new, wet hydrologic era resulting in a northward shift in slough vegetation communities within the WCA 3A impoundment (Zweig and Kitchens 2008). Typical Everglades vegetation, including tree islands, wet prairies, sawgrass marshes and aquatic sloughs also occur throughout WCA 3B. However, within WCA 3B, the ridge and slough landscape has been severely degraded by the virtual elimination of overland sheetflow due to the L-67 canal and levee system. WCA 3B experiences very little overland flow and has become primarily a rain-fed system predominated by shorter hydroperiod sawgrass marshes with relatively few sloughs or tree islands remaining. Water levels in WCA 3B are also too low and do not vary seasonally, contributing to poor ridge and slough patterning. Loss of sheetflow to WCA 3B has also accelerated soil loss reducing elevations of the remaining tree islands in WCA-3B and making them vulnerable to high water stages. The Decomp Physical Model (DPM) was installed in 2012 to provide flows across the L-67 from WCA 3A to 3B and answer key questions about the best plan and design to recreate sheetflow to restore the ridge and slough and tree island landscape in this area. The volume of water passed through the DPM test has been limited to date, as the operations are restricted to provide meaningful science inform CERP implementation and are limited due to water quality and downstream constraints.

Vegetative trends in ENP have included a substantial shift from the longer hydroperiod slough/open water marsh communities to shorter hydroperiod sawgrass marshes (Davis and Ogden 1997, Armentano et al. 2006). Flows through Shark River Slough under current system compartmentalization and water

management practices are greatly reduced when compared with pre-drainage conditions. The result has been lower wet season depths and more frequent and severe dry downs in sloughs and reduction in extent of shallow water edges (McVoy et al. 2011). Over-drainage in the peripheral wetlands along the eastern flank of (NESRS) has resulted in shifts in community composition, invasion by exotic woody species and increased susceptibility to fire. Areas within the eastern marl prairies along the boundary of ENP suffer from over-drainage, reduced water flow, exotic tree invasion and frequent human-induced fires (Lockwood et al. 2003; Ross et al. 2006). In addition, invasion of saw-grass marshes and wet prairies by exotic woody species has led to the conversion of some marsh communities to forested wetlands (Gunderson et. al. 1997).

In contrast to the vast extent of wetland communities, upland communities comprise a relatively small component of the Everglades landscape and are largely restricted to Long Pine Key, the northern shores of Florida Bay, and the many tree islands scattered throughout the region. Vegetative communities of Long Pine Key include rockland pine forest and tropical hardwood forest. In addition, substantial areas of tropical hardwood hammock occur along the northern shores of Florida Bay and on elevated portions of some forested islands.

The estuarine communities of Florida Bay have also been affected by upstream changes in freshwater flows through the Everglades. A reduction in freshwater inflows into Florida Bay and alterations of the normal salinity balance have affected mangrove community composition and may have contributed to a large-scale die-off of seagrass beds (USFWS 1999).

D.2.5.1.1.1 Slough/Open Water Marsh

The slough/open water marsh community occurs in the lowest, wettest areas of the Ever-glades. This community is a complex of open water marshes containing emergent, floating aquatic, and submerged aquatic vegetation components. The emergent marsh vegetation is typically dominated by spikerushes (*Eleocharis cellulosa* and E. *elongata*), beakrushes (*Rhynchospora tracyi* and *R. inundata*), and maidencane (*Panicum hemitomon*). Common floating aquatic dominants include fragrant water lily (*Nymphaea odorata*), floating hearts (*Nymphoides aquatica*), and spatterdock (*Nuphar lutea*); and the submerged aquatic community is typically dominated by bladderwort (*Utricularia foliosa*) and periphyton. As shown by Davis et al. (1997), vegetative trends in the ENP have included the conversion of slough/open water marsh communities to shorter hydroperiod sawgrass marshes.

D.2.5.1.1.2 Sawgrass Marsh

Sawgrass marshes are dominated by dense to sparse stands of *Cladium jamaicense*. Sawgrass marshes occurring on deep organic soils (more than one meter) form tall, dense, nearly monospecific stands. Sawgrass marshes occurring on shallow organic soils (less than one meter) form sparse, short stands that contain additional herbaceous species such as spikerush, water hyssop (*Bacopa caroliniana*), and marsh mermaid weed (*Proserpinaca palustris*) (Gunderson et al. 1997). The adaptations of sawgrass to flooding, burning, and oligotrophic conditions contribute to its dominance of the Everglades vegetation. Sawgrass-dominated marshes once covered an estimated 300,000 acres of the Everglades. Approximately 70,000 acres of tall, monospecific sawgrass marshes have been converted to agriculture in the EAA. Urban encroachment from the east and development within other portions of the Everglades has consumed an additional 79,000 acres of sawgrass-dominated communities (Davis and Ogden 1997).

D.2.5.1.1.3 Wet Marl Prairie

Wet marl prairies occur on marl soils and exposed limestone and experience the shortest hydroperiods of the slough/marsh/prairie wetland complex. Marl prairie is a sparsely vegetated community that is typically dominated by muhly grass (*Muhlenbergia capillaris*) and short-stature sawgrass. Additional important constituents include black sedge (*Schoenus nigricans*), arrowfeather (*Aristida purpurascens*), Florida little bluestem (*Schizachyrium rhizomatum*), and Elliot's lovegrass (*Eragrostis elliottii*). Marl prairie is found on marl substrates. Marls are fine, white, calcareous muds formed from calcite precipitated by a mixture of green algae, bole green algae, and diatoms, known as periphyton. Periphyton mats that grow loosely attached to the vegetation and exposed limestone are an important component of this community. Marl prairies occur in the southern Everglades along the eastern and western periphery of SRS. Approximately 146,000 acres of the eastern marl prairie have been lost to urban and agricultural encroachment (Davis and Ogden 1997). Pollen data indicate that the marl prairies west of SRS are not a natural feature of the Everglades landscape but developed after twentieth century hydrologic modification of the system reduced flow to the region (Bernhardt and Willard 2006). Prior to the modifications, plant communities at the sites analyzed by Bernhardt and Willard (2006) in western SRS consisted of sawgrass marshes. The authors concluded that "the current spatial distribution and community com-position of marl prairies are a response to water management and land cover changes of the twentieth century; and further sampling of modern marl prairie communities and adjacent communities is necessary to document the pre- and post-drainage distribution of marl prairie" (Bernhardt and Willard 2006).

D.2.5.1.1.4 Tree Islands

Tree islands occur within the freshwater marshes in areas of slightly higher elevation relative to the surrounding marsh. The lower portions of tree islands are dominated by hydrophytic, evergreen, broad-leaved hardwoods such as red bay (*Persea palustris*), sweetbay, dahoon holly (*Ilex cassine*), and pond apple (*Annona glabra*). Tree islands typically have a dense shrub layer that is dominated by coco-plum (*Chrysobalanus icaco*). Additional constituents of the shrub layer commonly include buttonbush and large leather fern (*Acrostichum danaeifolium*). Elevated areas on the upstream side of some tree islands may contain an upland tropical hardwood hammock community dominated by species of West Indian origin (Gunderson et al. 1997), with species composition shifting toward the north toward more temperate hardwood hammock species. Extended periods of flooding may result in tree mortality and conversion to a non-forested community. In the over-drained areas of WCA 3A, historic wildfires have consumed tree island vegetation and soils. Overall, the spatial extent of tree islands in WCA 3 declined by 61% between 1940 and 1995 (Patterson and Finck 1999). Portions of the WCAs have been flooded to the extent that many forested is-lands have lost all tropical hardwood hammock trees. Tree islands are considered an extremely important contributor to habitat heterogeneity and overall species diversity within the Everglades ecosystem because they provide nesting habitat and refugia for birds and up-land species and serve as hotspots of plant species diversity within the Greater Everglades (Sklar and van der Valk 2002, USFWS 1999). Tree islands also contain extraordinarily high levels of total phosphorus in their soil suggesting that they may play a major role in the biogeochemical cycles of nutrients in the Everglades (Troxler and Childers 2010; Wetzel et al. 2009, 2011). Wetzel et al. (2011) found that soil total phosphorus levels within WCA 3A and WCA 3B tree islands were approximately 4 times higher than the surrounding marsh total phosphorus levels. Tree islands within WCA 3B may help to capture and focus nutrients, assisting to minimize potential effects on sawgrass and wet prairie communities within this region (Wetzel et al. 2011).

D.2.5.1.1.5 Mangroves

Mangrove communities are forested wetlands occurring in intertidal, low-wave-energy, estuarine and marine environments. Within the action area, extensive mangrove communities occur in the intertidal zone of Florida Bay. Mangrove forests have a dense canopy dominated by four species: red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans*), white mangrove (*Laguncularia racemosa*), and buttonwood (*Conocarpus erectus*). Mangrove communities occur within a range of salinities from 0 to 40 parts per thousand (ppt). Florida Bay experiences salinities in excess of 40 ppt on a seasonal basis. Declines in freshwater flow through the Everglades have altered the salinity balance and species composition of mangrove communities within Florida Bay. Changes in freshwater flow can lead to an invasion by exotic species such as Australian pine (*Casuarina equisetifolia*) and Brazilian pepper (*Schinus terebinthifolius*).

D.2.5.1.1.6 Seagrass Beds

Seagrasses are submerged vascular plants that form dense rooted beds in shallow estuarine and marine environments. This community occurs in sub tidal areas that experience moderate wave energy. Within the action area, extensive seagrass beds occur in Florida Bay. The most abundant seagrasses in South Florida are turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*), and shoal grass (*Halodule wrightii*). Additional species include star grass (*Halophila engelmannii*), paddle grass (*Halophila decipiens*), and Johnson's seagrass (*Halophila johnsonii*). Widgeon grass may also occur in seagrass beds in areas of low salinity. Seagrasses have an optimum salinity range of 24 to 35 ppt, but can tolerate considerable short term salinity fluctuations. Large-scale seagrass die-off has occurred in Florida Bay since 1987, with over 18% of the total bay area affected. Suspected causes of seagrass mortality include high salinities and temperatures during the 1980s and long-term reductions of freshwater inflow to Florida Bay (RECOVER 2009).

D.2.5.1.1.7 Rockland Pine Forests

In Florida, pine rocklands are located on the Miami Rock Ridge in present day Miami and in ENP, in the Florida Keys, and in the Big Cypress Swamp. Pine rocklands differ to some degree between and within these areas with regard to substrate (e.g. amount of exposed limestone, type of soil), elevation, hydrology, and species composition (both plant and animal). Pine rocklands occur in a mosaic with primarily two other natural community types; rockland hammock and marl prairie. Pine rocklands grade into rockland hammock; pine rocklands have an open pine canopy and rockland hammock has a closed, hardwood canopy. Marl prairies differ from pine rocklands in having no pines, an understory dominated by grasses and sedges, and a minimal cover of shrubs.

Pine rocklands within the action area occur on the Miami Rock Ridge and extend into the Everglades as Long Pine Key. Pine rocklands occur on relatively flat terrain with moderately to well-drained soils. Limestone bedrock is close to the surface and the soils are typically shallow accumulations of sand, marl, and organic material in depressions and crevices in the rock surface. Pine rockland is an open, savanna-like community with a canopy of scattered South Florida slash pine (*Pinus elliottii var. densa*) and an open, low-stature understory. Most sites are wet for only short periods following heavy rains (Florida Natural Areas Inventory 1990). During the rainy season, however, some sites may be shallowly inundated by slow flowing surface water for up to 60 days per year. This is a fire-maintained community that requires regular burns to maintain the open shrub/herbaceous stratum and to control hardwood encroachment (Gunderson et. al, 1997). The over story is comprised of scattered South Florida slash pines. The shrub

layer is comprised of a diverse assemblage of tropical and temperate species. Common shrubs include cabbage palm (*Sabal palmetto*), coco-plum (*Chrysobalanus icaco*), myrsine (*Rapanea punctata*), saw palmetto (*Serenoa repens*), southern sumac (*Rhus copallinum*), strangler fig (*Ficus aurea*), swamp bay (*Persea palustris*), wax myrtle (*Myrica cerifera*), white indigo berry (*Randia aculeata*), and willow-bustic (*Sideroxylon salicifo-lium*). The herbaceous stratum is comprised of a very diverse assemblage of grasses, sedges, and forbs. Common herbaceous species include crimson bluestem (*Schizachyrium sanguineum*), wire bluestem (*Schizachyrium gracile*), hairy bluestem (*Andropogon longiberbis*), bushy bluestem (*Andropogon glomeratus var. pumilis*), candyweed (*Polygala grandiflora*), creeping morning-glory (*Evolvulus sericeus*), pineland heliotrope (*Heliotropium polyphyllum*), rabbit bells (*Crotolaria rotundifolia*), and thistle (*Cirsium horridulum*) (USFWS 1999). This community occurs on areas of relatively high elevation and consequently, has been subject to intense development pressure. In addition, fragmentation, fire suppression, invasion by exotic species, and a lowered water table have negatively affected the remaining tracts of pine rock-land (USFWS 1999).

D.2.5.1.1.8 Tropical Hardwood Hammock

Tropical hardwood hammocks occur on upland sites where limestone is near the surface. Tropical hardwood hammocks within the action area occur on the Miami Rock Ridge, along the northern shores of Florida Bay and on elevated outcrops on the upstream side of tree islands. This community consists of a closed canopy forest dominated by a diverse assemblage of hardwood tree species, a relatively open shrub layer, and a sparse herbaceous stratum. This community is dominated by West Indian species and contains numerous species whose entire United States distribution is limited to tropical hammocks of South Florida. Common canopy species include gumbo-limbo (*Bursera simaruba*), paradise tree (*Simarouba glauca*), pigeon-plum (*Coccoloba diversifolia*), strangler fig, wild mastic (*Sideroxylon foetidis-simum*), willow-bustic, live oak (*Quercus virginiana*), short-leaf fig (*Ficus citrifolia*), and wild tamarind (*Lysiloma bahamense*). Common understory species include black ironwood (*Krugiodendron ferreum*), inkwood (*Exothea paniculata*), lancewood (*Ocotea coriacea*), marlberry (*Ardisia escallonoides*), poisonwood (*Metopium toxiferum*), satinleaf (*Chrysophyllum oliviforme*), and white stopper (*Eugenia axillaris*). Common species of the sparse shrub/herbaceous layer include shiny-leaf wild-coffee (*Psychotria nervosa*), rouge plant (*Rivinia humilis*), false mint (*Dicliptera sexangularis*), bamboo grass (*Lasciacis divaricata*), and woods grass (*Oplismenus hirtellus*). This community occurs on areas of relatively high elevation and consequently, has been subject to intense development pressure. Fragmentation of remaining tracts, invasion by exotic species, and alterations of water table elevations have also had negative impacts on this community. Tropical hardwood hammocks on the Miami Rock Ridge have been affected by a lowered water table associated with the reduction of freshwater flow through the Everglades. In contrast, tree islands in the WCAs have been flooded to the extent that many have lost all tropical hardwood hammock trees.

D.2.5.1.2 Fish and Wildlife Resources

Aquatic macro invertebrates form a vital link between the algal and detrital food web base of freshwater wetlands and the fishes, amphibians, reptiles, and wading birds that feed up-on them. Important macro invertebrates of the freshwater aquatic community include crayfish (*Procambarus alleni*), riverine grass shrimp (*Palaemonetes paludosus*), amphipods (*Hyallela aztecus*), Florida apple snail (*Pomacea paludosa*), Seminole ramshorn (*Planorbella duryi*), and numerous species of aquatic insects (USACE 1999).

Small freshwater marsh fishes are also important processors of algae, plankton, macro-phytes, and macro invertebrates. Marsh fishes provide an important food source for wading birds, amphibians, and reptiles.

Common small freshwater marsh species include the native and introduced golden topminnow (*Fundulus chrysotus*), least killifish (*Heterandria formosa*), Florida flagfish (*Jordenella floridae*), golden shiner (*Notemigonus crysoleucas*), sailfin molly (*Poecilia latipinna*), bluefin killifish (*Lucania goodei*), oscar (*Astronotus ocellatus*), eastern mosquitofish (*Gambusia holbrookii*), and small sunfishes (*Lepomis spp*.) (USACE 1999). The density and distribution of marsh fish populations fluctuates with seasonal changes in water levels. Populations of marsh fishes increase during extended periods of continuous flooding during the wet season. As marsh surface waters recede during the dry season, marsh fishes become concentrated in areas that hold water through the dry season. Concentrated dry season assemblages of marsh fishes are more susceptible to predation and provide an important food source for wading birds (USACE 1999).

Within the Greater Everglades, numerous sport and larger predatory fishes occur in deeper canals and sloughs. Common species include largemouth bass (*Micropterus salmoides*), blue-gill *(Lepomis macrochirus),* redear sunfish (*Lepomis microlophus*), black crappie (*Pomoxis nigromaculatus*), Florida gar (*Lepisosteus platyrhincus*), threadfin shad (*Dorosoma petenense*), gizzard shad *(Dorosoma cepedianum*), yellow bullhead (*Ameiurus natilis*), white catfish (*Ameiurus catus*), bowfin (*Amia calva*), and tilapia (*Tilapia spp.)* (USACE 1999). Larger fishes are an important food source for wading birds, alligators, otters, raccoons, and mink.

The freshwater wetland complex supports a diverse assemblage of reptiles and amphibians. Common amphibians include the greater siren (*Siren lacertina*), Everglades dwarf siren (*Pseudobranchus striatus*), two-toed amphiuma (*Amphiuma means*), pig frog (*Rana grylio*), southern leopard frog (*Rana sphenocephala*), Florida cricket frog (*Acris gryllus*), southern chorus frog (*Pseudacris nigrita*), squirrel tree frog (Hy*la squirela*), and green tree frog (*Hyla cinerea*) (USACE 1999). Amphibians represent an important forage base for wading birds, alligators, and larger predatory fishes (USACE 1999).

Common reptiles of freshwater wetlands include the American alligator (*Alligator mississippiensis*), snapping turtle (*Chelydra serpentina*), striped mud turtle (*Kinosternon bauri*), mud turtle (*Kinosternon subrubrum*), cooter (*Chrysemys floridana*), Florida chicken turtle (*Deirochelys reticularia*), Florida softshell turtle (*Trionys ferox*), water snake (*Natrix sipidon*), green water snake (*Natrix cyclopion*), mud snake (*Francia abacura*), and Florida cottonmouth (*Agkistrodon piscivorus*) (USACE 1999).

The alligator was historically most abundant in the peripheral Everglades marshes and freshwater mangrove habitats, but is now most abundant in canals and the deeper slough habitats of the central Everglades. Drainage of peripheral wetlands and increasing salinity in mangrove wetlands as a result of decreased freshwater flows has limited the occurrence of alligators in these habitats (Mazzotti and Brandt 1994).

The freshwater wetlands of the Everglades are noted for their abundance and diversity of colonial wading birds. Common wading birds include the white ibis (*Eudocimus albus*), glossy ibis (*Plegadus falcenellus*), great egret (*Casmerodius albus*), great blue heron (*Ardea herodius*), little blue heron (*Egretta caerulea*), tricolored heron (*Egretta tricolor*), snowy egret (*Egretta thula*), green-backed heron (*Butorides striatus*), cattle egret (*Bubulcus ibis*), black-crowned night heron (*Nycticorax nycticorax*), yellow-crowned night heron (*Nycticorax violacea*), rose-ate spoonbill (*Ajaia ajaja*), and wood stork (*Mycteria americana*) (USACE 1999). The number of wading birds nesting in the Everglades has decreased by approximately 90 percent, and the distribution of breeding birds has shifted away from ENP into the WCAs (Bancroft et al. 1994). The WCAs support fewer numbers of breeding pairs with relatively lower reproductive success (USACE 1999). Water management practices and wetland losses are believed to be the primary cause of the declines (Bancroft et al. 1994).

Mammals that are well-adapted to the aquatic and wetland conditions of the freshwater marsh complex include the rice rat (*Oryzomys palustris natator*), round-tailed muskrat, and river otter (*Lutra canadensis*). Additional mammals that may utilize freshwater wetlands on a temporary basis include the white-tailed deer (*Odocoileus virginianus*), Florida panther (*Puma concolor coryi*), bobcat (*Lynx rufus*), and raccoon (*Procyon lotor*).

D.2.5.2 Federally Listed Species

USACE has consulted with the USFWS by letter dated September 26, 2017 on federally listed threatened and endangered species that may be present in the action area. In correspondence dated October 31, 2017 the USFWS provided a revised list for COP. USACE provided subsequent email correspondence seeking clarification on the revised list due to the recent listing of several species. Federally listed threatened and endangered species under the purview of the USFWS are either known to exist or potentially exist within the action area (**Table D.2-4** and **Figure D.2-27**). This includes one candidate species. Effects determinations are listed in **Table D.2-4**. Many of these species have been previously affected by habitat impacts resulting from wetland drainage, alteration of hydroperiod, wildfire and water quality degradation.

Table D.2-4. Status of federally threatened and endangered species with the potential to occur within the COP action area and USACE' affect determination (E: Endangered; T: Threatened; SA: Similarity of Appearance; CH: Critical Habitat; C: Candidate Species).

Common Name	Scientific Name	Status	May Affect Not Likely to Adversely Affect	May Affect	No Effect
Mammals	-	-	-	-	-
Florida panther	*Puma concolor coryi*	E	X	-	-
Florida manatee	*Trichechus manatus latirostris*	E, CH	X	-	-
Florida bonneted bat	*Eumops floridanus*	E	X	-	-
Birds	-	-	-	-	-
Cape Sable seaside sparrow	*Ammodramus maritimus mirabilis*	E, CH	-	X	-
Everglade snail kite	*Rostrhamus sociabilis plumbeus*	E, CH	-	X	-
Piping plover	*Charadrius melodus*	T	-	-	X
Red-cockaded woodpecker	*Picoides borealis*	E	-	-	X
Roseate tern	*Sterna dougallii*	T	-	-	X
Wood stork	*Mycteria americana*	T	-	X	-
Reptiles	-	-	-	-	-

Common Name	Scientific Name	Status	May Affect Not Likely to Adversely Affect	May Affect	No Effect
American Alligator	*Alligator mississippiensis*	T, SA	X	-	-
American crocodile	*Crocodylus acutus*	T, CH	X	-	-
Eastern indigo snake	*Drymarchon corais couperi*	T	X	-	-
Gopher tortoise	*Gopherus polyphemus*	C	-	-	X
Invertebrates	-	-	-	-	-
Bartram's hairstreak butterfly	*Strymon acis bartrami*	E, CH	-	-	X
Florida leafwing butterfly	*Anaea troglodyta floridalis*	E, CH	-	-	X
Miami blue butterfly	*Cyclargus thomasi bethunebakeri*	E	-	-	X
Schaus swallowtail butterfly	*Heraclides aristodemus ponceanus*	E	-	-	X
Stock Island tree snail	*Orthalicus reses (not incl. nesodryas)*	T	-	-	X
Plants	-	-	-	-	-
Crenulate lead plant	*Amorpha crenulata*	E	-	-	X
Deltoid spurge	*Chamaesyce deltoidea spp. deltoidea*	E	-	-	X
Garber's spurge	*Chamaesyce garberi*	T	-	-	X
Okeechobee gourd	*Cucurbita okeechobeensis ssp. Okeechobeenis*	E	-	-	X
Small's milkpea	*Galactia smallii*	E	-	-	X
Tiny polygala	*Polygala smallii*	E	-	-	X
Big pine partridge pea	*Chamaecrista lineata var. keyensis*	E	-	-	X
Blodgett's silverbush	*Argythamnia blodgettii*	T	-	-	X
Cape Sable thoroughwort	*Chromolaena frustrata*	E, CH	-	-	X
Carter's small-flowered flax	*Linum carteri var. Carteri*	E, CH	-	-	X
Everglades bully	*Sideroxylon reclinatum spp. austrofloridense*	T	-	-	X

Common Name	Scientific Name	Status	May Affect Not Likely to Adversely Affect	May Affect	No Effect
Florida brickell-bush	*Brickellia mosieri*	E, CH	-	-	X
Florida bristle fern	*Trichomanes punctatum spp. floridanum*	E	-	-	X
Florida pineland crabgrass	*Digitaria pauciflora*	T	-	-	X
Florida prairie-clover	*Dalea carthagenesis floridana*	E	-	-	X
Florida semaphore cactus	*Consolea corallicola*	E, CH	-	-	X
Pineland sandmat	*Chaemaesyce deltoidea pinetorium*	T	-	-	X
Sand flax	*Linum arenicola*	E	-	-	X

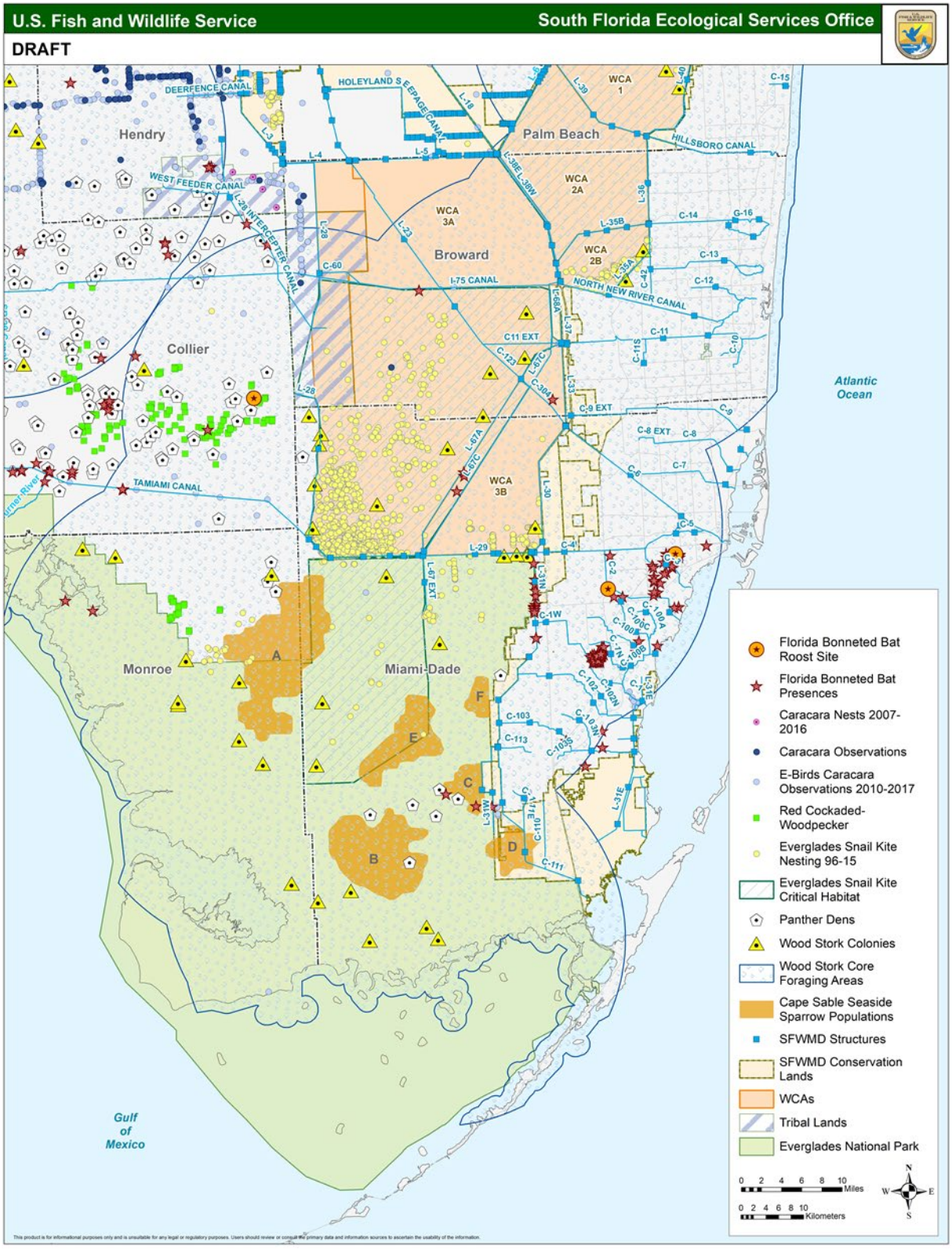


Figure D.2-27. Location of federally threatened and endangered species with the potential to occur in the study area.

D.2.5.3 Designated Critical Habitat

In addition to threatened and endangered species, the action area also includes or is adjacent to designated critical habitat for several species under the purview of the USFWS. This includes critical habitat for the Florida manatee, CSSS, snail kite, American crocodile, Bartram's hairstreak butterfly, Florida leafwing butterfly, Cape Sable thoroughwort, Carter's small-flowered flax, Florida brickell-bush, and Florida semaphore cactus.

D.2.5.3.1 Florida Manatee Critical Habitat

Critical habitat was designated for the Florida manatee (listed in that regulation as *Trichechus manatus*) on September 24, 1976 (41 FR 41914) with a final correction on September 27, 1977 (42 FR 47840-47845). Critical habitat in Florida that is in the COP action area includes all U.S. territorial waters adjoining the coast and islands and all connected bays, estuaries, and rivers from Gordon's Pass, near Naples, Collier County, southward to and including Whitewater Bay, Monroe County; all waters of Card, Barnes, Blackwater, Little Blackwater, Manatee, and Buttonwood Sounds between Key Largo, Monroe County, and the main-land of Dade County; Biscayne Bay, and all adjoining and connected lakes, rivers, canals, and waterways from the southern tip of Key Biscayne northward to and including Maule Lake, Dade County. **Figure D.2-28** illustrates a map created from the physical description of the published designated critical habitat. Primary constituent elements for manatee critical habitat have not been defined.

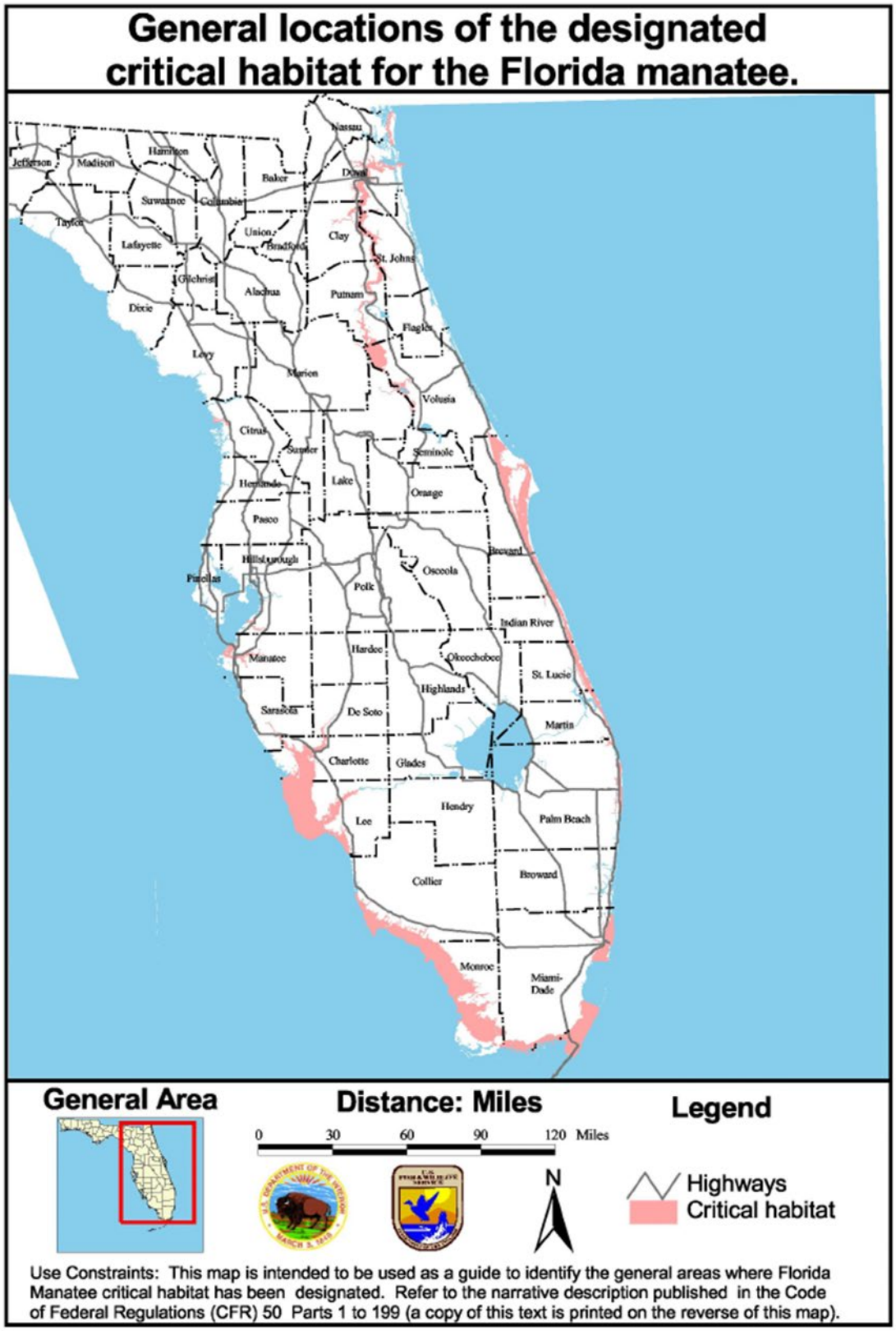


Figure D.2-28. Critical habitat for the Florida Manatee

D.2.5.3.2 Cape Sable Seaside Sparrow Critical Habitat

Designated critical habitat for the CSSS include areas of land, water, and airspace in the Taylor Slough vicinity of Collier, Dade, and Monroe counties, with the following components: those portions of ENP within T57S R36E, T57S R36E, T57S R37E, T58S R35E, T58S R36E, T58S R37E, T58S R35E, T58S R36E, T59S R35E, T59S R36E, T59S R37E. Areas outside of ENP within T55S R37E Sec. 36; T55S R38E Sec. 31, 32; T56S R37E Sec. 1, 2, 11-14, 23-26; T56S R38E Sec. 5-7, 18, 19; T57S R37E Sec. 5-8; T58S R38E Sec. 27, 29-32; T59S R38E Sec. 4 (CFR Vol. 72, No. 214 / 11-6-07). Reference **Figure D.2-29**. Designated CSSS critical habitat within the COP action area includes ENP.

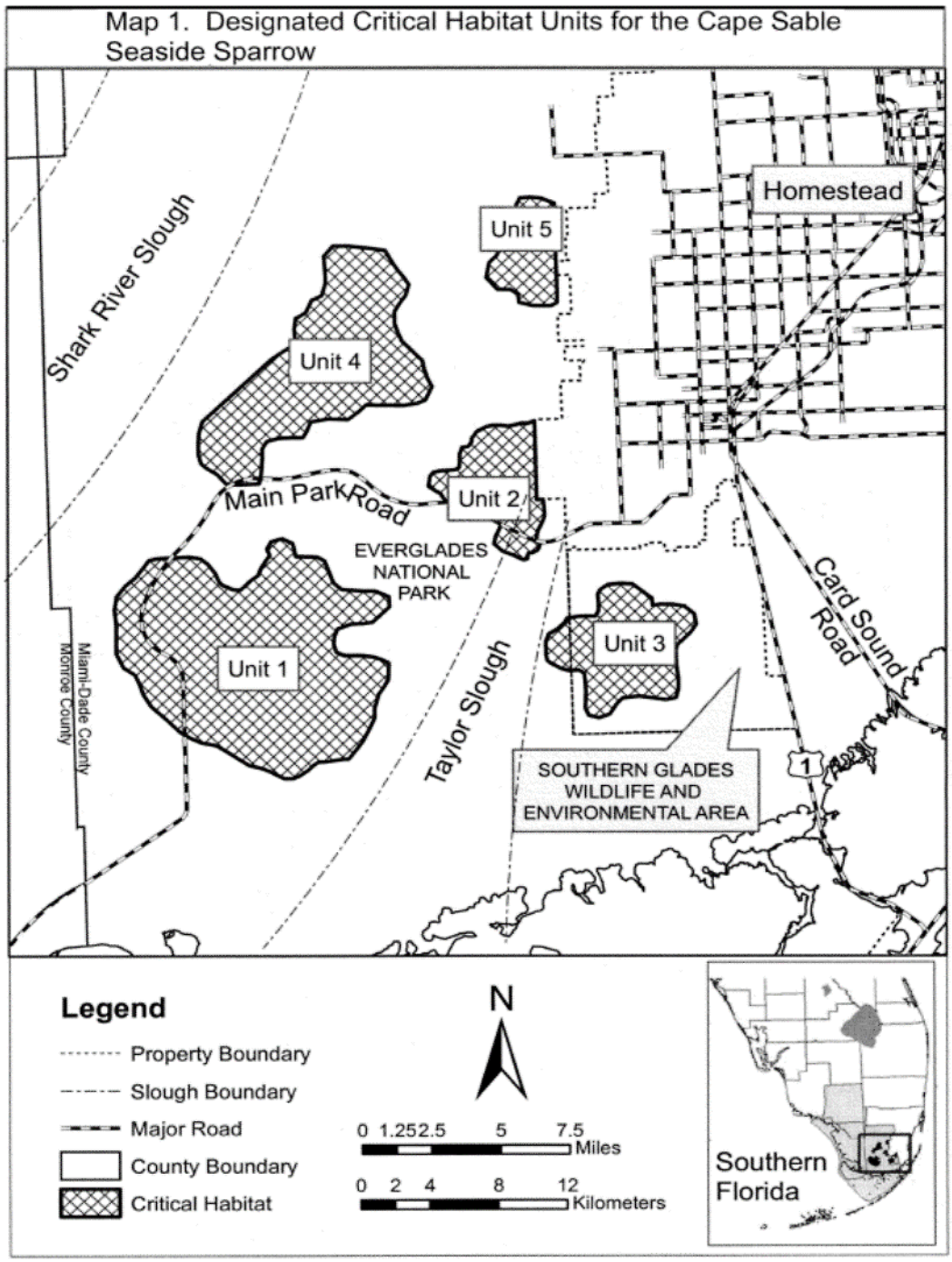


Figure D.2-29. Critical habitat for the Cape Sable Seaside Sparrow

D.2.5.3.3 Everglade Snail Kite Critical Habitat

Critical habitat was designated for the Everglade Snail Kite on August 11, 1977 (42 FR 40685-40690) with a final correction on September 22, 1977 (42 FR 47840-47845). Critical habitat for the Everglade snail kite in Florida includes areas of land (predominantly marsh), water, and airspace, with the following components (Tallahassee Meridian): (1) St. Johns Reservoir, Indian River County: T33S R37E SW1/4 Sec.

6, W1/2 Sec. 7, Sec. 18, Sec 19.; (2) Cloud Lake Reservoir, St. Lucie County; T34S R38E S1/2 Sec. 16, N1/2 Sec. 21; (3) Strazulla Reservoir, St. Lucie County; T34S R38E SW1/4 Sec. 21; (4) western parts of Lake Okeechobee, Glades and Hendry Counties, extending along the western shore to the east of the levee system and the undiked high ground at Fisheating Creek, and from the Hurricane Gate at Clewiston northward to the mouth of the Kissimmee River, including all the Elocharis flats of Moonshine Bay, Monkey Box, and Observation Shoal, but excluding the open water north and west of the northern tip of Observation Shoal, north of Monkey Box, and east of Fisheating Bay; (5) Loxahatchee National Wildlife Refuge (WCA 1), Palm Beach County, including Refuge Management compartments A, B, C, and D, and all of the main portion of the Refuge as bounded by levees L-7, L-39, and L-40; (6) WCA 2A, Palm Beach and Broward Counties, as bounded by levees L-6, L-35B, L-36, L-38, and L-39; (7) WCA 2B, Broward County, as bounded by levee L-35, L-35B, L-36, and L-38; (8) WCA 3A, Broward and Miami-Dade Counties, as bounded by Florida Highway 84. Levees L-68A, L-67A (north of Miami Canal), and L-67C (south of Miami Canal). L-29 and L-28 and a line along the undiked northwestern portion of the area; (9) that portion of ENP, Miami-Dade County, within the following boundary; beginning at the point where ENP meets Florida Highway 94 in T54S R35 Sec. 20, thence eastward and southwest along the ENP boundary to the southwest corner of Sec. 2 in T58S R35E, thence westward along the south sides of Sec. 3, 4, 5, and 6 in T58S R35E to the Miami-Dade-Monroe County line, thence northward along the Miami-Dade-Monroe County line to the ENP boundary, thence eastward and northward along the ENP boundary to the point of beginning. Reference **Figure D.2-30**. Primary constituent elements for snail kite critical habitat have not been defined.

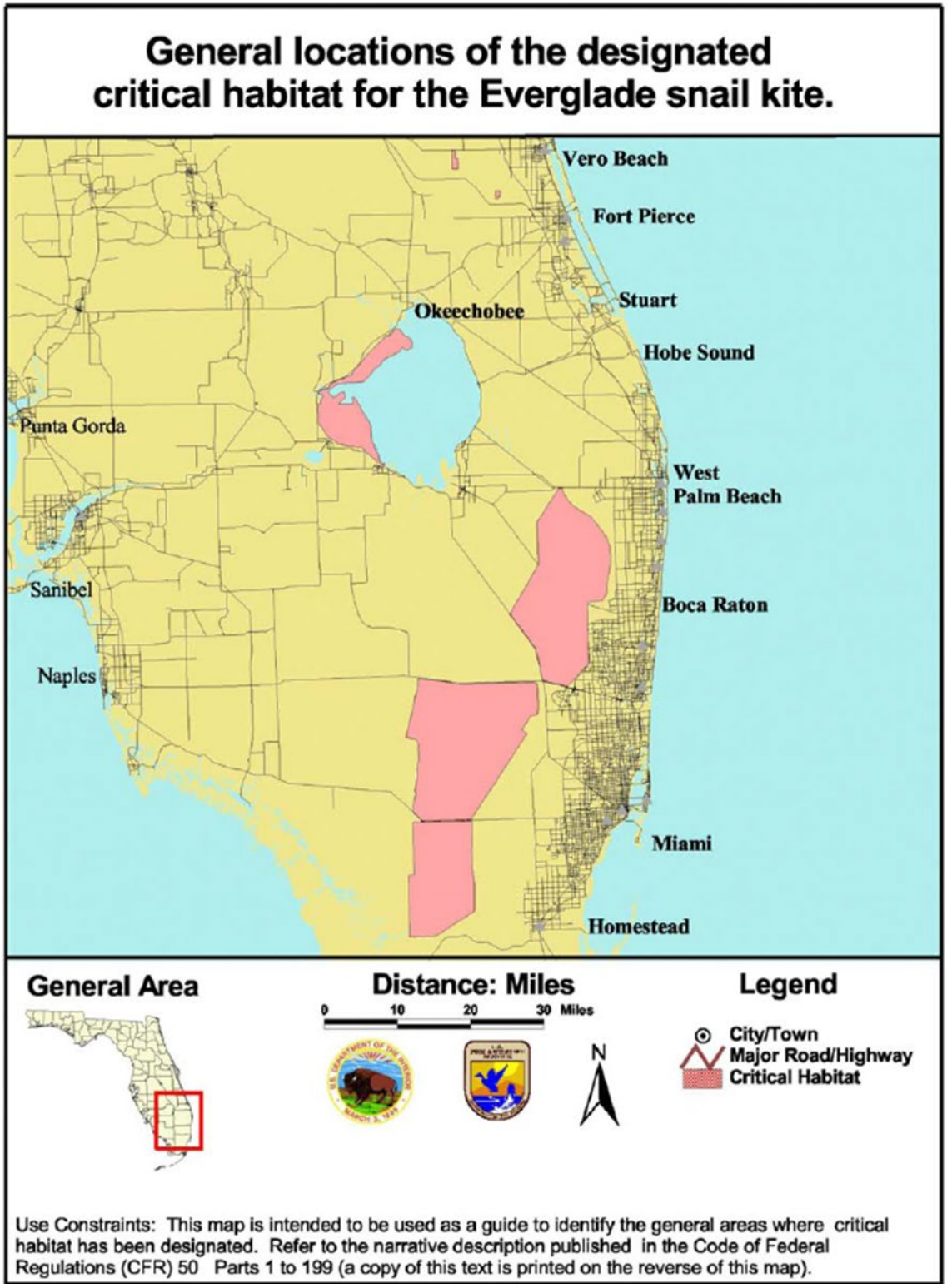


Figure D.2-30. Critical habitat for the Everglade Snail Kite

D.2.5.3.4 American Crocodile Critical Habitat

Critical habitat was designated for the American crocodile on September 24, 1976 (41 FR 41914) with a final correction on September 27, 1977 (42 FR 47840-47845). Critical habitat for the American crocodile within Florida includes all land and water within the following boundary: Beginning at the easternmost tip of Turkey Point, Dade County, on the coast of Biscayne Bay; then southeastward along a straight line to Christmas Point at the southern-most tip of Elliott Key; then southwestward along a line following the shores of the Atlantic Ocean side of Old Rhodes Key, Palo Alto Key, Angelfish Key, Key Largo, Plantation Key, Wind-ley Key, Upper Matecumbe Key, Lower Matecumbe Key, and Long Key; then to the western-most tip of Middle Cape; then northward along the shore of the Gulf of Mexico to the north side of the mouth of Little Sable Creek; then eastward along a straight line to the northern-most point of Nine-Mile Pond; then northeastward along a straight line to the point of be-ginning. Reference **Figure D.2-31**.

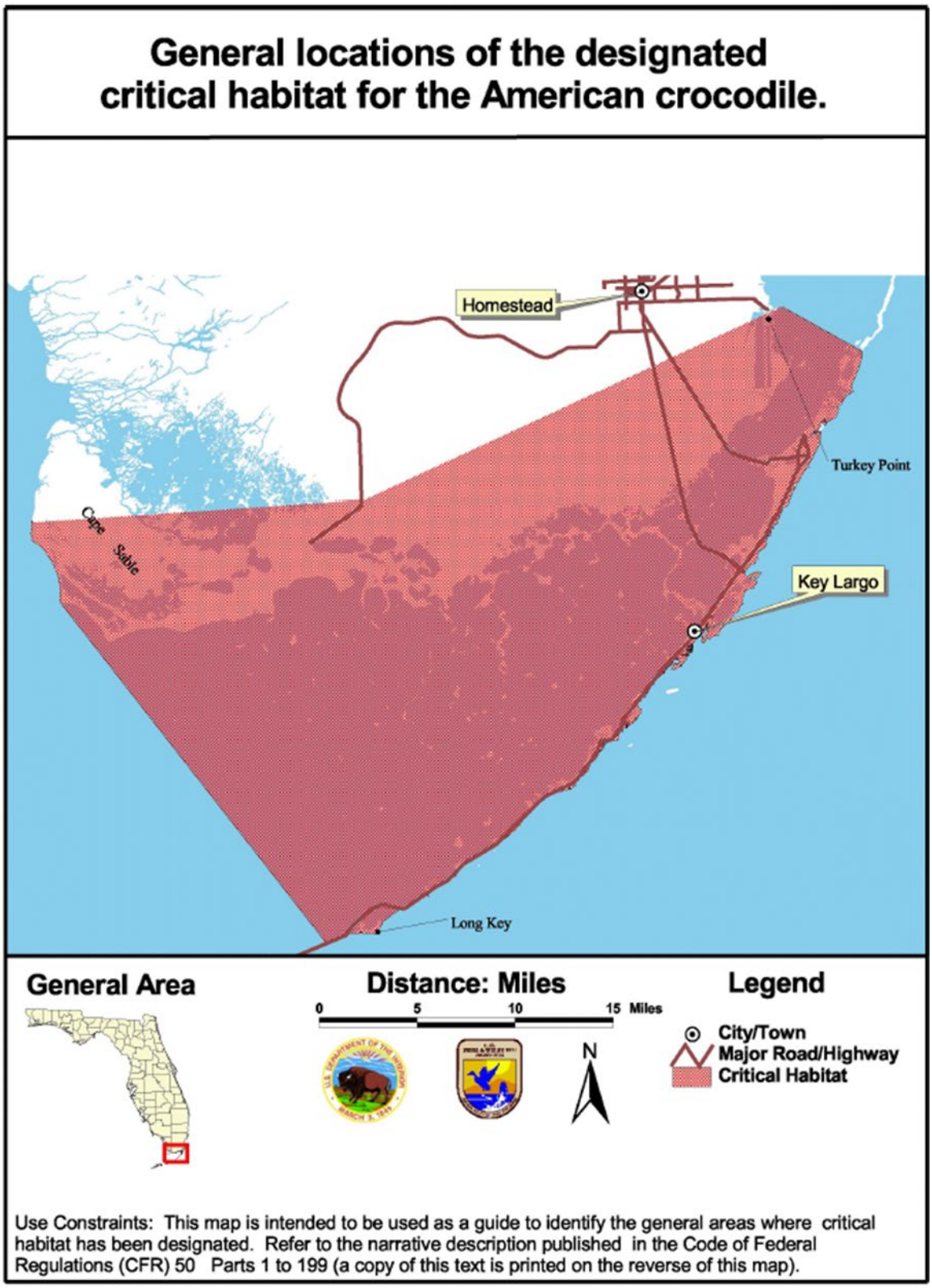


Figure D.2-31. Critical habitat for the American crocodile.

D.2.5.3.5 Bartram's Hairstreak Butterfly and Florida Leafwing Butterfly Critical Habitat

Critical habitat was designated for Bartram's hairstreak butterfly and the Florida leafwing butterfly on August 12, 2014 (79 FR 47180 at 47183). Critical habitat for the Bartram's hairstreak butterfly consists of seven units consisting of 4,670 hectares (11,539 acres) in Miami-Dade and Monroe Counties. The seven units are: (1) BSHB1 ENP Miami-Dade County: (2) BSHB2 Navy Wells Pineland Preserve, Miami-Dade County; (3) BSHB3 Camp Owaissa Bauer, Miami-Dade County; (4) BSHB4 Richmond Pine Rocklands, Miami-Dade County; (5) BSHB5 Big Pine Key, Monroe County; (6) BSHB6 No Name Key, Monroe County; (7) BSHB7 Little Pine Key, Monroe County. Reference **Figure D.2-32**. Critical habitat for the Florida leafwing butterfly consists of four units consisting 4,273 hectares (10,561 acres) in Miami-Dade and Monroe Counties. The four units are: (1) FLB1 ENP Miami-Dade County; (2) FLB2 Navy Wells Pineland Preserve, Miami-Dade County; (3) FLB3 Richmond Pine Rocklands, Miami-Dade County; and (4) FLB4 Big Pine Key, Monroe County. Reference **Figure D.2-33**. Designated critical habitat for the Florida leafwing butterfly occurs entirely within Bartram's hairstreak units BSHB1, BSHB2, BSHB4, and BSHB5. Five of the seven critical habitat units (BSHB1-BSHB5) were identified as being occupied by the Bartram's hairstreak butterfly when critical habitat was designated. One of the four critical habitat units (FLB1) was identified as being occupied by the Florida leafwing butterfly when critical habitat was designated. Primary constituent elements for Bartram's hairstreak butterfly and the Florida leafwing butterfly have been defined and are further described in 79 FR 47180 at 47183.

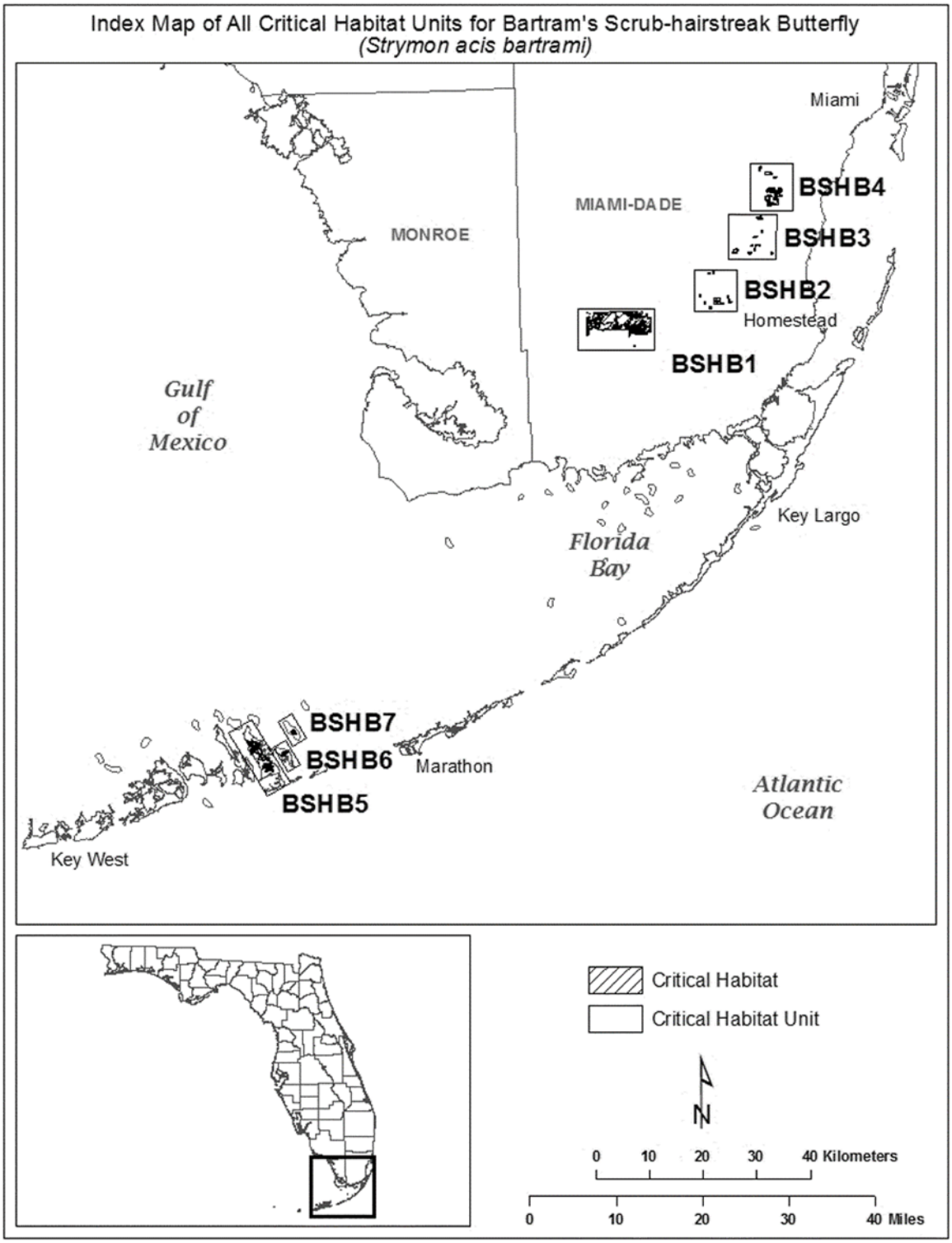


Figure D.2-32. Critical habitat for Bartram's Hairstreak Butterfly

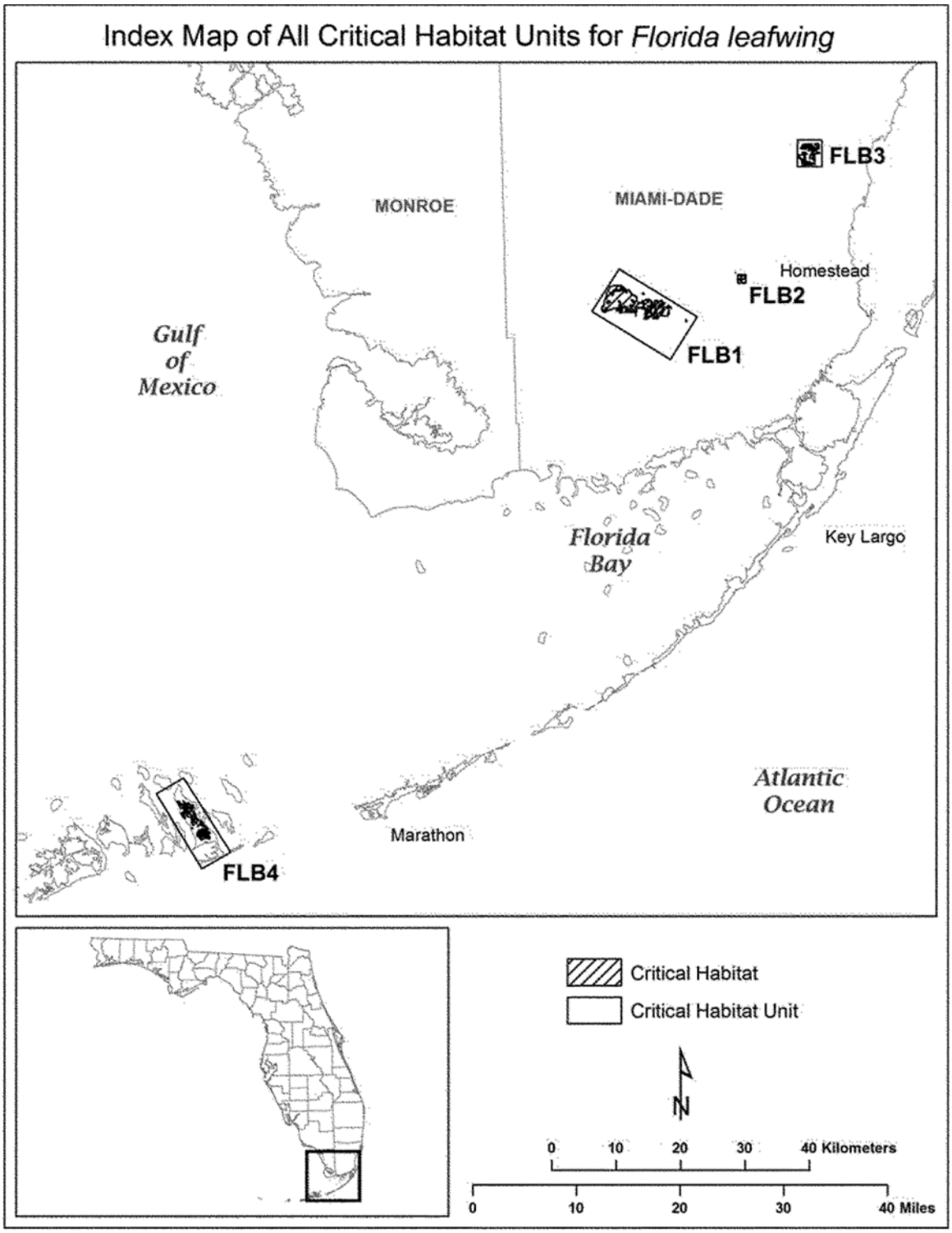


Figure D.2-33. Critical habitat for the Florida Leafwing Butterfly

D.2.5.3.6 Cape Sable Thoroughwort Critical Habitat

Critical habitat was designated for the Cape Sable thoroughwort on January 8, 2014 (79 FR 1552). The USFWS designated approximately 4,439 hectares (10,968 acres) in Miami-Dade and Monroe Counties.

Critical habitat for the Cape Sable thoroughwort consists of nine units. The nine units include: (1) ENP; (2) Key Largo; (3) Upper Matecumbe Key; (4) Lignumvitae Key; (5) Lower Matecumbe Key; (6) Long Key; (7) Big Pine Key; (8) Big Munson Island; and (9) Boca Grande Key. Reference **Figure D.2-34**. Seven of the nine critical habitat units were identified as being occupied by the plant when critical habitat was designated. These include critical habitat units ENP, Upper Matecumbe Key, Lignumvitae Key, Long Key, Big Munson Island, and Boca Grande Key. Primary constituent elements the Cape Sable thoroughwort have been defined and are further described in 79 FR 1552.

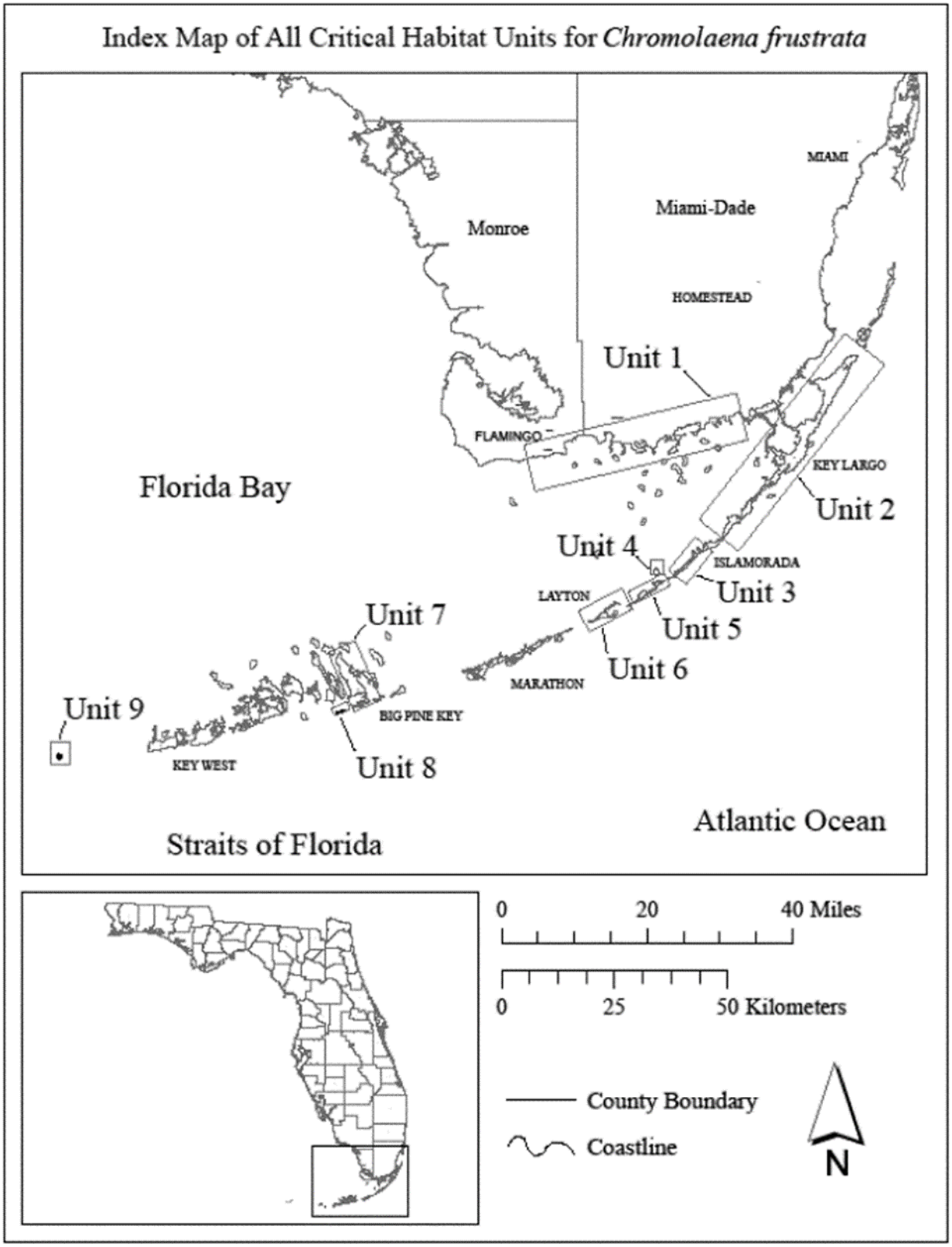


Figure D.2-34. Critical habitat for the Cape Sable Thoroughwort.

D.2.5.3.7 Carter's Small-Flowered Flax and Florida Brickell-Bush Critical Habitat

Critical habitat was designated for Carter's small-flowered flax and the Florida Brickell-bush on August 17, 2015 (80 FR 49847). The USFWS designated approximately 1,072 hectares (2,649 acres) for Carter's small-flowered flax and approximately 1,062 hectares (2,624 acres) for the Florida Brickell-bush. The critical habitat areas for these plants are located entirely in Miami-Dade County and largely overlap, for a combined total of approximately 1,095 hectares (2,706 acres). Because of the highly fragmented nature of the remaining rockland habitat, these large overall unit boundaries encompass multiple, small designations (i.e. subunits) within each unit; only these subunits within the unit boundaries are designated as critical habitat. Critical habitat for Carter's small-flowered flax consists of seven units. Reference **Figure D.2-35**. The seven units include: (1) Unit LCC1 Trinity Pineland and surrounding areas; (2) Unit LCC2 Nixon Smiley Pineland Preserve and surrounding areas; (3) Unit LCC3 USDA subtropical Horticultural Research Station and surrounding areas; (4) Unit LCC4 Richmond Pinelands and surrounding areas; (5) Unit LCC5 Quail Roost Pineland and surrounding areas; (6) Unit LCC6 Camp Owaissa Bauer and surrounding areas; and (7) Unit LCC7 Navy Wells Pineland Preserve and surrounding areas. Three of the critical habitat units were identified as being occupied by Carter's small-flowered flax (LCC2, LCC3, and LCC6) when critical habitat was designated. Critical habitat for the Florida Brickell-bush consists of seven units. Reference **Figure D.2-36**. The seven units include: (1) Unit BM1 Trinity Pineland and surrounding areas; (2) Unit BM2 Nixon Smiley Pineland Preserve and surrounding areas; (3) Unit BM3 USDA subtropical Horticultural Research Station and surrounding areas; (4) Unit BM4 Richmond Pinelands and surrounding areas; (5) Unit BM5 Quail Roost Pineland and surrounding areas; (6) Unit BM6 Camp Owaissa Bauer and surrounding areas; and (7) Unit BM7 Navy Wells Pine-land Preserve and surrounding areas. Four of the critical habitat units were identified as being occupied by the Florida Brickell-bush (BM2, BM4, BM5, BM6, and BM7) when critical habitat was designated. Primary constituent elements for Carter's small-flowered flax and the Florida Brickell-bush have been defined and are further described in 80 FR 49847. Carter's small-flowered flax and the Florida Brickell-bush are endemic to and occur exclusively within pine rockland habitat on the Miami Rock Ridge outside of ENP.

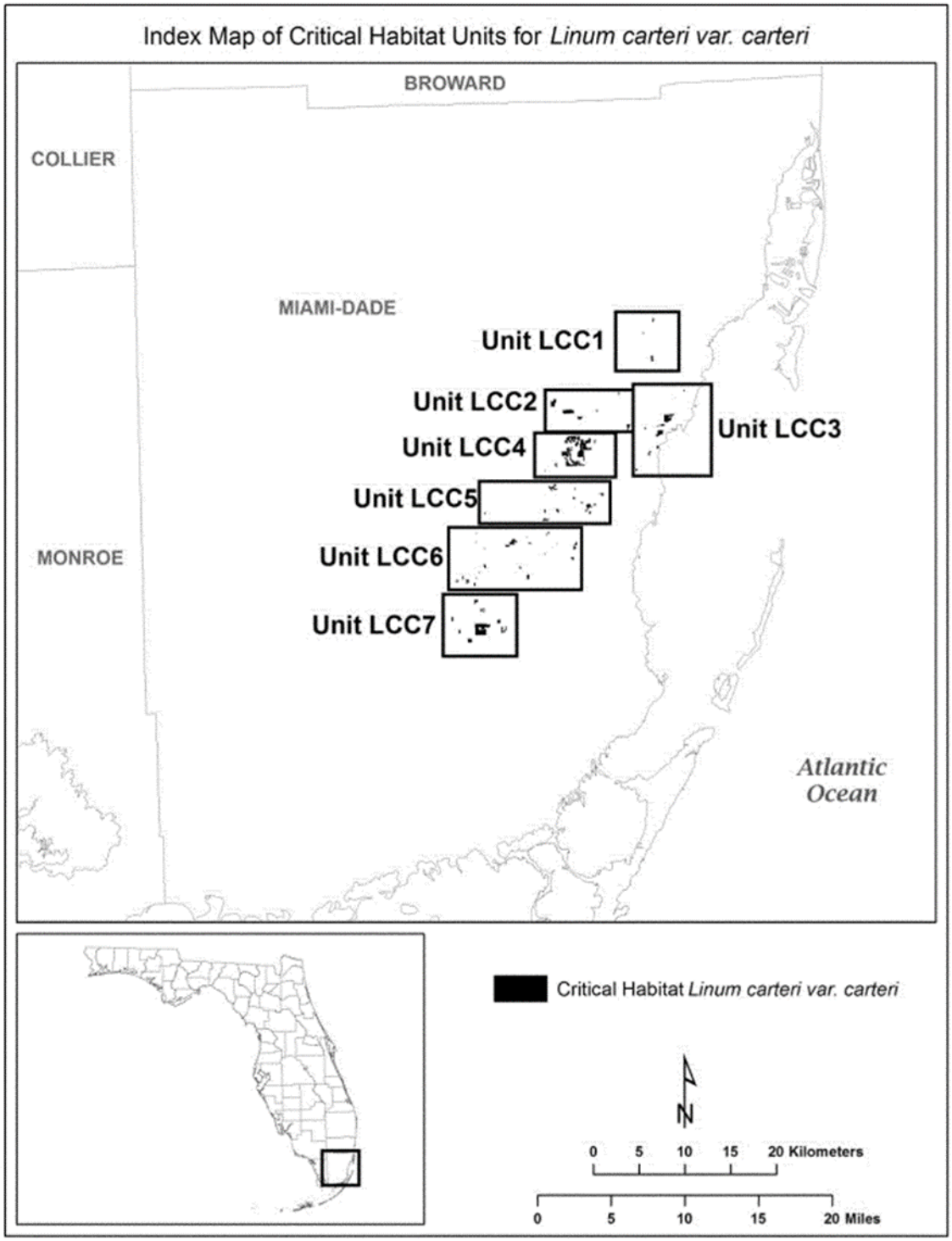


Figure D.2-35. Critical habitat for Carter's Small-Flowered Flax

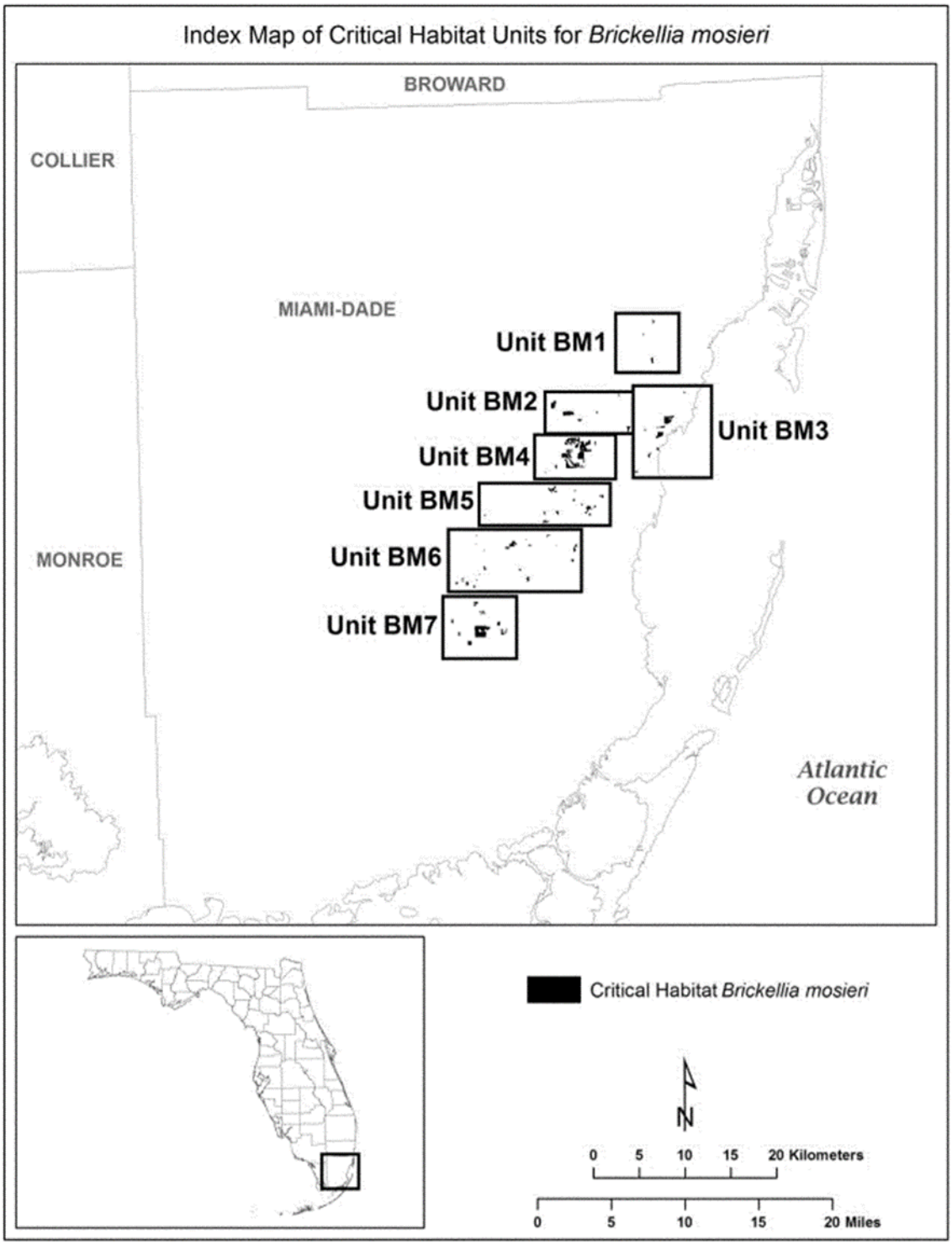


Figure D.2-36. Critical habitat for Florida Brickell-Bush

D.2.5.3.8 Florida Semaphore Cactus Critical Habitat

Critical habitat was designated for the Florida semaphore cactus January 22, 2016 (81 FR 3866). The USFWS designated approximately 1,785 hectares (4,411 acres) in Miami-Dade and Monroe Counties. The

four units include: (1) FSC1 Swan Key in Biscayne National Park; (2) FSC2 Key Largo, Monroe County; (3) FSC3 Big Pine Key, Monroe County; and (4) FSC4 Little Torch Key, Monroe County. Four of the critical habitat units were identified as being occupied by the Florida semaphore cactus when critical habitat was designated. Reference **Figure D.2-37.** Primary constituent elements have been defined and are further described in 81 FR 3866.

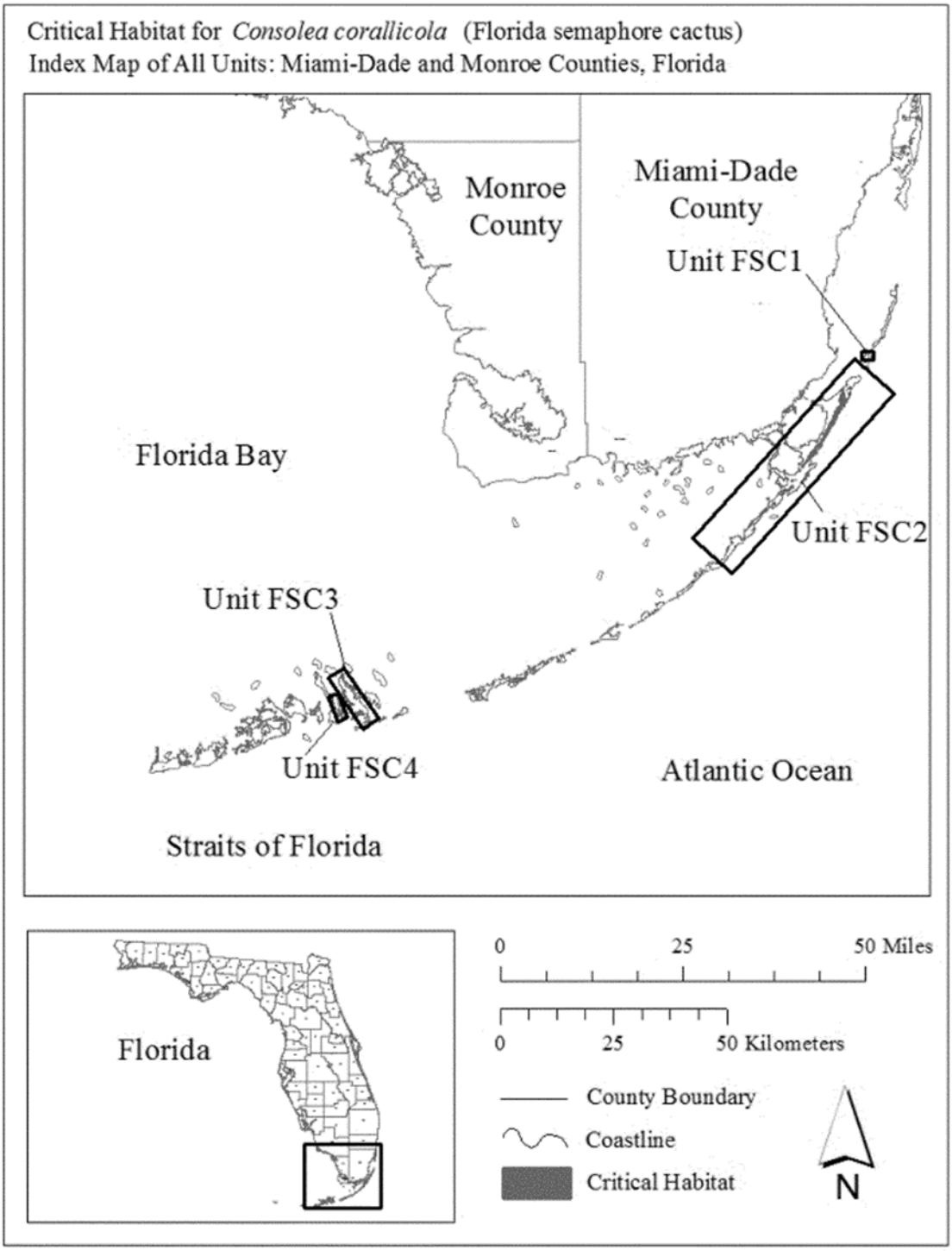


Figure D.2-37. Critical habitat for Florida Semaphore Cactus.

D.2.6 Effect Determinations

The following provides USACE's effect determinations for federally listed species under the purview of USFWS.

D.2.6.1 "No Effect" Determinations

Federally threatened or endangered species that are known to potentially exist within close proximity of the action area, but which will not likely be of concern are discussed in detail below.

D.2.6.1.1 Piping Plover and "No Effect" Determination

The piping plover is a small shorebird, measuring up to 7.25 inches (18.4 centimeters) in length with a wingspan of 14-15.5 inches (35.6-39.4 centimeters) (Alsop 2002). This species has a white belly, pale grayish upperparts, bright yellow-orange legs, and a small bi-colored bill. Breeding piping plovers have a black stripe across their forehead and a dark ring partially surrounding their neck (Florida Natural Areas Inventory 2001). The diet of the piping plover primarily consists of insects, crustaceans, and marine worms (USFWS 2011). Piping plovers inhabit sandy beaches, sand flats, and mudflats along coastal areas (FNAI 2001). The species can be found along the Gulf Coast states and Mexico, along the Atlantic Coast from Florida to Newfoundland, and west to northern Michigan and Wisconsin. The nesting range extends from southern Canada to Nebraska (FNAI 2001). Pairs of piping plovers arrive at breeding grounds starting in late March and early April (USFWS 2011). Plovers depart their breeding grounds for their wintering grounds from July through late August, but southward migration extends through November. Piping plovers do not breed in Florida but spend a large portion of their year "wintering" here. Piping plovers spend up to 10 months of their life cycle on their migration and winter grounds. The main threat to piping plover is habitat loss. Development on beaches has reduced the amount of suitable wintering areas available (USFWS 2011). Due to lack of preferred wintering habitat within the action area, USACE has determined that the Proposed Action would have no effect on the piping plover.

D.2.6.1.2 Red-Cockaded Woodpecker and "No Effect" Determination

The red-cockaded woodpecker is identified by its conspicuous white cheek patch, black and white cross-barred back, black cap and nape, white breast and flanks with black spots. In addition, the males have a small bright red spot on each side of the black cap (USFWS 1999). Red-cockaded woodpeckers are a social species and live in groups with a breeding pair and up to four helpers, generally male offspring from the previous year. Approximately 200 acres of mature pine forests are necessary to support each group's nesting and foraging habitat needs. Juvenile females will leave the group prior to the breeding season and establish a breeding pair within a solitary male group. Breeding pairs are monogamous and will raise a single brood each breeding season. Three to four small white eggs will be laid within the roost cavity and incubated by members of the group for a period of ten to twelve days. Chicks are also fed by members of the group and remain within the roost cavity for approximately 26 days. Insects including ants, caterpillars, moths, grasshoppers, spiders, and beetle larvae comprise approximately 85 percent of their diet. The remainder of their diet consists of wild grapes, cherries, poison ivy berries, blueberries, and nuts such as pecans (USFWS 1999).

Red-cockaded woodpeckers live in mature pine forests, specifically those with longleaf pines averaging 80 to 120 years old and loblolly pines averaging 70 to 100 years old. Destruction of its preferred long-leaf pine habitat by humans or disease (pines afflicted by fungus or red-ring rot) resulted in the woodpecker becoming listed as endangered in 1970. The current range is from eastern Texas to the southeastern United States and southern Florida. The red-cockaded woodpecker is primarily an upland species, also inhabiting hydric pine flatwoods. Due to lack of appropriate habitat within the action area, USACE has determined that the Proposed Action would have no effect on the piping plover.

D.2.6.1.3 Roseate Tern and "No Effect" Determination

The roseate tern is a mid-sized tern that can reach a length of 15.7 inches (40 centimeters) with a wingspan of 23.6 inches (60 centimeters) (USFWS 1999). This species has a black cap, gray upperparts, white underparts, and a white forked tail. Roseate terns have a thin black bill which becomes red during the breeding season (FNAI 2001). The diet of the roseate tern primarily consists of small fish and invertebrates. Roseate terns forage in the surf along the shore. The species can be found within North America from Canada south to the Florida Keys, and on islands throughout the Caribbean. In South Florida, the roseate tern's main nesting areas are located in the Florida Keys and the Dry Tortugas where they nest on isolated islands, rubble islets, and dredge spoils. Roseate terns are present on breeding grounds in South Florida between May and August. The main threat to the roseate tern is human disturbance during nesting (USFWS 1999). Due to lack of preferred habitat within the action area, USACE has determined that the Proposed Action would have no effect on the roseate tern.

D.2.6.1.4 Bartram's Hairstreak Butterfly and Florida Leafwing Butterfly and "No Effect" Determination

The Bartram's hairstreak is a small butterfly approximately 1 inch (25 millimeters) in length with a forewing length of 0.4 to 0.5 inches (10 to 12.5 mm). Bartram's hairstreak is easily recognized by broad white bands with a black edge that can be seen when the wings are closed. This species does not exhibit sexual or seasonal dimorphism. The Florida leafwing is a medium-sized butterfly approximately 2.75 to 3 inches (76 to 78 millimeters) in length. The open wing surface color is red to red-brown, the closed wing is gray to tan, with a tapered outline, cryptically looking like a dead leaf when the butterfly is at rest. The Florida leafwing exhibits sexual dimorphism, with females being slightly larger and with darker coloring along the wing margins than the males (79 FR 47183).

The Bartram's hairstreak butterfly and the Florida leafwing butterfly both occur within pine rockland habitat, and occasionally associated rockland hammock and hydric pine flatwoods. Reproduction and development occur entirely within the pine rocklands. Immature stages occur entirely on the host plant, the pineland croton. Adults disperse and roost within the pine rockland canopy, and also in associated rockland hammock and hydric pine flatwood vegetation interspersed within these pinelands. The Bartram's hairstreak butterfly has been observed every month throughout its range; however the exact number of broods appears to be sporadic from year to year, with varying peaks in seasonal abundance. The Florida leafwing produces multiple generations per year with an entire life cycle of about 2 to 3 months and maintains continuous broods throughout the year (79 FR 47183).

The Bartram's hairstreak butterfly is extant within ENP, and several pineland fragments on the mainland of Miami-Dade County, the smallest being Navy Wells Pineland Preserve. The Florida leafwing is extant within ENP and until 2006 had occurred on Big Pine Key in the Florida Keys and historically in pineland fragments on mainland Miami-Dade County. The Florida leafwing butterfly was once locally common at Navy Wells Pineland Preserve and the Richmond Pine Rocklands to the northeast of ENP, however, Florida leafwings are not known to have bred at either location in 25 years. The Bartram's hairstreak and Florida leafwing butterflies can disperse to make use of appropriate habitat in ENP as studies indicate they are able to disperse throughout the landscape as far as 5 kilometers (3 miles) utilizing high quality habitat patches (79 FR 47183). At present, ongoing surveys suggest that the Bartram's hairstreak and Florida leafwing butterflies actively disperse throughout the Long Pine Key region of ENP (79 FR 47183). Five of the seven critical habitat units (BSHB1-BSHB5) are currently occupied by the Bartram's scrub-hairstreak (BSHB1 ENP Miami-Dade County; BSHB2 Navy Wells Pineland Preserve; Miami-Dade County; BSHB3 Camp

Owaissa Bauer, Miami-Dade County; BSHB4 Richmond Pine Rocklands, Miami-Dade County; BSHB5 Big Pine Key, Monroe County). One of the four critical habitat units is currently occupied by the Florida leaf wing butterfly (FLB1 ENP Miami-Dade County) (79 FR 47183). Designated critical habitat for the Florida leafwing butterfly occurs entirely within the Bartram's hairstreak units. Reference **Figure D.2-32** and **Figure D.2-33**.

These butterflies were listed as endangered in part due to their specificity on a single host plant and loss of associated habitat. Pine rockland communities occur on areas of relatively high elevation and consequently, have been subject to intense development pressure. In addition, pine rocklands are a fire-maintained community and require regular burns to maintain the open shrub/herbaceous stratum and to control hardwood encroachment. Fire suppression, fragmentation, invasion by exotic species, and a lowered water table have negatively affected the remaining tracts of pine rocklands. Populations of the Bartram's hairstreak and Florida leafwing butterflies have declined throughout their historic range. Distributions are extremely limited. Additional factors for population declines also include the use of insecticides for mosquito control and collecting (79 FR 47183).

The Bartram's hairstreak butterfly and the Florida leafwing butterfly have the potential to occur within the pine rocklands of ENP on Long Pine Key. Although potentially suitable habitat exists within the action area, USACE has determined that the implementation of the Proposed Action will have no effect on these species due to the lack of anticipated changes in hydrology within pine rockland habitat.

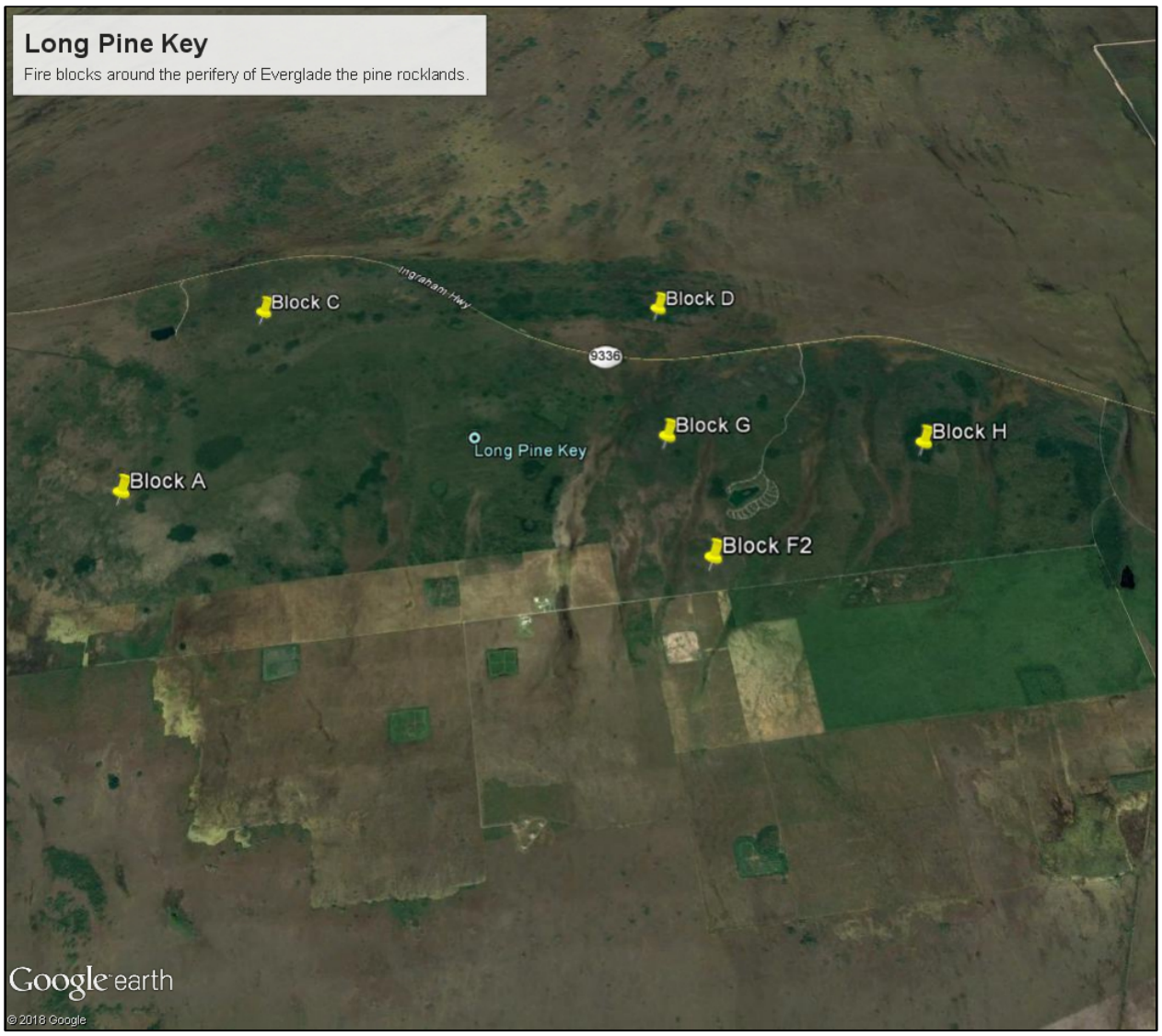


Figure D.2-38. Long Pine Key in ENP.

During plan formulation efforts for COP, USFWS requested additional RSM-GL output for locations (Blocks A, C, D, F2, G, and H) in the pine rocklands identified on **Figure D.2-38** to support evaluation of pine rockland species, including the Florida leafwing butterfly, as the entire population of this species occurs within this map. USFWS used ENP's fire management blocks to represent the overall boundaries of the Everglade pine rocklands. **Figure D.2-39** through **Figure D.2-44** illustrate stage duration curves for ECB19RR and ALTQ for each of the requested locations in the pine rocklands. Hydrologic effects for ALTQ+ are expected to be similar. Under the Proposed Action, there are no proposed changes to water levels within these areas, as demonstrated by the figures below, and as such, any effect on pine rocklands from action implementation is expected to be insignificant. USACE has determined that the Proposed Action would have no effect on Bartram's hairstreak butterfly and its designated critical habitat or the Florida leafwing butterfly and its designated critical habitat.

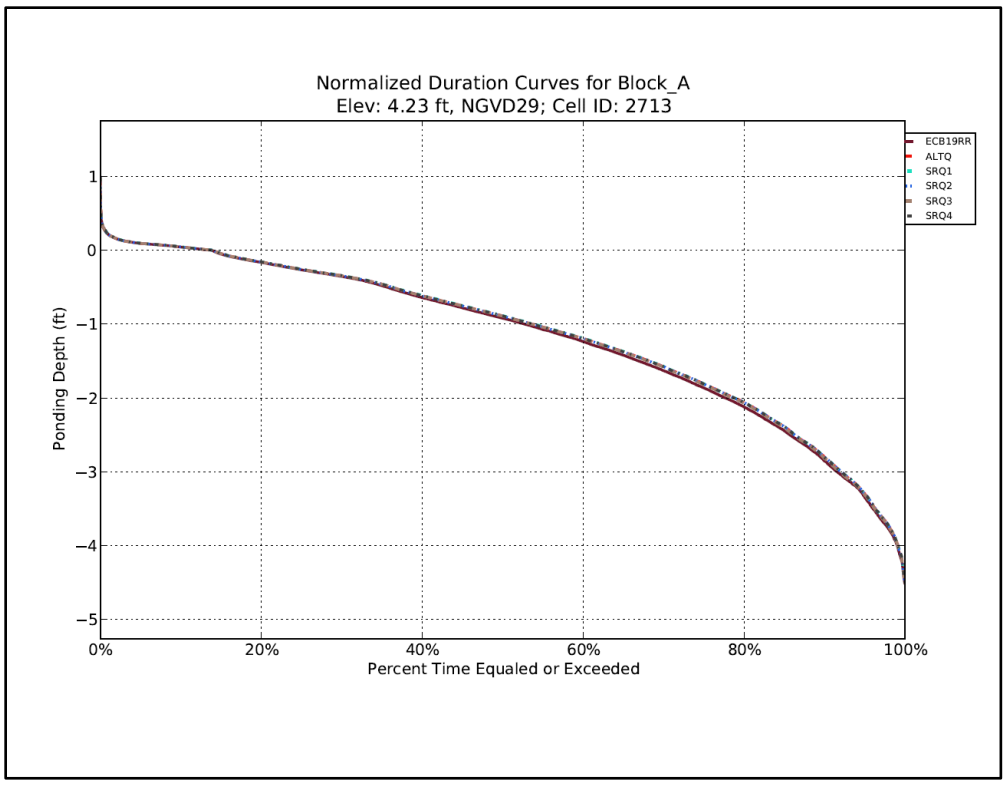


Figure D.2-39. Normalized duration curve for Block A over the period of record (1965-2005).

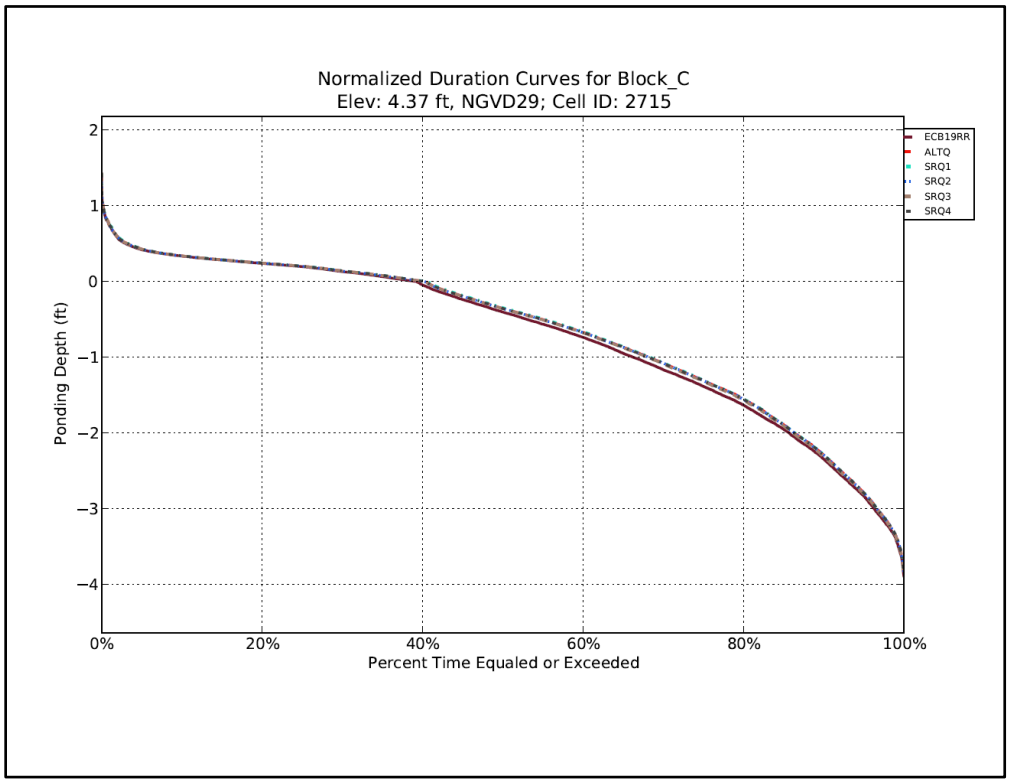


Figure D.2-40. Normalized duration curve for Block C over the period of record (1965-2005).

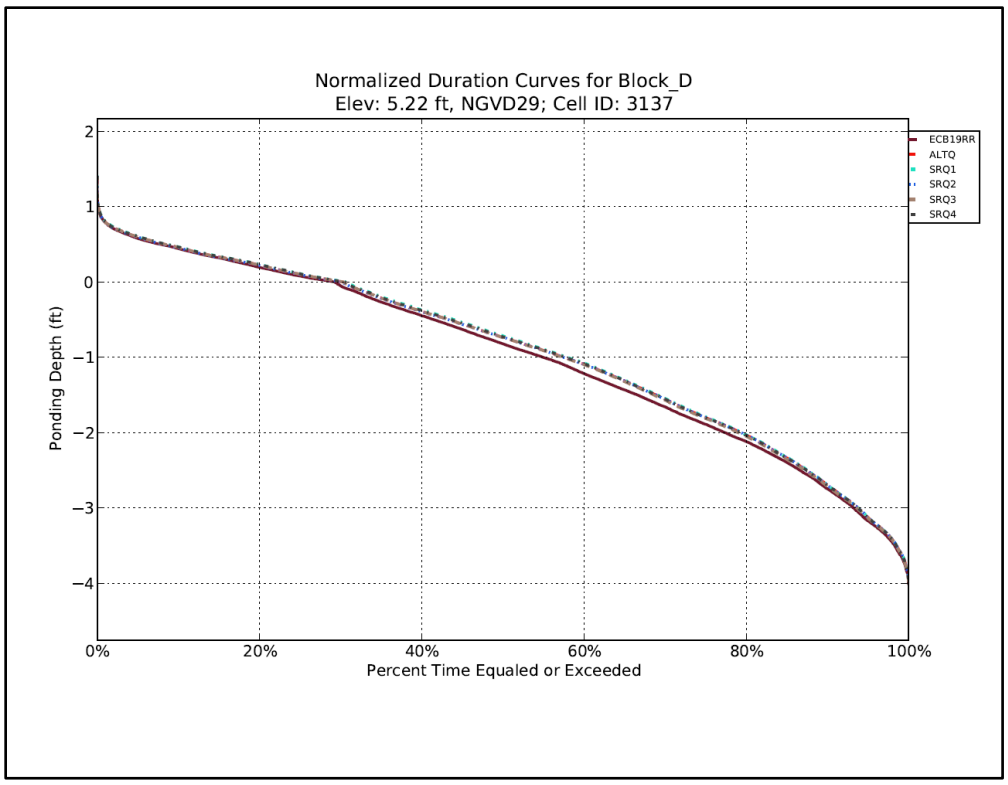


Figure D.2-41. Normalized duration curve for Block D over the period of record (1965-2005).

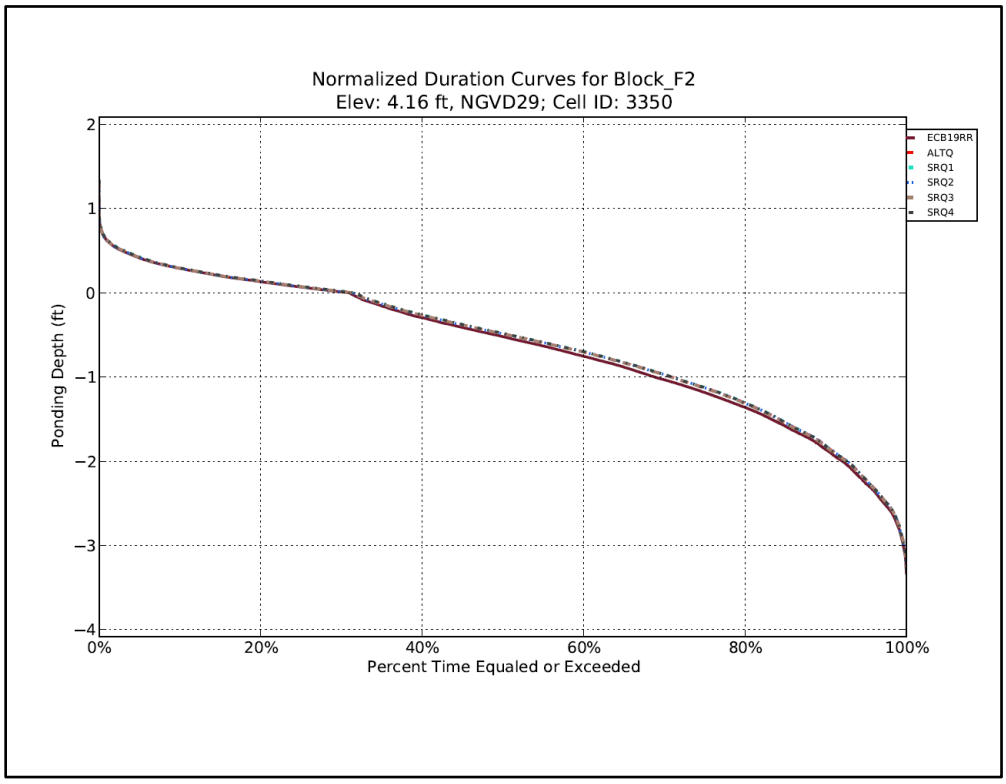


Figure D.2-42. Normalized duration curve for Block F2 over the period of record (1965-2005).

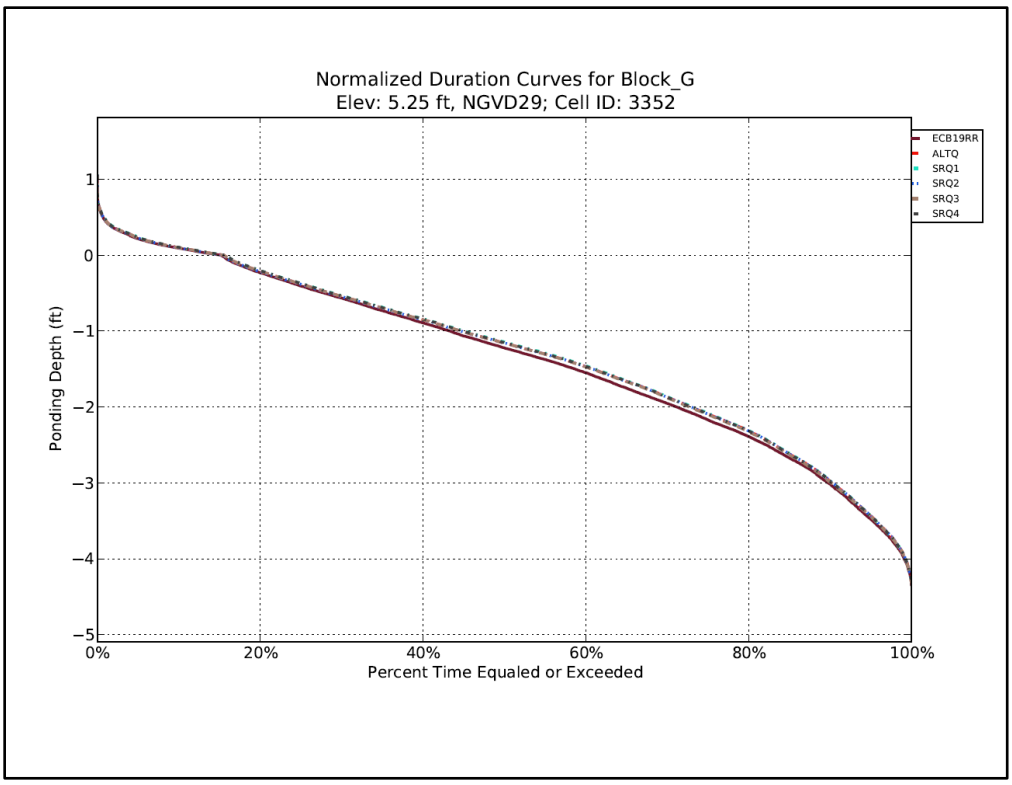


Figure D.2-43. Normalized duration curve for Block G over the period of record (1965-2005).

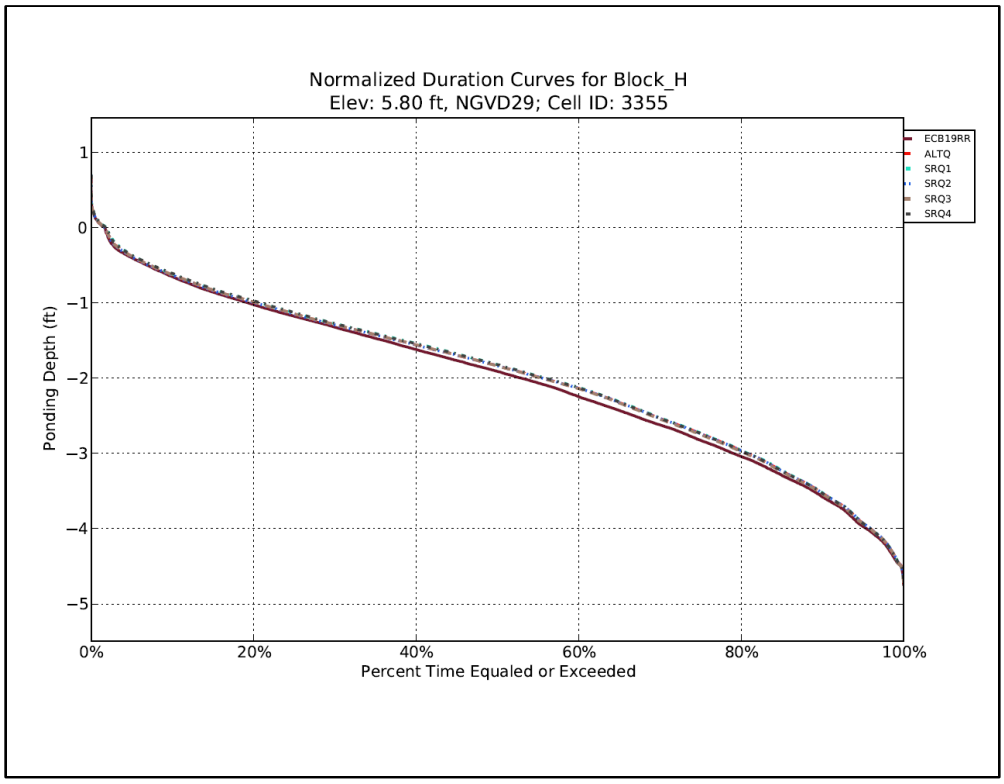


Figure D.2-44. Normalized duration curve for Block H over the period of record (1965-2005).

D.2.6.1.5 Miami Blue Butterfly and "No Effect" Determination

The Miami blue is a small butterfly endemic to Florida. The Miami blue has a forewing length of 10 to 13 millimeters. Males and females are both bright blue dorsally, but females have an orange eyespot near their hind wing. Both sexes have a gray underside with four black spots. The Miami blue butterfly occurs at the edges of tropical hardwood hammocks, beachside scrub, and occasionally in rockland pine forests. Larval host plants include the seed pods of nickerbeans (*Caesalpinia spp*.), blackbeards (*Pithecellobium spp.)*, and balloon vine (*Cardiospermum halicababum*), a non-native species. Adults feed on the nectar of Spanish needles (*Bidens pilosa*), cat tongue (*Melanthera aspera*), and other weedy flowers near disturbed hammocks. Primarily a South Florida coastal species, the Miami blue's historic distribution ranged as far north as Hillsborough County on the Gulf Coast and Volusia County on the Atlantic Coast and extended south to the Florida Keys and the Dry Tortugas (FWC 2013). The butterfly was thought to be extinct following Hurricane Andrew in 1992, but was observed in November 1999 at Bahia Honda State Park in the Florida Keys. More than 329 surveys conducted at locations in mainland Florida and the Keys have failed to detect other colonies of this species. As the Miami blue butterfly is not known to occur within the action area, USACE has determined that the Proposed Action will have no effect on this species.

D.2.6.1.6 Schaus Swallowtail Butterfly and "No Effect" Determination

Schaus' swallowtail is a large dark brown and yellow butterfly that can have a forewing length of up to 2.3 inches (5.8 centimeters). This species has contrasting white or yellow markings across the forewing, and a series of yellow blotches that continues along the forewing to the hind wing. It also has a black "tail" with yellow edging, and an orange patch on the underside of the hind wing. The Schaus' swallowtail butterfly is endemic to South Florida and the Florida Keys. The Schaus' butterfly normally maintains a single annual brood that occurs in late spring. Most sightings have been recorded between mid-April and mid-July although a second brood has occasionally been noted in August. Adults are short lived and use torchwood (*Amyris elemifera*) and wild lime (*Zanthoxylum fagara*) as a food plant for larval development (USFWS 1999, USFWS 2004, USFWS 2008).

The present distribution of the Schaus' swallowtail butterfly is limited to tropical hardwood hammocks in portions of Miami-Dade and Monroe Counties. Formerly, this vegetation type occurred more widely in South Florida, but has been largely eliminated on the mainland. The largest remaining populations of the Schaus' swallowtail as documented by the USFWS in 2008 occur on southern Elliot Key in Biscayne National Park and associated smaller islands south to Key Largo, Key Largo Hammock State Botanical State Park and Crocodile Lake National Wildlife Refuge (USFWS 1999, USFWS 2004, USFWS 2008). Although Schaus' swallowtail butterflies were sighted historically on Lignumviate Key, Big Pine Key, and Upper Matecumbe Key, regular sightings of this species are uncommon south of Key Largo (USFWS 1999, USFWS 2004, USFWS 2008). The last known mainland specimen was collected at Coconut Grove in 1924, however following re-introduction efforts in 1995-1997, the Schaus' swallowtail has been observed within the Deering Estate in southeastern Miami-Dade County (USFWS 1999, USFWS 2004, USFWS 2008). Re-introduction efforts also occurred in 1995-1997 in northern Key Largo (Key Largo Hammock State Botanical State Park and Crocodile Lake National Wildlife Refuge), central Key Largo (John Pennekamp Coral Reef State Park), in southern Key Largo (Curry Tract, Florida Keys Wildlife and Environmental Area), and on Lower Matecumbe Key (Klopp Tract, Lignumvitae Key Botanical State Park) with success documented shortly after introduction; however long term monitoring suggests that re-introduction into several of the sites has not affected the abundance or distribution of the species within the Florida Keys (USFWS 2008). Decline has been attributed primarily to habitat destruction, mosquito control practices, and over-harvesting by collectors (USFWS 1999). As the Schaus' swallowtail butterfly is not known to

occur within the action area, USACE has determined that the Proposed Action will have no effect on this species.

D.2.6.1.7 Stock Island Tree Snail and "No Effect" Determination

The Stock Island tree snail is a large snail that can reach a length of 2.2 inches (5.5 centimeters). Its thin shell is white to light brown with three brownish to purple horizontal stripes that surround the shell. Numerous narrow brownish to purple stripes can be found vertically on the shell surface. The species also has a white inner shell spiral and shell tip (FNAI 2001). Stock Island tree snail feed on epiphytic (growing on the surface of a plant) lichens, fungi, and algae on their host tree (USFWS 1999). The Stock Island tree snail inhabits tropical hardwood hammocks. Host trees include poisonwood (*Metopium toxiferum*), pigeon plum (*Coccoloba diversifolia*), Jamaican dogwood (*Piscidia piscipula*), strangler fig (*Ficus aurea*), and gumbo limbo (*Bursera simarouba*) (FNAI 2001). Stock Island tree snails are active mainly during the May through November wet season when breeding, feeding, and dispersion takes place. Dry periods (December through April) are spent in aestivation, in which the snail forms a tight sealed barrier between the aperture and a tree trunk or branch. Snails may come out of aestivation briefly to feed during dry-season rains or go into aestivation during summer dry spells.

This species is endemic to Stock Island and Key West in the Florida Keys, but became extinct in its native range in 1992. Several small populations remain, however, only in locations where the snail has been introduced outside of its historic range (USFWS 1999). Population declines, habitat destruction and modification, pesticide use, and over-collecting led to the listing of this species (USFWS 1999). The historic distribution of the Stock Island tree snail was thought to be limited to hardwood hammocks on Stock Island and Key West and possibly other lower Keys hammocks. The range of this species has been artificially extended through the actions of collectors who have introduced it to Key Largo and the southernmost reaches of the mainland. The snail has been documented to occupy six sites outside of its historic range including ENP and BCNP. Snails were first introduced by collectors to a small area in ENP in the late 1980s. From 1987 to 1994, the presence of snails was reported, but by 1995, surveys revealed the snails were no longer present. A population of snails has previously been reported in Big Cypress, however surveys were not conducted to confirm their occurrence. The status of the populations in ENP and BCNP is considered to be declining or extirpated (USFWS 1999). Due to the lack of preferred subtropical hardwood hammock habitat in the action area and current distribution of the species, USACE has determined that the Proposed Action would have no effect on this species.

D.2.6.1.8 Crenulate Lead-Plant and "No Effect" Determination

The crenulate lead-plant grows up to 5 feet tall and has reddish-purple branches. Leaves are alternate with 25-33 opposite leaflets. Leaflets are 0.5-1.5 inches long and alternate. The upper surface of the leaflets are gray-green. The lower surface of the leaflets are paler and dotted with glands. The margins are scalloped. Flower spikes are 6 to 8 inches long and are white or lavender. Plants are smooth and hairless throughout. The crenulate lead-plant is a perennial, deciduous shrub that inhabits marl prairies and wet pine rocklands in a small area of Miami-Dade County. The crenulate lead-plant is known from a 20 square mile area from Coral Gables to Kendall, Miami-Dade County (USFWS 1999). Its historic range was only slightly greater, extending south to Cutler and north to the Little River in northeast Miami-Dade County. This range encompasses an area 5 miles east to west and 12 miles north to south. Currently, eight locations are known to be inhabited by the plant (USFWS 1999); four are located in parks owned by the Miami-Dade County Parks Department; one site is located in the Bird Road railroad right of way and the three remaining sites are located in the vicinity of Snapper Creek and Old Cutler Road, Red Road and

SW 8th Street, and Schoolhouse Road (USFWS 1999). Fairchild Tropical Gardens in cooperation with Miami-Dade County Parks Department, h3as also introduced a population of 108 plants to a pine rockland habitat adjacent to Addison Hammock at the Charles Deering Estates (USFWS 1999). The crenulate lead-plant occurs in plant communities that were historically associated with seasonally hydrated soils and frequent burning, including wet pinelands, transverse glades, and hammock edges. It can be found growing in poorly-drained sands within pine rocklands or in wet prairies with rock outcrop complex soils. It requires open sun to partial shade. Agricultural, urban and commercial development within Miami-Dade County have destroyed pine rockland communities where this species occurred. Other threats to the continued existence of this species include fire suppression, drainage and exotic plant invasion. As the crenulate lead-plant is not known to occur within the action area, USACE has determined that the Proposed Action will have no effect on this species.

D.2.6.1.9 Okeechobee Gourd and "No Effect" Determination

The Okeechobee gourd is an annual or perennial, fibrous rooted, high-climbing vine with tendrils. The Okeechobee gourd possesses heart to kidney-shaped leaf blades, with 5 to 7 angular, shallow lobes, and irregularly serrated margins. Young leaves are covered with soft hairs. The cream-colored flowers are bell-shaped. The light green gourd is globular or slightly oblong, with 10 indistinct stripes, and hard shelled with bitter flesh. The seeds are gray-green and flat (USFWS 1999). The Okeechobee gourd was historically found on the southern shore of Lake Okeechobee, in Palm Beach County, and formerly in the Everglades (USFWS 1999). In recent surveys, the species has been found to be restricted to sites along the middle St. Johns River in Volusia County and around Lake Okeechobee in Glades and Palm Beach counties (USFWS 2009). It has been recently documented along the southeastern shore of Lake Okeechobee, including Torry Island, Ritta Island, Kreamer Island, and the southern shore of the Lake Okeechobee Rim Canal (USFWS 2009). The documented population of the Okeechobee gourd around the southeastern shore of Lake Okeechobee is strongly associated with Torry muck, a soil formed in the extensive pond apple forests that once surrounded the lake. However, successful growth and reproduction of the gourd under cultivation suggests that the species can grow in a wider range of soils (USFWS 1999).

Around Lake Okeechobee, the gourd relies on pond apple trees to support its vines above rising water levels during the wet season. Other trees and shrubs, such as willow (*Salix caroliniana*) and cypress (*Taxodium distichum*), may also provide suitable support for the vines. Along the St. Johns River, Okeechobee gourds are most typically found growing on elderberry and common reed (*Phragmites spp*.). The Okeechobee gourd also seems to readily germinate on alligator nests around Lake Okeechobee, which provide suitably elevated soil berms in full sun, with no competition from other plants. These disturbed sites provide areas where competition is reduced and elevated areas that promote the growth of elderberry, button bush, and other erect bushes and shrubs (USFWS 1999).

The plants' decline is largely attributable to conversion of swamp forests to agriculture and water level management in Lake Okeechobee. For the gourd to maintain viable healthy populations, fluctuations in lake level are necessary. High lake levels facilitate dispersal and inundate and destroy aggressive weeds in local habitats. As lake levels decrease, the cleared open habitats allow the quickly germinating Okeechobee gourd seeds to sprout and begin climbing before they have to compete with other pioneer species. Water regulation practices can greatly influence the timing and duration of flooding and drying cycles across remnant areas of suitable elevation and soils around Lake Okeechobee. Permanent inundation of suitable soils is detrimental to the plant. Another potential threat to this plant is the proliferation of exotic plant species around the edges of Lake Okeechobee (USFWS 1999). Under COP, areas around Lake Okeechobee are not anticipated to change. There are no proposed changes to water

levels within these areas. Due to the rare occurrence of observations within the action area and habitat requirements, USACE has determined that the Proposed Action would have no effect on the Okeechobee gourd.

D.2.6.1.10 Big Pine Partridge Pea and "No Effect" Determination

The Big Pine partridge pea was listed as endangered by the USFWS on September 29, 2016 (81 FR 66842). The Big Pine partridge pea is a small prostrate to ascending, perennial, herbaceous shrub that is 3.9 to 31.5 inches tall (10 to 80 centimeters) with yellow flowers and pinnately compound leaves. It has one to several branched stems arising from a contorted rootstock. The fruit is an elongate pod similar to that of a pea, with a soft fuzzy texture, which turns gray with age and eventually splits open to release seeds. The plant is a perennial, but some stems will die back every year, and a small portion of plants may go dormant for a year or more. Peak flowering and fruiting occurs in the summer from May to August. Flowers require insect visitation for pollination (80 FR 58536; September 29, 2015). The plant occurs in pine rocklands of the lower Florida Keys and adjacent disturbed sites, including roadsides. Within pine rocklands habitat, the Big Pine partridge pea is associated with areas that have few hardwoods and over story palms are abundant. The plant is often found in a clumped distribution surrounded by large areas of bare, open rock that do not support plant growth. The Big Pine Partridge Pea is endemic to the lower Florida Keys in Monroe County. Historical records exist for occurrences on five islands within the Florida Keys including Big Pine Key, No Name Key, Ramrod Key, Cudjoe Key, and Sugarloaf Key. The current range of the Big Pine partridge pea is Big Pine Key and Cudjoe Key (80 FR 58536; September 29, 2015). The decline of the plant can be largely attributed to loss of pine rocklands habitat to development and modification of this habitat due to inadequate fire management. Habitat loss, fragmentation, and degradation, and associated pressures from increased human population, are major threats. Hurricanes and storm surge have also impacted population levels. Other threats include competition from non-native plants, management practices on roadsides and disturbed sites (mowing, sodding and herbicide use) and small population size (80 FR 58536; September 29, 2015). Due to the rare occurrence of observations within the action area and habitat requirements, USACE has determined that the Proposed Action would have no effect on the Big Pine Partridge pea.

D.2.6.1.11 Blodgett's Silverbush and "No Effect" Determination

Blodgett's silverbush was listed as threatened by the USFWS on September 29, 2016 (81 FR 66842). Blodgett's silverbush is an erect, perennial shrub or herb that is 4 to 24 inches tall (10 to 60 centimeters) with a woody base and small, green flowers. The stems and leaves are covered with small hairs. The leaves are arranged alternately along the stems and are long and are oval or elliptic in shape and often are colored a distinctive, metallic bluish green when dried. The fruit is a woody capsule which contains the seeds. Flowering and fruiting occur throughout the year (80 FR 58536; September 29, 2015). The plant occurs in pine rocklands, in sunny gaps or edges of rockland hammock and coastal berm, and on roadsides. Blodgett's silverbush historically occurred from central and southern Miami-Dade County from Brickell Hammock to Long Pine Key in ENP, and in Monroe County throughout the Florida Keys from Totten Key south to Key West. Blodgett's silverbush is currently known from central Miami-Dade County from Coral Gables and southern Miami-Dade County to Long Pine Key southwest to Boca Chica Key. The decline of the plant can be largely attributed to loss of pine rocklands habitat to development and modification of this habitat due to inadequate fire management. Habitat loss, fragmentation, and degradation, and associated pressures from increased human population, are major threats. Hurricanes and storm surge have also impacted population levels. Other threats include competition from non-native plants,

management practices on roadsides and disturbed sites (mowing, sodding and herbicide use) and small population size (80 FR 58536; September 29, 2015).

Blodgett's silverbush has the potential to occur within the pine rocklands of ENP on Long Pine Key. Under the Proposed Action, there are no proposed changes to water levels within these areas, and as such, any effect on pine rocklands from action implementation is expected to be insignificant. Reference **Section D.2.6.1.4**, **Figure D.2-39** through **Figure D.2-44** for stage duration curves for ECB19RR and ALTQ in the pine rocklands of ENP. Hydrologic effects for ALTQ+ are expected to be similar. USACE has determined that the Proposed Action would have no effect on Blodgett's silverbush.

D.2.6.1.12 Cape Sable Thoroughwort and "No Effect" Determination

The Cape Sable thoroughwort is endemic to South Florida and is a flowering perennial herb that is 5.9-9.8 inches (15 to 25 centimeters) tall (78 FR 63802) with erect stems. The blue to lavender flowers are borne in heads, usually in clusters of two to six. Flowers are produced mostly in the fall, though sometimes year round. The Cape Sable thoroughwort was historically known in Miami-Dade and Monroe Counties, both on the Florida mainland and the Florida Keys, and along Florida Bay. The species was observed historically on Big Pine Key, Boca Grande Key, Fiesta Key, Key Largo, Key West, Knight's Key, Lignumvitae Key, Long Key, Upper Matecumbe Key, and Lower Matecumbe Key. The Cape Sable thoroughwort grows in open canopy habitats, including coastal berms and coastal rock barrens, and in semi-open to closed canopy habitats, including buttonwood forests, coastal hardwood hammocks, and rockland hammocks.

The current range of the species includes areas in ENP and five islands in the Florida Keys. In ENP, Cape Sable thoroughwort populations occur in buttonwood forests and coastal hardwood hammocks from the Coastal Prairie Trail near the southern tip of Cape Sable to Madeira Bay (78 FR 63802). In the Florida Keys, the species is now only known from Upper Matecumbe Key, Lower Matecumbe Key, Lignumvitae Key, Long Key, Big Munson Island, and Boca Grande Key. It no longer exists on Key Largo, Big Pine Key, Fiesta Key, Knight's Key or Key West (78 FR 63802). Coastal hardwood hammock that supports the Cape Sable thoroughwort in ENP is a species rich, tropical hardwood forest. Though similar in most characteristics, coastal hardwood hammock develops on a substrate consisting of elevated marl ridges with a very thin layer of organic layer. The plant species composition of coastal hardwood hammocks also differs somewhat from that of rockland hammock. Forests dominated by buttonwood often exist in upper tidal areas, especially where mangrove swamp transitions to rockland or coastal hardwood hammock.

The decline of the species is primarily the result of habitat loss from commercial and residential development, sea level rise, storms, competition from non-native plants, predation by non-native herbivores, and wildfires. Critical habitat for the species occurs in nine separate units across approximately 4,439 hectares (10,968 acres) in Miami-Dade and Monroe Counties. Reference **Figure D.2-34**. Implementation of the Proposed Action is not expected to affect coastal rock berms and barrens within ENP where the species may occur; therefore, USACE has determined that the Proposed Action will have no effect on this species or its designated critical habitat.

D.2.6.1.13 Carter's Small-flowered Flax and "No Effect" Determination

Carter's small-flowered flax is an annual or short lived perennial herb endemic to Miami- Dade County, where it grows in pine rocklands, particularly in disturbed pine rocklands. Its stem is erect, 9.0-14.2 inches tall, commonly branched near the base and covered with minute hairs. Its leaves are slender, 0.7-1.0 inches long and are entire, alternate, and closely overlap at the base of the plant. Flowers are yellow.

Little research has been done into the reproductive biology of the plant. Field observations indicate that the species does not usually occur in great abundance. The plant is currently associated with pine rocklands that have undergone some sort of substrate disturbance (e.g., firebreaks, canal banks, edges of railway beds). All known occurrences over the last 15 years have been within either scarified pine rockland, disturbed areas adjacent to or within pine rocklands, or completely disturbed areas having a limestone substrate (80 FR 49845 49866; August 17, 2015). Carter's small-flowered flax has experienced substantial destruction, modification, and curtailment of its habitat and range. Specific threats to the plant includes habitat loss, fragmentation, and modification cause by development (i.e. conversion to both urban and agricultural land uses) and inadequate fire management. Only small and fragmented occurrences of the plant remains. Indications are that most existing populations are marginal at best. The current range of Carter's small-flowered flax spans a small geographic area, – a narrow band no more than 2.5 miles in width, and approximately 16.7 miles in length, respectively, along the Miami Rock Ridge.

Carter's small-flowered flax is endemic to and occurs exclusively within pine rockland habitat on the Miami Rock Ridge outside of ENP. Critical habitat for the species consists of seven units across approximately 1,072 hectares (2,649 acres) in Miami-Dade County. Reference **Figure D.2-35**. USACE has determined that the Proposed Action will have no effect on this species or its designated critical habitat.

D.2.6.1.14 Everglades Bully and "No Effect" Determination

The Everglades bully was listed as threatened by the USFWS on October 6, 2017 (82 FR 46694). The Everglades bully is a single to many stemmed shrub, 3 to 6 feet (ft.) (1 to 2 meters (m)) tall. The branches are smooth, slightly bent, and somewhat spiny. The leaves are thin, oval-shaped, 0.8 to 2 inches (2 to 5 centimeters (cm)) long, evergreen, lance-shaped, and fuzzy on their undersides. The flowers are in axillary clusters. The Everglades bully grows in pine rockland habitat, marl prairie habitat and within the ecotone between both habitats. These habitats are maintained by regular fire, and are prone, particularly marl prairie, to annual flooding for several months during the wet season. The plant also grows on the sunny edges of rockland hammock habitat which is fire resistant. Little is known about the life history of the sub species, including pollination, biology, seed production or dispersal. Reproduction is sexual with new plants generated from seeds. Flowers are produced from April to May, and fruit ripens from June to July. The plants can stand partial inundation with fresh water for a portion of the year but do not tolerate salinity (82 FR 46694; October 6, 2017).

The historical range of the plant is limited to Collier, Miami-Dade, and Monroe Counties. In Miami-Dade County, the plant was known from central and southern Miami-Dade County along the Miami Rock Ridge, which extends from Long Pine Key in the Everglades northward through urban Miami to the Miami River. In Monroe County, the plant is known from BCNP on the mainland, and was collected as far south as Key Largo, in the Florida Keys. In Collier County, the subspecies has been recorded only within BCNP. The current range of the Everglades bully is BCNP, the Long Pine Key region of ENP and pine rocklands adjacent to ENP. The sub species is extirpated from Key Largo and has not been found in surveys of pine rocklands on Key Largo, Big Pine Key, Cudjoe Key, and Lower Sugarloaf Key. The largest population is currently present at Long Pine Key in ENP. The most recent population estimate within ENP is estimated at 10,000 to 100,000 plants in 2013 (82 FR 46694; October 6, 2017). In Miami-Dade County, outside ENP, plants have been observed at Larry and Penny Thompson Park within the Richmond Pine Rocklands, at Quail Roost Pinelands, at Navy Wells Pineland Preserve, at Sunny Palms Pinelands, and in the pine rocklands at Grant Hammock and Pine Ridge Sanctuary. Surveys in the Gum Slough region of Lostmans Pines in BCNP reported finding the plant with limited distribution; however it is suggested that the Everglades bully is more widespread in BCNP than is currently known (82 FR 46694; October 6, 2017).

Declines of the plant have been attributed to habitat loss from fire suppression or inadequate fire management. Historically, fire served to maintain the boundary between pine rockland and rockland hammock by eliminating encroachment of hardwoods into pine tocklands. Absent natural or prescribed fire, many pine rocklands have succeeded to rockland hammock. Canopy cover on the interior of rockland hammock is too dense to support herbs and smaller shrub species such as the Everglades bully (82 FR 46694; October 6, 2017). Threats from other natural or manmade factors include nonnative, invasive plants; management practices (such as mowing); recreation (including ORV use), effects from small population size and isolation; limited geographic range; and stochastic events including hurricanes, storm surges, and wildfires.

The Everglades bully has the potential to occur within the pine rocklands of ENP on Long Pine Key. Under the Proposed Action, there are no proposed changes to water levels within these areas, and as such, any effect on pine rocklands from action implementation is expected to be insignificant. Reference **Section D.2.6.1.4**, **Figure D.2-39** through **Figure D.2-44** for stage duration curves for ECB19RR and ALTQ in the pine rocklands of ENP. Hydrologic effects for ALTQ+ are expected to be similar. USACE has determined that the Proposed Action would have no effect on the Everglades bully.

D.2.6.1.15 Florida Brickell-Bush and "No Effect" Determination

The Florida Brickell-bush is a perennial herb. Mature plants are 1 to 3.5 feet tall (0.3-1.1 meters), slender, erect, and branching. Leaves are 1–3 centimeters (cm) (0.4–1.2 inches (in)) long, alternate, narrow, linear, thick, usually spreading or curved downward, entire or slightly toothed, and resin-dotted. The flower heads are in loose, open clusters at the ends of branches. Disk flowers are white in small, dense heads surrounded by hairy, slightly ribbed bracts; there are no ray flowers, although long-style branches (white, sometimes brown) may appear to be rays (78 FR 61273 61293; October 3, 2013). Little research has been done into the reproductive biology of the plant. Field observations indicate that the species does not usually occur in great abundance—populations are typically sparse and contain a low density of plants even in well-maintained pine rockland habitat. Flowering takes place primarily in the fall (August–October), but individuals may be found in flower during most of the year. The Florida brickell bush grows exclusively in pine rocklands on the Miami Rock Ridge in Miami-Dade County outside the boundaries of ENP. This area extends from the ENP boundary, near the park entrance road, northeast approximately 72 kilometers (km) (45 miles (mi)) to the ridge's end near North Miami. The Florida Brickell-bush tends to occur on exposed limestone with minimal organic litter and in areas with only minor amounts of substrate disturbance. The Florida Brickell-bush was historically known from central and southern Miami-Dade County from South Miami to Florida City, a range of approximately 22.5 miles along the Miami Rock Ridge. The plant is currently distributed from central and southern Miami-Dade County from SW 120th St. to Florida City (78 FR 61273 61293; October 3, 2013). The decline of the species is primarily the result of habitat loss from commercial and residential development, lack of adequate fire management, proliferation of nonnative species and sea level rise.

The Florida Brickell-bush is endemic to and occurs exclusively within pine rockland habitat on the Miami Rock Ridge outside of ENP. Critical habitat for the species consists of seven units across approximately 1,062 hectares (2,624 acres) in Miami-Dade County. Reference **Figure D.2-36**. USACE has determined that the Proposed Action will have no effect on this species or its designated critical habitat.

D.2.6.1.16 Florida Bristle Fern

The Florida bristle fern is very small in size and superficially resembles other bryophytes, such as mosses and liverworts, making it difficult to observe in its natural habitat. It is mat forming, has no roots, and contains trichomes (hair-like/bristle-like outgrowth) on the tip of the fern. The Florida bristle-fern is generally epiphytic (a plant that grows non-parasitically upon another plant) or epipetric (growing on rocks), typically growing in rocky outcrops of rockland hammocks, in oolitic limestone solution holes, and, occasionally, on tree roots in limestone surrounded areas. These rockland habitats occur on the Miami Rock Ridge (80 FR 60463; October 6, 2015).

The historical range of the Florida bristle fern included southern (Miami-Dade County) and central (Sumter County) Florida. In Miami- Dade, the historical range of the subspecies extended from Royal Palm Hammock (now in ENP) at its southern limit, northeast to Deering-Snapper Creek Hammock, which includes the modern day site of Smather's Four fillies Farm residential area, near R. Hardy Matheson Preserve. Plants in Miami-Dade were known to historically occur in at least 11 hammocks: Deering Snapper Creek Hammock, Castellow Hammock, Silver Palm Hammock, Ross Hammock, Royal Palm Hammock, Hattie Bauer Hammock, Shields Hammock, Nixon Lewis Hammock, Fuchs Hammock, Addison Hammock (in the Deering Estate at Cutler), and Matheson Hammock (80 FR 60463; October 6, 2015). The current range of the Florida bristle fern within Miami-Dade County is located on public lands that include Castellow Hammock Park, Hattie Bauer Hammock, Fuchs Hammock Preserve, and Meissner Hammock, three of which are owned by the county and the fourth is owned by the State and leased to the county (80 FR 60463; October 6, 2015). Over the years, systematic surveys have been conducted in ENP in Royal Palm Hammock and other hammocks on Long Pine Key (also in ENP); however surveys were not successful in finding the plant. Factors affecting the sub-species include habitat modification and destruction caused by human population growth and development (80 FR 60463; October 6, 2015).

The Florida bristle fern has the potential to occur within the pine rocklands of ENP on Long Pine Key. Under the Proposed Action, there are no proposed changes to water levels within these areas, and as such, any effect on pine rocklands from action implementation is expected to be insignificant. Reference **Section D.2.6.1.4**, **Figure D.2-39** through **Figure D.2-44** for stage duration curves for ECB19RR and ALTQ in the pine rocklands of ENP. Hydrologic effects for ALTQ+ are expected to be similar. USACE has determined that the Proposed Action would have no effect on the Florida bristle fern.

D.2.6.1.17 Florida Semaphore Cactus and "No Effect" Determination

The Florida semaphore cactus is a tree-like cactus that grows up to 6 feet (2 meters) tall with an erect main trunk, which is elliptical or oval in cross section and armed with spines. The flowers are bright red and the fruits are yellow and eggs shaped (78 FR 63802). The Florida semaphore cactus occurs in rockland hammocks, coastal berm, and buttonwood forests. The plant appears on sandy soils and limestone rocklands soils with little organic cover and seems to prefer areas where canopy cover and sun exposure are moderate. The cacti was known historically from three islands of the Florida Keys in Monroe County: Key Largo, Big Pine Key, and Little Torch and from Swan Key, a small island in Biscayne Bay in Miami-Dade County. The current range includes two naturally occurring populations in Biscayne National Park (BNP) in Miami-Dade County, and one at the Nature Conservancy's Torchwood Hammock Preserve on Little Torch Key, a small island in the Florida Keys in Monroe County. Experimental plantings have been conducted at several sites on State and Federal conservation lands in the Florida Keys from 1996 to 2012 with mixed results (78 FR 63802). The decline of the species is primarily the result of habitat loss from commercial and residential development, vandalism, overutilization (collection by lobbyists, also known

as poaching), infection by fungal pathogens, and predation by the moth *Cactoblastis cactorum*, competition from non-native plants, sea level rise, storms, and wildfire. Critical habitat for the species occurs in four separate units across approximately 1,785 hectares (4,411 acres) in Miami-Dade and Monroe Counties. **Reference Figure D.2-37**. Implementation of the Proposed Action is not expected to affect coastal rock barrens; therefore, USACE has determined that the action will have no effect on this species or its designated critical habitat.

D.2.6.1.18 Sand Flax and "No Effect" Determination

Sand flax was listed as endangered by the USFWS on September 29, 2016 (81 FR 66842). Sand flax is a small perennial herb that is 14 to 21 inches tall (35 to 53 centimeters) with yellow flowers. When not in flower, it resembles a short, wiry grass. The plant has one to several stems arising from its base and leaves are linear in shape and are arranged alternately along stems. The fruit is a woody capsule which splits when dry to release seeds. The plant produces flowers year round with maximum flowering from April to September, with a peak around March and April (80 FR 58536; September 29, 2015). The plant occurs in pine rocklands, disturbed pine rocklands, dry marl prairie, and disturbed areas on rocky spoils adjacent to these habitats.

The historical range consists of central and southern Miami-Dade County and Monroe County in the lower Florida Keys. In Miami-Dade County, records for the species were widespread from the Coconut Grove area to the southern part of the county, close to what is now the main entrance to ENP and Turkey Point. In the Florida Keys there are records of the species from Big Pine Key, Ramrod Key, Upper and Lower Sugarloaf Keys, Park Key, Boca Chica Key, Middle Torch Key, and Big Torch Key. The current range of sand flax consists of eight extant populations in Miami-Dade County and four extant populations in the Florida Keys. In Miami-Dade County, the current distribution is from just north of SW 184 Street (in the Martinez Pinelands Preserve) south to the intersection of Card Sound Road and the C-102 Canal, and west to SW 264 Street and 177 Avenue (Everglades Archery Range at Camp Owaissa Bauer). In the Florida Keys, the current distribution includes four islands: Big Pine Key, Upper and Lower Sugarloaf Keys, and Big Torch Key (80 FR 58536; September 29, 2015). While pine rocklands historically were the primary habitat of the plant, the species is currently rare in relatively undisturbed pine rocklands, with the exception of plants on Big Pine Key. Several occurrences are in pine rockland remnants that are dominated by native pine rockland species, but have little or no pine canopy or sub canopy. Occurrences reported from marl prairie are at sites that have been artificially drained or are scraped pine rocklands that function more like marl prairie (80 FR 58536; September 29, 2015).

The decline of the plant can be largely attributed to loss of pine rocklands habitat to development and modification of this habitat due to inadequate fire management. Habitat loss, fragmentation, and degradation, and associated pressures from increased human population, are major threats. Hurricanes and storm surge have also impacted population levels. Other threats include competition from non-native plants, management practices on roadsides and disturbed sites (mowing, sodding and herbicide use) and small population size (80 FR 58536; September 29, 2015).

As the sand flax is not known to occur within the action area, USACE has determined that the Proposed Action will have no effect on this species.

D.2.6.1.19 Florida Pineland Crabgrass and "No Effect" Determination

Florida pineland crabgrass was listed as threatened by the USFWS on October 6, 2017 (82 FR 46694). Florida pineland crabgrass is a small perennial clump-grass appearing blue to gray with reddish brown stems, typically 1.5 to 3 feet (0.5 to 1 m) tall. The leaves form a subtle zig-zag pattern as the leaf blades come off the stem at an angle. Flowers are dull green, very small, and occur on wispy spikes on the ends of the leafy stems with usually only a few flower clusters forming per clump of grass. Little is known about the life history of Florida pineland crabgrass including pollination biology, seed production, or dispersal. The plant produces flowers from summer to late fall on both new and older growth, some plants have been observed to finish seeding as late as December. The plant occurs between the seasonally flooded ecotone of pine rocklands and marl prairies, although the species may overlap somewhat into both habitats. The species can withstand inundation of freshwater for one to several months each year. Pine rocklands and marl prairies are maintained by regular fire, and are prone, particularly marl prairie, to annual flooding for several months during the wet season (82 FR 46694; October 6, 2017).

Florida pineland crabgrass occurred historically within central and southern Miami-Dade County along the Miami Rock Ridge, from southern Miami to the Long Pine Key region of ENP. A single plant was discovered in 1995 within marl prairie habitat at the Martinez Pinelands in the Richmond Pine rocklands. However, this plant has since disappeared. Three other historical occurrences in Miami-Dade County have been documented: (1) a site between Cutler and Longview Camp; (2) Jenkins Homestead; and (3) south Miami. However little is known regarding the status of these populations. The current range of Florida pineland crabgrass includes ENP and BCNP. Surveys suggest the species occurs throughout Long Pine Key of ENP, and is much wider ranging than previously known within ENP. Florida pineland crabgrass is widely distributed within the Lostmans Pines region of BCNP in Monroe County as well. Surveys in 2002 documented the presence of Florida pineland crabgrass within BCNP within this area, representing the first known occurrence of the species outside Miami-Dade County. Subsequent surveys for the species within BCNP have documented up to nine occurrences, some of which contain an estimated 500-600 plants. Surveys conducted within the Gum Slough region of Lostmans Pines indicated that the species is widely distributed in the region with a total of 2,365 plants counted within pineland and sawgrass based survey plots. The range wide population estimate for Florida pineland crabgrass is 100,000 to 200,000 individuals at Long Pine Key and greater than 10,000 individuals within BCNP (82 FR 46694; October 6, 2017). Populations remain abundant within ENP and BCNP. Declines of the plant have been attributed to habitat loss from fire suppression or inadequate fire management. Threats from other natural or manmade factors include nonnative, invasive plants; management practices (such as mowing); recreation (including ORV use), effects from small population size and isolation; limited geographic range; and stochastic events including hurricanes, storm surges, and wildfires.

Florida pineland crabgrass has the potential to occur within the pine rocklands of ENP on Long Pine Key. Under the Proposed Action, there are no proposed changes to water levels within these areas, and as such, any effect on pine rocklands from action implementation is expected to be insignificant. USACE has determined that the Proposed Action would have no effect on Florida pineland crabgrass. Reference **Section D.2.6.1.4**, **Figure D.2-39** through **Figure D.2-44** for stage duration curves for ECB19RR and ALTQ in the pine rocklands of ENP. Hydrologic effects for ALTQ+ are expected to be similar.

D.2.6.1.20 Florida Pineland Sandmat and "No Effect" Determination

Pineland sandmat was listed as threatened by the USFWS on October 6, 2017 (82 FR 46694). The pineland sandmat is an ascending to erect perennial herb. The stems are hairy and often reddish. The leaf blades range from kidney shaped or triangle shaped and elliptic to oval. The fruit is 2 mm broad and seeds are 1 mm long transversely wrinkled and yellowish in color. Little is known about the life history of the plant, but it is believe to be somewhat long lived. Fruit production is year round with a peak in the fall. The plant occurs in pine rocklands. Pine rocklands are maintained by regular fire, and are prone to annual flooding for several months during the wet season; however the pineland sandmat generally occurs in higher elevation pine rocklands at Long Pine Key in ENP, in areas rarely subject to flooding. The plant can stand partial inundation with fresh water for a portion of the year but does not tolerate salinity. The pineland sandmat occurred historically only within the southern portion of the Miami Rock Ridge from Homestead to the Long Pine Key region of ENP. The pineland sandmat has been encountered consistently within Long Pine Key, as well as Miami-Dade County owned conservation lands adjacent to ENP. The total population size is estimated to be between 15,500 to 146,000 individuals, with the majority of the population occurring on Long Pine Key at the time of listing (82 FR 46694; October 6, 2017). Pine rockland fragments outside of the Everglades represent about half of the subspecies extend range; however the subspecies is most abundant within ENP. Declines of the plant have been attributed to habitat loss from fire suppression or inadequate fire management. Threats from other natural or manmade factors include nonnative, invasive plants; management practices (such as mowing); recreation (including ORV use), effects from small population size and isolation; limited geographic range; and stochastic events including hurricanes, storm surges, and wildfires.

The pineland sandmat has the potential to occur within the pine rocklands of ENP on Long Pine Key. Under the Proposed Action, there are no proposed changes to water levels within these areas, and as such, any effect on pine rocklands from action implementation is expected to be insignificant. USACE has determined that the Proposed Action would have no effect on the pineland sandmat. Reference **Section D.2.6.1.4**, **Figure D.2-39** through **Figure D.2-44** for stage duration curves for ECB19RR and ALTQ in the pine rocklands of ENP. Hydrologic effects for ALTQ+ are expected to be similar.

D.2.6.1.21 Florida Prairie Clover and "No Effect" Determination

The Florida prairie-clover was listed as endangered by the USFWS on October 6, 2017 (82 FR 46694). The Florida prairie-clover is a short-lived (less than 8 years) perennial shrub that is 2.6 to 9.8 feet (0.8 to 3.0 m) tall with a light brown woody stem and non-woody, light brown or reddish branches. The leaves are composed of 9 to 15 oval, gland-tipped leaflets, and are gland-dotted on the underside. The flowers are in small loose heads at ends of hairy, glandular stalks, less than 0.4 in long. The flower color is white and maroon; each of the petals is different lengths and shapes. The fruit is a small one-seeded pod, mostly enclosed by the hairy, gland-dotted calyx. The Florida-prairie clover grows in pine rockland, rockland hammock, marl prairie, and coastal berm, and in the ecotones between these habitats. The species may also occur along roadsides within these habitats. The life history of the plant appears to be short-lived (less than 8 years) with a persistent seed bank. The plant produces flowers from October to March and fruit ripen from November to April. Seed maturation is January to May with a peak in February to March. The plants can withstand partial inundation with fresh water for a portion of the year, but do not tolerate salinity (82 FR 46694; October 6, 2017).

The historical range of the plant includes Miami-Dade, Monroe, Collier, and Palm Beach Counties. There have been no reports of this plant from Palm Beach County since 1918. In Miami-Dade County, the plant

has been extirpated from a number of historical locations, including Castellow Hammock, ENP, the Coral Gables area, pinelands south of the Miami River, and Cox Hammock. The plant is also presumed to be extirpated within ENP. The current range includes BCNP, three Miami-Dade conservation areas, and three additional unprotected lands within the Cutler Bay region of Miami-Dade County. In 1999, the plant was rediscovered within BCNP. Subsequent surveys of the four extant populations on BCNP occurred after this time. Surveys confirmed the presence of the plant in two locations within BCNP. The first being an area north of Oasis Visitor Center which contained 236 plants (of various ages) and represents the largest extant population within BCNP. The second extant population was confirmed in the Pinecrest region (along Loop Road) of BCNP, a historical location within the Preserve; however, only 17 plants were encountered. The plant was not found at 11-Mile Road, nor at a second location along Loop Road, during the surveys (82 FR 46694; October 6, 2017). Declines of the plant have been attributed to habitat loss from fire suppression or inadequate fire management. Threats from other natural or manmade factors include nonnative, invasive plants; management practices (such as mowing); recreation (including ORV use), effects from small population size and isolation; limited geographic range; and stochastic events including hurricanes, storm surges, and wildfires.

As the Florida prairie-clover is not known to occur within the action area, USACE has determined that the Proposed Action will have no effect on this species.

D.2.6.1.22 Deltoid Spurge, Garber's Spurge, Small's Milkpea, and Tiny Polygala and "No Effect" Determination

The Deltoid spurge is a small perennial herb with many wiry stems radiating from a taproot. The herb forms mats or tufts up to 6 inches long over exposed limestone. Leaves are 0.25 inches long and are thick and rounded-triangular (deltoid) in shape. Leaves are opposite, smooth or sometimes hairy below, bright green, and have slightly rolled-under margins. Flowers are solitary and are in cup-like structures with tiny, petal-like glands (USFWS 1999). The Deltoid spurge is endemic to the pine rocklands of the Miami rock ridge and occurs only in Miami Dade County, Florida. The plant is historically known to occur in pine rocklands from the Goulds area north to the center of the city of Miami. The northern portion of its range has been completely modified by urban expansion (USFWS 1999). Results of a project to map the extant pine rockland habitat indicate that currently, the species is known to remain on 14 public lands (12 county, 1 State, 1 Federal) an undetermined number of private lands from southern Miami to Homestead (USFWS 2010b). The deltoid spurge tends to occur in areas with an open shrub canopy, exposed limestone, and minimal litter (pine needles, leaves, and other organic materials). It is most often found growing at the edges of sand pockets with plants growing both in sand (sometimes in association with tiny polygala) and on limestone. The survival and recovery of the Deltoid spurge is threatened by habitat loss from urban development, fire suppression, and exotic plant infestation (USFWS 1999).

Garber's spurge is a short lived perennial herb, softly hairy throughout, with, wiry, erect stems and is up to 12 inches longs. Leaves are 0.5 inches long, oval, opposite, with very short stalks and entire or minutely toothed margins. The plant has small cup-like structures holding flowers. The fruit is a pubescent capsule. The seeds either are smooth or have transverse ridges, but are not wrinkled (USFWS 1999). Garber's spurge is known from pine rocklands, coastal flats, coastal grasslands, and beach ridges in Miami-Dade and Monroe counties. It requires open sunny areas and needs periodic fires to maintain habitat suitability. It is found throughout its historic range. Historically, it occurred from Perrine, Miami-Dade County, and west to Cape Sable, Monroe County, and to the Sand Keys west of Key West, Monroe County (USFWS 1999). Garber's spurge is currently known from about 17 populations, including two in Miami-Dade County and one at Cape Sable (on two Capes within ENP) and on 14 islands in the Keys in Monroe County

(Bahia Honda, Big Torch Key, Boca Grande Key, Crawl Key, Key Largo, Cudjoe Key, Fat Deer Key, Grassy Key, Long Key, Long Point Key, Lower Matecumbe Key, Marquesas Keys, Sugarloaf Key, Summerland Key) (USFWS 2007). The species formerly occurred on at least twice as many islands in the Keys, across a wider range of the Miami-Rock Ridge in Miami-Dade County, and formerly ranged more widely on Cape Sable. The plant is no longer known from Collier County (USFWS 2007). The plant has been documented within Long Pine Key in ENP (USFWS 2007). The plant occurs at low elevations either on thin sandy soils or directly on limestone. It is found in a variety of open to moderately shaded habitat types. In pine rocklands, it grows out of crevices in limestone. On Cape Sable within ENP, it has been reported on hammock edges, open grassy prairies, and backdune swales. In the Florida Keys, it grows on semi-exposed limestone shores, open calcareous salt flats, pine rocklands, calcareous sands of beach ridges, and along disturbed roadsides (USFWS 1999). The survival and recovery of Garber's spurge is threatened by habitat loss from urban development, fire suppression, and exotic plant infestation. In addition, remaining habitat is fragmented and most populations are small, making them more susceptible to extirpation.

The tiny polygala was listed as threatened by the USFWS on July 8, 1985 (50 FR 29345 29349). The tiny polygala is an erect short-lived herbaceous species. The tiny polygala forms a roseatte and grows no more than 8 cm tall. Flowers are small and numerous in a crowded head at the top of the stem. The plant contains 1-4 usually unbranched stems. Leaves are 0.5 inches wide and 2 inches long often taller than the flower heads, lance shaped and slightly wider toward the tip. Most plants germinate and die within one year. Seedlings can be observed from late October through April, but are most typically seen from December to February. Flowers appear throughout the year with a peak during the summer (USFWS 1999). The plant occurs in four distinct habitats with similar characteristics; pine rockland, scrub, high pine and open coastal spoil. All of these habitats are dry and prone to periodic natural fire. Within these habitats the plant requires high light levels and open sand with little to no organic litter accumulation. Prior to 1995, the tiny polygala was thought to be a local endemic of pine rocklands and scrub in Miami-Dade and Broward counties (the Miami and Fort Lauderdale metro areas, respectively); however extensive surveys conducted expanded the known range into northern Palm Beach and south central Martin Counties (USFWS 2010c). The plant is currently known to occur at eight sights within Miami-Dade, Palm Beach, Martin and St. Lucie Counties with the highest density of sites located in southern Miami-Dade County (USFWS 2010c). The survival and recovery of tiny polygala is threatened by habitat loss from urban development, fire suppression, and exotic plant infestation.

The small's milkpea is a small, trifoliate, perennial legume with small, purple flowers. The stems are grayish and grow up to 2 m long. The 1 to 2.2 cm long leaflets are broadly ovate to elliptic. Small's milkpea is a perennial legume that usually flowers during the summer months. The plant occurs in the pine rocklands of southern Miami-Dade County. At the time of its listing, Small's milkpea was only known at two sites near Homestead in Miami-Dade County. A 1994 survey found Small's milkpea at seven additional sites on public land: Seminole Wayside, Navy Wells, Sunny Palms, Pine Island, Ned Glenn, Goulds, and the HRS site in Florida City/Miami-Dade County Park and Recreation Department is actively managing five of the six publicly owned sites. Small's milkpea was also found in small numbers on privately owned pine rockland fragments. Small's milkpea is not known to occur on Long Pine Key in ENP (USFWS 1999).

The Deltaoid spurge, Garber's spurge, tiny polygala, and small's milkpea have the potential to occur within the pine rocklands of ENP on Long Pine Key. Under the Proposed Action, there are no proposed changes to water levels within these areas, and as such, any effect on pine rocklands from action implementation is expected to be insignificant. USACE has determined that the Proposed Action would have no effect on these species. Reference **Section D.2.6.1.4**, **Figure D.2-39** through **Figure D.2-44** for stage duration curves

for ECB19RR and ALTQ in the pine rocklands of ENP. Hydrologic effects for ALTQ+ are expected to be similar.

D.2.6.2 "May Affect" Determinations

Federally threatened or endangered species that are known to potentially exist within close proximity of the action area, and may be affected are discussed in detail below.

D.2.6.2.1 Florida Panther and "May Affect Not Likely To Adversely Affect" Determination

The Florida panther was once the most widely distributed mammal (other than humans) in North and South America. One of 30 cougar subspecies, Florida panther is tawny brown on the back and pale gray underneath, with white flecks on the head, neck and shoulder. Male panthers weigh up to 130 pounds and females reach 70 pounds. Preferred habitat consists of cypress swamps, pine and hardwood hammock forests. The main diet of the Florida panther consists of white-tailed deer, sometimes wild hog, rabbit, raccoon, armadillo and birds. Florida panthers are solitary, territorial, and often travel at night. Males have a home range of up to 400 square miles and females about 50 to 100 square miles. Female panthers reach sexual maturity at about three years of age. Mating season is December through February. Gestation lasts about 90 days and females bear two to six kittens. Juvenile panthers stay with their mother for about two years. Females do not mate again until their young have dispersed. The main survival threats to the Florida panther include habitat loss due to human development and population growth, collision with vehicles, parasites, feline distemper, feline alicivirus (an upper respiratory infection), and other diseases.

COP is an operational plan to redistribute the amount and timing of releases from WCA 3A to ENP. COP has the potential to affect both the Primary and Secondary Zones of the Service's "Focus Area" for the Florida panther (**Figure D.2-45**). The focus area is based on scientific information on panther habitat usage provided in Kautz et al. 2006 and Thatcher et al. 2006, and denotes areas in Florida where developmental projects could potentially affect the panther. The Panther Focus Area south of the Caloosahatchee River is divided into Primary, Secondary, and Dispersal Zones. The Primary Zone is currently occupied and supports the only known breeding population of Florida panthers in the world. These lands are important to the long-term viability and persistence of the panther in the wild. The Secondary Zone lands are contiguous with the Primary Zone and although these lands are used to a lesser extent by panthers, they are important to the long-term viability and persistence of the panther in the wild. Panthers use these lands in a much lower density than in the Primary Zone. The Dispersal Zone is a known corridor between the Panther Focus Area south of the Caloosahatchee River to the Panther Focus Area north of the Caloosahatchee River. **Figure D.2-46** displays Florida panther telemetry data from February of 1981 through June of 2017 obtained from the Florida Fish and Wildlife Conservation Commission (FWC 2018).

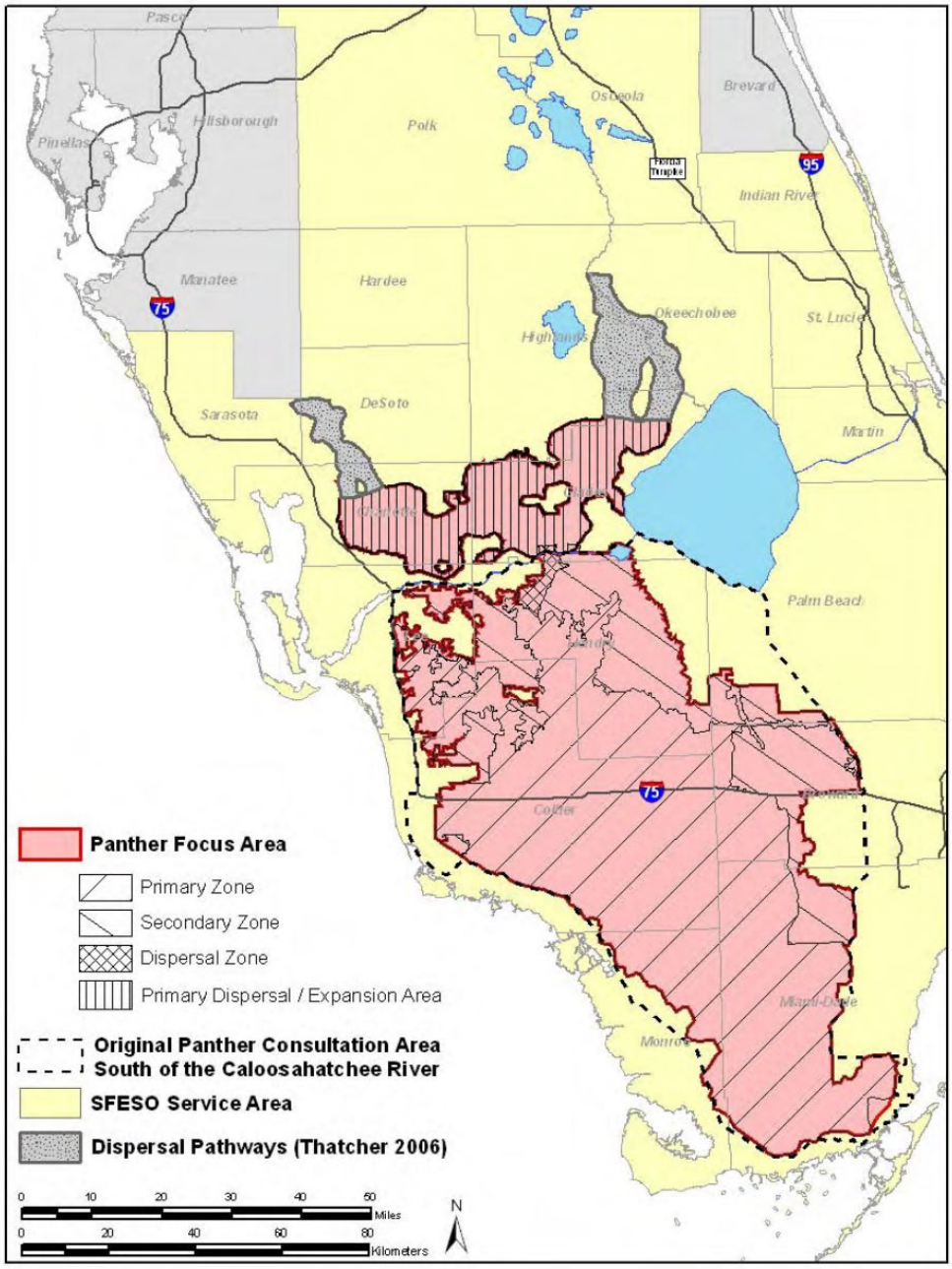


Figure D.2-45. Florida panther zones in South Florida.

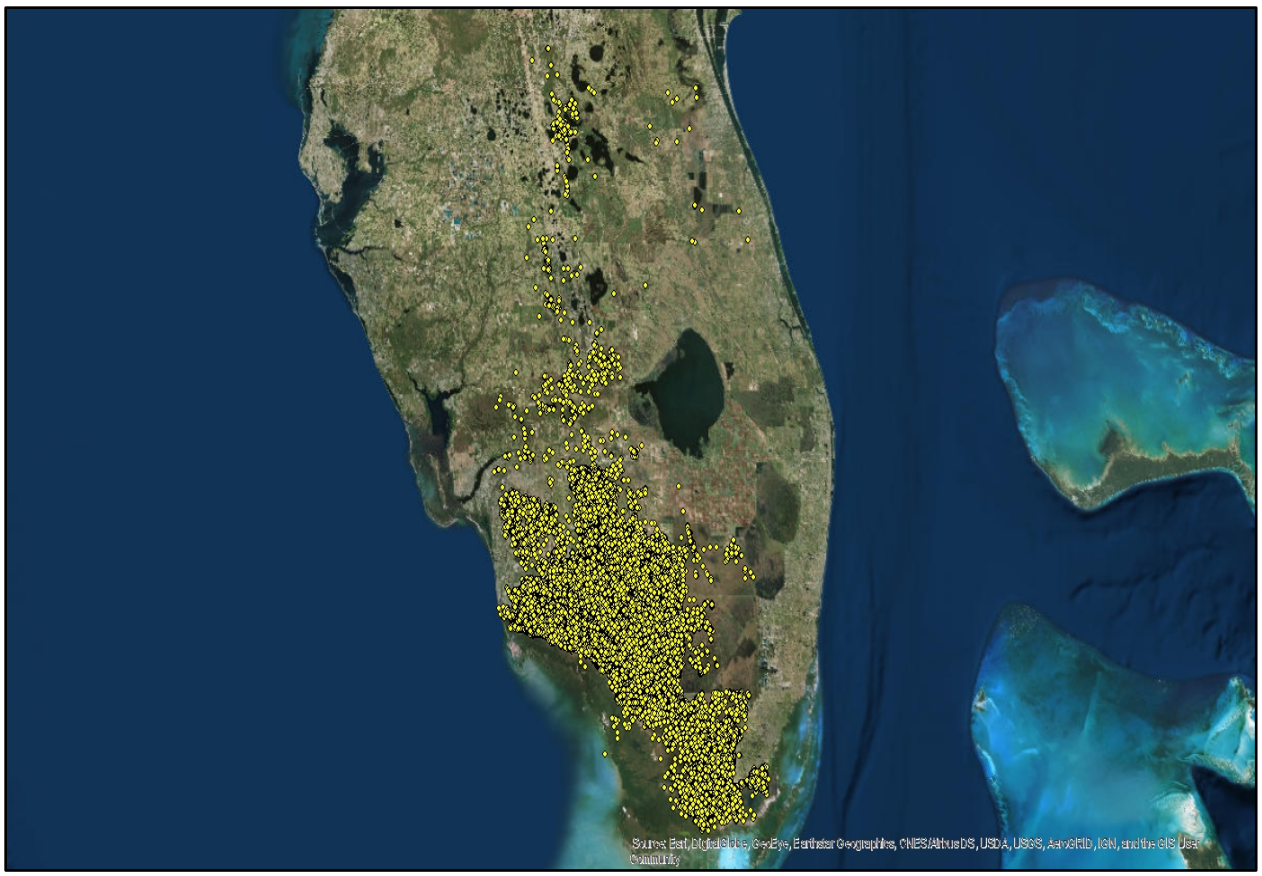


Figure D.2-46. Florida panther telemetry information (1981-2017).

Panther prey density is an important factor in evaluating panther habitat. The type of prey available to the panther affects the health and distribution of the panther, as well as its ability to breed and support young. Due to increased water flow and changes in water distribution it is anticipated that currently over drained areas in ENP would be rehydrated. Reference **Section D.2.4.2** for a description of expected differences in water depths and hydroperiods under ALTQ+ in WCA 3 and ENP in comparison to ECB19RR. ALTQ+ increased overland flow, water depths and resulting hydroperiods in portions of ENP, including NESRS and Taylor Slough. Inundation duration is the percent period of time water levels are above ground surface over the modeled period of record (1965-2005). **Figure D.2-47** depicts the difference in inundation duration over the period of record for ALTQ relative to ECB19RR. Values greater than zero on the horizontal axis indicate increased inundation duration relative to ECB19RR. Values less than zero indicate decreased inundation duration relative to ECB19RR. ALTQ increased inundation duration at all indicator regions (IRs) south of Tamiami Trail (IRs in NESRS (IR129, IR130, IR131, and IR132) and in Taylor Slough (IR133N and IR133S)) relative to ECB19RR. The target for this performance measure (i.e. Natural Systems Model (NSM)) was not met under COP in ENP; however, significant improvement toward the target was observed. ALTQ decreased inundation duration at IRs in WCA 3A and WCA 3B relative to ECB19RR. The greatest magnitude of increase was observed in WCA 3A at IR118, IR119, and IR123. IR118 and IR119 are located east of the Miami Canal and north of WCA 3B in WCA 3A. IR123 is located west of the Miami Canal in central to southern WCA 3A. Decreases in inundation duration were also observed in WCA 3B at IR124, IR125, and IR126. Observed differences between ALTQ at any given location ranged from +/- 5 PPOR of inundation (1% of the period of record equates to ~ 150 days). ALTQ+ would result in similar effects as discussed under ALTQ

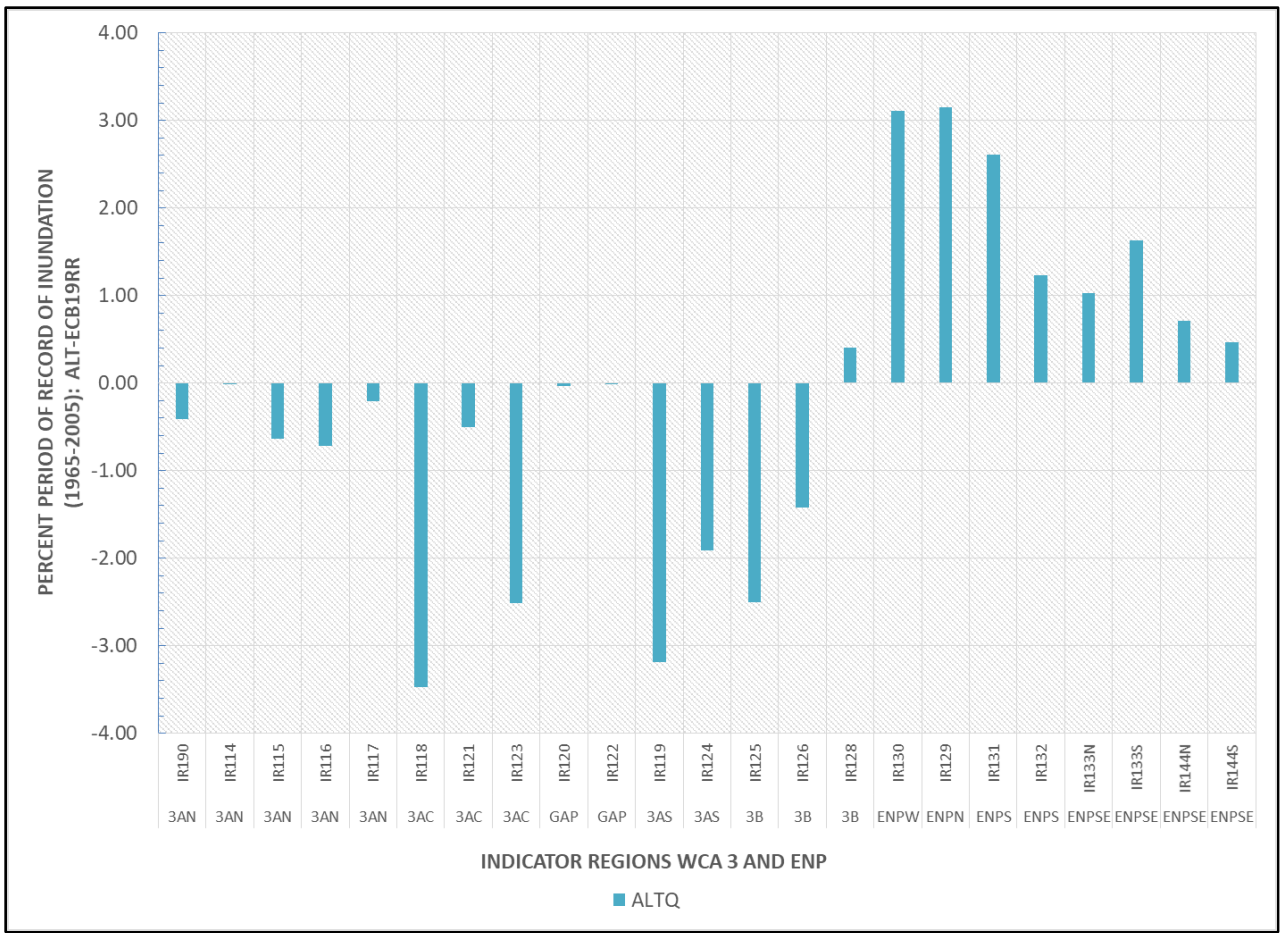


Figure D.2-47.Difference in inundation duration (percent period of record in which water depth is above land surface elevation) for each COP alternative relative to ECB19RR.

Since potentially suitable habitat occurs in the study area, increased water deliveries to ENP could affect Florida panther habitat. However, as lands in the study area become restored to their more historic natural values, improvements to prey may result in greater use by the Florida panther. Small mammals including raccoons and river otters would benefit from increased crayfish and small prey fish biomass in rehydrated areas in ENP as a result of COP. In addition, by lowering portions of WCA 3A and WCA 3B more upland habitat may become available within the Florida panther's primary and secondary zone, directly benefiting the species. However, COP is not expected to convert upland habitat to wetlands where it currently exists in the study area. The Everglades Landscape Vegetation Succession Model (ELVes) was used to predict vegetation community change over time in response to environmental conditions. Reference **Figure D.2-69** through **Figure D.2-71** and **Section D.2.6.2.8**. Results of the modeling indicated that at the broad landscape scale there were few large community changes predicted to occur within most of the action area. Decreases in floating emergent marsh were observed in portions of WCA 3A adjacent to the L-67A/C levee. Based on this information, and the fact that Florida panther is a wide ranging species, USACE has determined that the Proposed Action may affect, but is not likely to adversely affect the Florida panther.

D.2.6.2.2 Florida Manatee and "May Affect Not Likely to Adversely Affect" Determination

The Florida manatee is a large, plant-eating aquatic mammal with a fusiform body that is compressed dorsoventrally and is grey to grey brown in color. Florida manatees live in that can be found in the shallow coastal waters, rivers, and springs of Florida. Florida manatees live in freshwater, brackish, and marine habitats, can move freely between salinity extremes. It can be found in both clear and muddy water. Because they are a subtropical species with little tolerance for cold, they remain near warm water sites in peninsular Florida during the winter. During periods of intense cold, Florida manatees will remain at these sites and will tend to congregate in warm springs and outfall canals associated with electric generation facilities. During warm interludes, Florida manatees move throughout the coastal waters, estuaries, bays, and rivers of both coasts of Florida and are usually found in small groups. During warmer months, Florida manatees may disperse great distances. Florida manatees have been sighted as far north as Massachusetts and as far west as Texas and in all states in between (Rathbun et al. 1982, Fertl et al. 2005). Water depths of at least three to seven feet (one to two meters) are preferred and flats and shallows are avoided unless adjacent to deeper water.

Over the past centuries, the principal sources of Florida manatee mortality have been opportunistic hunting by man and deaths associated with unusually cold winters. As of 2016, the Florida Fish and Wildlife Conservation Commission (FWC) reported 520 Florida manatee deaths that year, which is more than the total number of deaths reported in 2009 (429 deaths), related to the prolonged cold water conditions in the winter of 2009-2010. Today, poaching is rare, but high mortality rates from human-related sources threaten the future of the species. In general, the largest single mortality factor is collision with boats and barges. Florida manatees also are killed in flood gates and canal locks, by entanglement or ingestion of fishing gear, and through loss of habitat and pollution.

Florida manatees have been observed in conveyance canals throughout the action area (**Figure D.2-48** and **Figure D.2-49**) and in adjacent nearshore seagrass beds throughout Florida Bay including all waters of Card, Barnes, Blackwater, Little Blackwater, Manatee and Buttonwood sounds. The extensive acreages of seagrass beds in Florida Bay provides important feeding areas for Florida manatees. Florida manatees also depend upon canals as a source of freshwater and resting sites. It is highly likely that Florida manatees also depend on the deep canals as a cold-weather refuge. The relatively deep waters of the canals respond more slowly to temperature fluctuations at the air/water interface than the shallow bay waters. Thus, the canal waters remain warmer than open bay waters during the passage of winter cold fronts.

The Florida manatee's critical habitat includes all waters of Card, Barnes, Blackwater, Little Blackwater, Manatee and Buttonwood sounds between Key Largo, Monroe County and main-land Miami-Dade County (**Figure D.2-28**). Another component of designated critical habitat is defined as Biscayne Bay, and all adjoining and connected lakes, rivers, canals, and waterways from the southern tip of Key Biscayne northward to and including Maule Lake, Dade County. No specific primary or secondary constituent elements were included in the critical habitat designation. However, researchers agree that essential habitat features for Florida manatee include seagrasses for foraging, shallow areas for resting and calving, channels for travel and migration, warm water refuges during cold weather and freshwater for drinking.

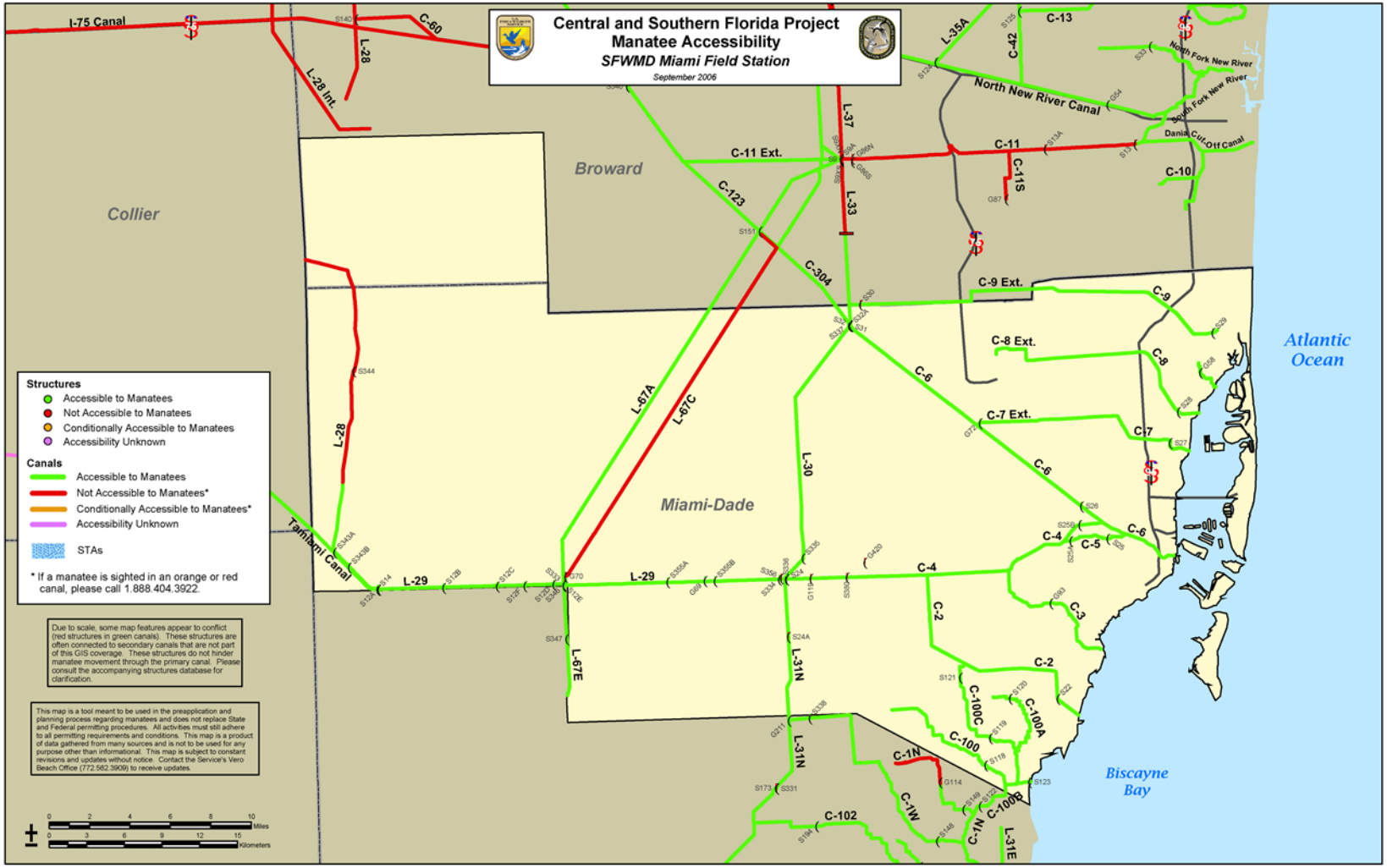


Figure D.2-48. West Indian Manatee Central and South Florida accessibility (Miami Field Station).

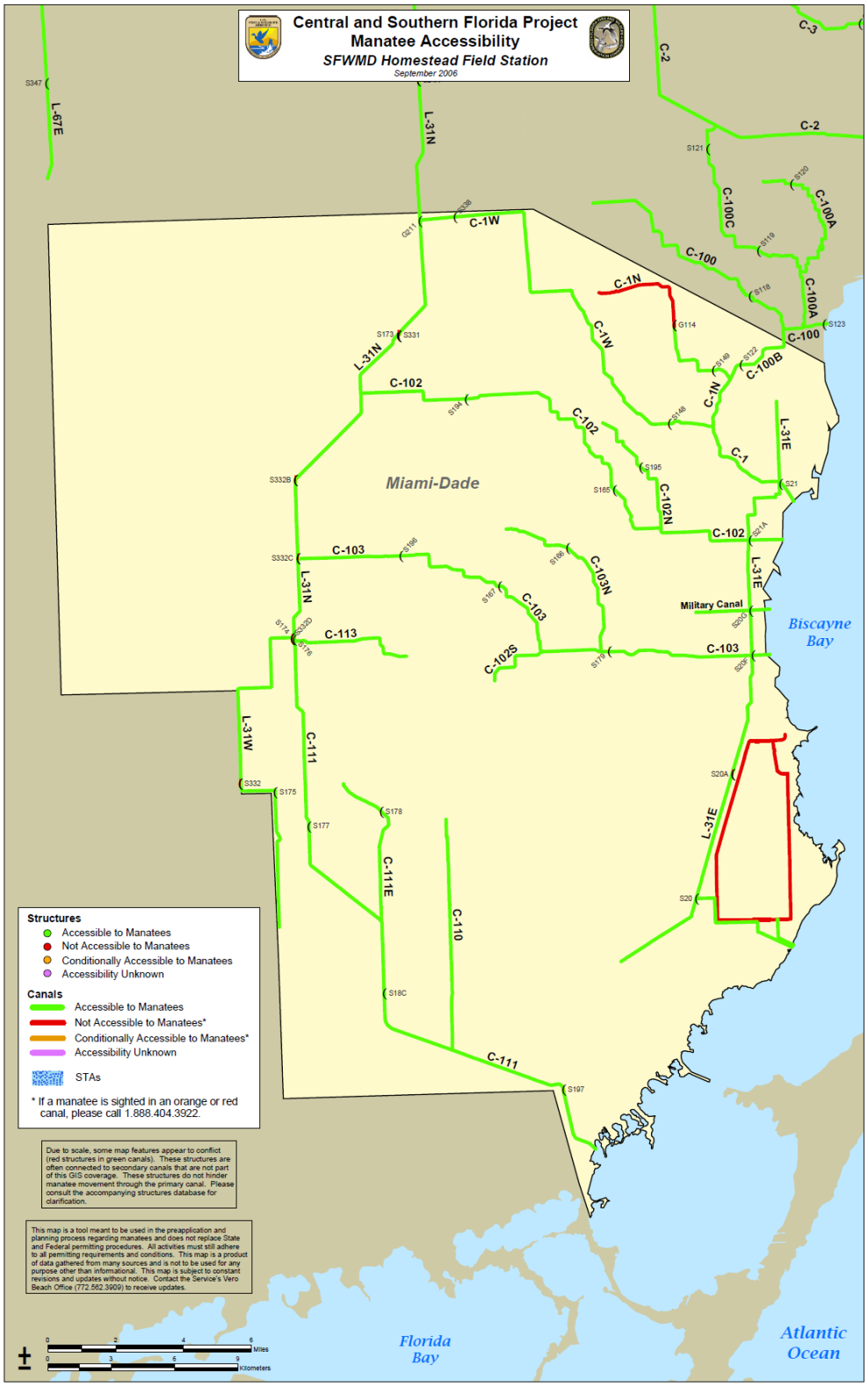


Figure D.2-49. West Indian Manatee Central and South Florida accessibility (Homestead Field Station)

Florida Bay has a strong dependence on freshwater flow from the Everglades. Florida Bay is the main receiving water body of the central Everglades system and has been heavily influenced by historic upstream changes in the timing, distribution and quantity of freshwater flows. Salinity throughout Florida Bay depends on the relationship and interaction of several factors, such as weather patterns (e.g. temperature, precipitation), tides, freshwater groundwater input, and freshwater surface flow. Freshwater surface flow and upstream stage (which influences groundwater input) are the most influential drivers affecting salinity in Florida Bay, especially in the northern and eastern portions of Florida Bay.

Restoration goals for salinity in Florida Bay are: (1) to restore oligohaline and mesohaline salinity patterns in the near-shore environment; (2) lower the average salinity in Florida Bay; (3) reduce the frequency, duration, magnitude, and spatial extent of hypersaline (>40 psu [practical salinity unit]) conditions throughout Florida Bay, and; (4) restore seasonal deliveries of freshwater more typical of the natural system. Freshwater flows are a quarter to half of their pre-drainage levels (Marshall et al. 2009, Marshall and Wingard 2012). Water flowing into the South Dade Conveyance System and the northern reaches of ENP can reach Florida Bay through the following routes: (1) SRS surface water can enter Whitewater Bay and the coastal waters of the Gulf of Mexico, then wrap around Cape Sable and diffusely enter western Florida Bay; (2) surface water that flows north and west of the Rocky Glades may seep or, with very high water, flow into Taylor Slough and then flow to central and eastern Florida Bay, and (3) water derived from local rainfall or canals along the ENP eastern boundary can enter Florida Bay via Taylor Slough by surface and groundwater connections. Freshwater deliveries to Florida Bay through these routes have decreased with drainage of the Everglades over the last century. All three of these routes likely influence salinities in Florida Bay today. However, for an evaluation of potential impacts to Florida Bay, a statistical suite of performance measures that heavily weights predicted salinity patterns to stages in upper SRS was used.

COP modeling evaluations showed that the proposed action has the potential to improve freshwater flows to Florida Bay. ALTQ increased flows toward Florida Bay across Transect T23 relative to ECB19RR. This east west transect crosses southern Taylor Slough and the Northern ENP Panhandle, east of the slough. ALTQ increased average annual flows by 36,000 acre feet. Small increases in average annual flows were also observed across the more northerly Taylor Slough headwater transects TSH1 and TSH2 (**Table D.2-22**).

Performance of ALTQ in Florida Bay was measured by evaluating changes in salinity conditions in both the wet (June through November) and dry season (December through May) by utilizing the RECOVER Florida Bay performance measure (RECOVER 2012). Simulated hydrology results from RSM-GL for ALTQ and ECB19RR were post-processed using multiple linear regression (MLR) statistical models to estimate salinity conditions at 17 marine monitoring network (MMN) stations in Florida Bay. These models do not capture the processes that deliver freshwater to Florida Bay. Instead, they indicate that conditions and processes that increase water depths in SRS Taylor Slough are correlated with the conditions and processes that change salinity in Florida Bay. Until a mechanistic model of flow patterns for this part of the ecosystem is available, this is the only tool currently available, and results should be cautiously considered when evaluating forecasts.

Results from the MMN stations are then aggregated into six zones of similarity within Florida Bay based on water quality characteristics. Zones evaluated include North Bay, East Bay, East Central Bay, Central Bay, South Bay, and West Bay. **Table D.2-5** and **Table D.2-6** depicts the mean annual dry season and mean annual wet season salinities for ECB19RR in North Bay, East Bay, East Central Bay, Central Bay, South Bay,

and West Bay. Percent differences shown in **Table D.2-5** and **Table D.2-6** are the decrease in salinity from ECB19RR to ALTQ as a percent of ECB19RR absolute salinity. Decreases in mean wet salinity for ALTQ relative to ECB19RR were small in all Florida Bay zones. For each zone, decreases in dry season salinity exceeded decreases in wet season salinity. These differences may be ecologically significant because they reflect long-term seasonal means and not short-term or even annual extremes (e.g., periods with hypersalinity). Also, the timing of lowered salinity, being more in the dry season, may be ecologically significant because salinity peaks with associated ecological damage are most common in the late dry season and early wet season if precipitation delays occur. Overall the differences in salinity between ALTQ and ECB19RR were less than 5%. Such a difference is far less than the tolerance range of Florida Bay's foundation communities, seagrass beds and mangrove wetlands and islands. Each alternative appears to have the potential to improve salinity conditions, but it remains to be tested via COP implementation, whether the estimates of seasonal means estimated here will be accurate and whether hydrologic and salinity modifications yield ecological benefits in Florida Bay. Hydrologic conditions in Florida Bay under ALTQ+ is expected to be very similar to ALTQ with no significant change.

Table D.2-5. Mean annual dry season salinity for ECB19RR and percent salinity decrease in Florida Bay zones.

Florida Bay Zone	Dry Season Mean Salinity ECB19RR (PSU)	Dry Season ALTQ % Decrease from ECB19RR
North	25.07	4.7%
East	29.88	2.8%
East Central	29.00	2.6%
Central	35.50	3.0%
South	34.71	2.2%
West	36.12	2.1%

Table D.2-6. Mean annual wet season salinity for ECB19RR and percent salinity decrease in Florida Bay zones.

-	Wet Season Mean Salinity ECB19RR (PSU)	Wet Season ALTQ % Decrease from ECB19RR
North	18.30	3.3%
East	24.74	2.0%
East Central	27.60	1.2%
Central	32.61	1.4%
South	33.31	1.0%
West	34.81	0.8%

COP evaluations also estimated differences in water quantity and distribution patterns from the C-111 Canal at the southern extremity of the SDCS between the S-18C and S-197. S-197 provides a gravity outlet for stormwater runoff, as well as water seepage from ENP, which is conveyed through the SDCS during high water and flood conditions. Water released through S-197 discharges into Manatee Bay. S-197 also acts as a barrier to prevent saltwater intrusion into the freshwater wetlands via the C-111 canal. Nearshore salinity conditions within the estuaries downstream of the southeast Everglades within ENP (Long Sound, Joe Bay, and northeast Florida Bay) and the Model Lands east of the ENP Panhandle (Manatee Bay, Barnes Sound, and Card Sound) are elevated much of the year as a result of the less than

adequate freshwater flow deliveries. Overland flow of freshwater into these estuaries is preferred as compared with discharges through S-197. However, low volume releases to Manatee Bay through this structure are considered preferential to high volume releases that result in increased incidence of large salinity swings as well as increased nutrient load delivery. Releases at S-197 also have the potential to decrease flows to Taylor Slough, and subsequently Florida Bay. Currently, water that discharges from S-18C when S-197 is closed mostly flows over the scraped down canal banks into ENP's Eastern Panhandle towards the tidal creeks feeding into Long Sound and Joe Bay.

ALTQ decreased structure flow through S-197 and improved overbank flow into ENP's Eastern Panhandle relative to ECB19RR (**Table D.2-7**). ALTQ decreased annual flows by 41,000 acre feet on average. ALTQ increased overbank flow into ENP from C-111 between S-18C and S-197 by 25,000 acre feet on average. ALTQ also decreased the number of days of no flow through S-197 (ALTQ 175 days) and the number of days flow through S-197 ranged from 0 to 400 cfs (ALTQ 174 days) relative to ECB19RR. ALTQ+ would result in similar effects as discussed under ALTQ.

Table D.2-7. Modeled annual water outflow volume from C-111 canal, via overbank flow between S-18C and S-197, releases through S-197 daily flow distribution over the period of record (1965-2005).

-	ECB19RR	ALTQ
Average annual flow volume (thousand acre feet) through S-197	60 KAC-FT	19 KAC-FT
Average annual flow volume (thousand acre feet) overland between S-18C and S-197	76 KAC-FT	101 KAC-FT
Number of Days of No Flow through S-197	143 Days	318 Days
Number of Days Flow through S-197 ranged from 0 to 400 cfs	216 Days	42 Days
Number of Days Flow through S-197 ranged from 400 to 800 cfs	3 Days	4 Days
Number of Days Flow through S-197 greater than 800 cfs	4 Days	2 Days

The RECOVER salinity performance measure for the southern coastal systems does not currently extend past Florida Bay into Biscayne Bay and was therefore unavailable for an evaluation of this area. Under the existing condition, flows to Biscayne Bay predominantly enter the northern part of the Bay and occur during storm events when large volumes of water from WCA 3 are routed down the Miami Canal to reduce flooding risks. COP identified the opportunity to better balance flows across Biscayne Bay, by setting a goal to increase the volumes delivered to the southern portion of the Bay while decreasing the volumes delivered to the northern portion of the Bay. ALTQ slightly decreased average annual flow from canals to the entirety of Biscayne Bay relative to ECB19RR. ALTQ decreased flows by approximately 21,000 acre feet per year on average. Flows to Central Bay were essentially maintained under ALTQ. ALTQ increased average annual flows to South Bay by approximately 10,000 acre feet. While ALTQ reduced overall flows to Biscayne Bay compared to ECB19RR, the reduction was accounted for entirely by changes to flow in the northern portion of Biscayne Bay which is receiving too much flow during storm events. Reference **Table D.2-8**. Concurrently, ALTQ increases freshwater flow to southern Bay, the location of most of Biscayne National Park and CERP's Biscayne Bay Coastal Wetlands Project. This is an area with unnaturally

high salinity and increased freshwater flow can yield ecological benefits for this region. ALTQ+ would result in similar effects as discussed under ALTQ.

Table D.2-8. Total average annual flow (thousand acre feet) from canals to portions of Biscayne Bay over the period of record (1965-2005) with percentage changes relative to ECB19RR.

-	ECB19RR	ALTQ (% Change Relative to ECB19RR)
Biscayne Bay – North (S-25+S-25B+S-26+S-27+S-28+S-29)	509.3 KAC-FT	487.7 KAC-FT (-4.13%)
Biscayne Bay – Central (G-93+S-22+S-123)	106.9 KAC-FT	104.7 KAC-FT (-1.87%)
Biscayne Bay – South (S-20F+S-20G+S-21+S-21A)	248.9 KAC-FT	259.2 KAC-FT (4.02%)

Improvements in seasonal inflow deliveries to Florida Bay and southern Biscayne Bay has the potential to improve conditions suitable for seagrass survival. Seagrasses within Florida Bay and southern Biscayne Bay have long suffered from high salinities due to long-term reductions of freshwater flow. Increased freshwater flows to the coastal estuaries would improve salinity, therefore having the potential to reduce stress on sea grasses that are important to foraging manatees. COP is an operational plan to redistribute the amount and timing of releases from WCA 3A to ENP. No construction (i.e. canal removal/backfilling) is proposed in canals that Florida manatees have access to under COP. USACE has determined that the Proposed Action may affect, but is not likely to adversely affect the Florida manatee and its critical habitat.

D.2.6.2.3 Florida Bonneted Bat and "May Affect Not Likely to Adversely Affect" Determination

The Florida bonneted bat is Florida's only endemic bat and is also Florida's largest bat (Owre 1978, Belwood 1981, Belwood 1992, Timm and Genoways 2004). Males and females are not significantly different in size (Timm and Genoways 2004). The species has dark brown fur and large broad ears that join together and slant forward over the eyes (FBC 2005). Relatively little is known regarding the ecology and habitat requirements of this species. In general, bats will forage over ponds, streams and wetlands and require roosting habitat for daytime roosting, protection from predators and rearing of young (Marks and Marks 2008a). Bats in South Florida roost primarily in trees and manmade structures (Marks and Marks 2008a). Florida bonneted bats roost in tree cavities, rocky outcrops and dead palm fronds while in residential communities, the bats roost in Spanish tile roofs, but have also been found in attics, rock or brick chimneys and fireplaces of old buildings (Marks and Marks 2008a). The species roosts singly or in colonies consisting of a male and several females (Belwood 1992). Colonies are small, with the largest reported as just a few dozen individuals. The Florida bonneted bat is non-migratory. The species is active year round and does not have periods of hibernation or torpor (Timm and Genoways 2004). The bat is a nocturnal insectivore and relies upon echolocation to navigate and detect prey. Females give birth to a single pup. The maternity season for most bat species in Florida occurs from mid-April through mid-August (Marks and Marks 2008a). During the early portion of the season, females give birth and leave young in the roost while foraging to support lactation. During the latter part of this season, young and females forage together until the young are able to forage and survive on their own (Marks and Marks 2008a). Limited data suggests that a female may undergo a second birthing season within a given year (Timm and Genoways 2004, FBC 2005).

Florida bonneted bats are capable of dispersing long distances from roost sites to foraging areas. In general, open, fresh water and wetlands provide prime foraging areas for bats (Marks and Marks 2008b). Bats will forage over ponds, streams and wetlands, and will drink when flying over open water. During dry seasons, bats become more dependent on remaining ponds, streams, and wetland areas for foraging purposes (Marks and Marks 2008b). Florida bonneted bats are closely associated with forested areas because of their tree-roosting habits (Robson 1989; Belwood 1992; Eger 1999), but specific information is limited. Eger (1999) noted that in forested areas, old, mature trees are essential roosting sites for this species. The presence of roosting habitat is also critical for the rearing of young (Marks and Marks 2008b). For most bats, the availability of suitable roosts is an important, limiting factor (Humphrey 1975). Loss of suitable habitat is believed to be the primary cause of population decline. Other perceived threats include pesticide and herbicide use, which decrease populations of insects, the bats primary prey. Since the Florida bonneted bat is suspected to have high roost site fidelity, the loss of a roost site may cause greater hardship to the species than the loss of a roost site for other, more labile species (Ober 2012).

At present, only three active, natural roost sites are known, and only limited information on historical sites is available. Echolocation calls have been recorded in a wide array of habitat types: pine flatwoods, pine rocklands, cypress, hardwood hammocks, scrubby flatwoods, mixed shrubs, mangroves, wetlands, swamps, rivers, lakes, ponds, canals, developed park lands, groves, tropical gardens, disturbed nonnative areas, rural lands, residential areas, and urban landscapes (Marks and Marks 2008a–c; 2012; Smith 2010). The range of this species is limited to southern Florida. Records indicate that it was once common in the 1950s and early 1960s near Coral Gables and Miami (Belwood 1992). Active roost sites occur at Avon Park Air Force Range dis-covered in 2013, the Florida Panther National Wildlife Refuge (FPNWR) discovered in 2015 and in BCNP discovered in 2015 (USFWS 2016).

Habitat loss and alteration in forested and urban areas are major threats to the Florida bonneted bat (Belwood 1992, Timm and Arroyo-Cabrales 2008). In natural areas, this species may be impacted when forests are converted to other uses or when old trees with cavities are removed (Belwood 1992, Timm and Arroyo-Cabrales 2008). In urban settings, this species may be impacted when buildings with suitable roosts are demolished (Robson 1989, Timm and Arroyo-Cabrales 2008) or when structures are modified to exclude bats. Although the species' habitat preferences and extent of range are not well understood, significant land use changes have occurred in South Florida and additional habitat losses are expected in the future, placing the species at risk. Uncertainty regarding the species' specific habitat needs and requirements arguably contributes to the degree of this threat. Loss of suitable habitat is believed to be the primary cause of population decline. Other perceived threats include pesticide and herbicide use, which decrease populations of insects, the bats primary prey. Since the Florida bonneted bat is suspected to have high roost site fidelity, the loss of a roost site may cause greater hardship to the species than the loss of a roost site for other, more labile species (Ober 2012).

The USFWS has defined consultation areas for the Florida bonneted bat in South Florida (**Figure D.2-49**). The Florida bonneted bat is restricted to south, southwest, and south-central Florida. The main action area falls within the defined consultation area.

Any actions that occur in areas known to be occupied by the Florida bonneted bat and result in the removal of potential roost sites (snags, trees) or impact foraging habitat (filling in of canals and ditches) are likely to have direct and indirect adverse effects to the Florida bonneted bat and its habitat. COP is an operational plan to redistribute the amount and timing of releases from WCA 3A to ENP. No construction is proposed. The potential presence of Florida bonneted bats have been documented within the action area as illustrated in **Figure D.2-50**. This figure was provided by the USFWS and notes the

potential presence of Florida bonneted bats along portions of the L-67A and L-67C canals and levees, as well as adjacent to NESRS along the L-31N canal and levee. At present, no active, natural roost sites are known to occur within the study area. Due to increased water flow and changes in water distribution it is anticipated that currently over drained areas in ENP would be rehydrated. Reference **Section D.2.4.2** for a description of changes in hydrology expected under ALTQ+ in WCA 3 and ENP. The restoration of sheetflow is anticipated to help restore historic habitats which are used by the Florida bonneted bat for roosting, and also allow for natural fire and exotic plant management. Current wildfire conditions persist that damage the canopy available to the Florida bonneted bat for roosting sites, and exotic and nuisance plants that dominate in drained conditions presumably do not contribute to natural roosting or forage habitat conditions. The Florida bonneted bat is known to forage along wetlands and open water (Marks and Marks 2008a) and roost within pine flatwoods and other forested habitats (Belwood 1981, Robson 1989, Belwood 1992, Eger 1999). This species forages for insects at night while flying over water. ALTQ+ may improve forage conditions in ENP by increasing the quality of existing wetlands which may contribute to increases in insect populations in the area. USACE has determined that the Proposed Action may affect, but is not likely to adversely affect the Florida bonneted bat.

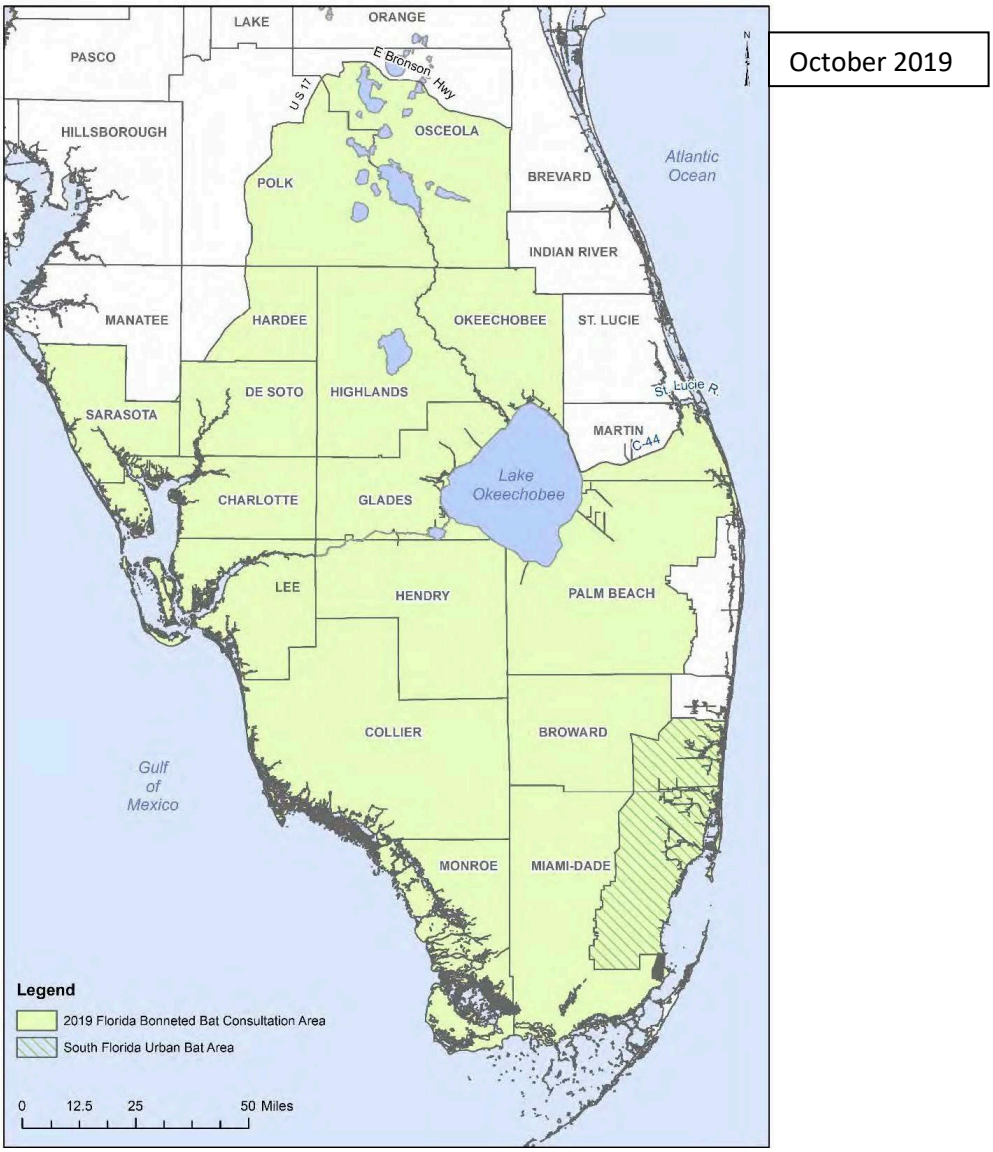


Figure D.2-50. Florida Bonneted Bat consultation area.

D.2.6.2.4 Cape Sable Seaside Sparrow and "May Affect" Determination

Measuring 13-14 centimeters in length, CSSS is one of nine subspecies of seaside sparrows (Werner 1975). CSSS are non-migratory residents of freshwater to brackish marshes and their range is restricted to the lower Florida peninsula. They were originally listed as endangered in 1969 due to their restricted range (USFWS 1999). Subsequent changes in their habitat have further reduced their range and continue to threaten this subspecies with extinction.

CSSS appear to prefer mixed marl prairie communities that include muhly grass (*Muhlenbergia filipes*) for nesting (Stevenson and Anderson 1994). These short-hydroperiod (the period of time during which a wetland is covered by water) prairies contain a mosaic of moderately dense, clumped grasses, interspersed with open space that permit ground movements by the sparrows (USFWS 1999). According

to previous literature, (Werner 1975; Bass and Kushlan 1982), CSSS are generally not found in communities dominated by dense sawgrass, cattail (Typha spp.) monocultures, long hydroperiod wetlands with tall, dense vegetative cover, spikerush marshes, and sites supporting woody vegetation. However, recent research has revealed that CSSS within the Dogleg North plot sub-population B (CSSS-B) were successfully nesting in "very thick, tall sawgrass" (Virzi and Davis 2013; Slater et al. 2014). Curnett and Pimm (1993) indicated that CSSS also avoid sites with permanent water cover; however, more recent evidence has shown that CSSS successfully nested in areas in which "water levels were extremely high approaching knee-deep at times with 100% coverage the entire summer" (Virzi and Davis 2013). The combination of hydroperiod and periodic fire events are critical in the maintenance of suitable mixed marl prairie communities for the CSSS (Kushlan and Bass 1983).

CSSS nest in the spring when the marl prairies are dry. While the majority of nesting activities have been observed between March 1 and July 15 when Everglades marl prairies are dry, (Lockwood et al. 1997, 2001), nesting has been reported as early as late February (Werner 1975), and as late as early August (Dean and Morrison 2001). Males will establish breeding territories in early February (Balent et al. 1998) and defend these territories throughout the breeding season (USFWS 1999). Male sparrows vocalize to attract females and this particular breeding activity has been shown to decrease with increased surface water conditions (Nott et al. 1998; Curnutt and Pimm 1993).

Successful CSSS breeding requires that breeding season water levels remain at or below ground level in the breeding habitat. Nott et al. (1998) cited a "10-centimeter (cm)" rule for maximum water depth over which the CSSS will initiate nesting. This conclusion was based upon observations within the ENP range-wide survey in which no singing males were heard when water depths exceeded that level. However, Dean and Morrison (1998) demonstrated that nesting may occur when average water depths exceed this rule. In addition, more recent evidence has shown that not only were CSSS able to successfully breed in areas with standing water that was "approaching knee deep at times"; but also that they were able to successfully produce multiple broods (3) in the Dogleg Plot of CSSS-B "despite heavy rains that began in early-May and deep water levels that persisted throughout the breeding season in the study plot" (Virzi and Davis 2013; Slater et al. 2014).

CSSS construct their nests relatively close to the ground in clumps of grasses composed primarily of muhly, beakrushes (*Rhynchospora spp.*), and Florida little bluestem (*Schizachyrium rhizomatum*) (Pimm et al. 2002). The average early season nest height is 17 centimeters (6.7 inches) above ground, while the average late season nest height is 21 centimeters (8.3 inches) above ground (Lockwood et al. 2001). The shift in average nest height after the onset of the wet season rainfall pattern, which typically begins in early June (Lockwood et al. 2001), appears to be an adaptive response to rising surface water conditions. In general, the CSSS will raise one or two broods within a season; however, if weather conditions permit, a third brood is possible (Kushlan et al. 1982; USFWS 1983). A new nest is constructed for each successive brood. The end of the breeding season is triggered by the onset of the rainy season when ground water levels rise above the height of the nest off the ground (Lockwood et al. 1997).

CSSS will lay three to four eggs per clutch (Werner 1975; Pimm et al. 2002) with a hatching rate ranging between 0.66 and 1.00 (Boulton et al. 2009b). The nest cycle lasts between 34 and 44 days in length and includes a 12-13 day incubation period, 9-11 day nestling period and 10-20 days of post-fledgling care by both parents (Sprunt 1968; Trost 1968; Woolfenden 1956, 1968; Lockwood et al. 1997; Pimm et al. 2002). Nest success rate varies between 21 and 60 percent, depending upon timing of nest initiation within the breeding season (Baiser et al. 2008; Boulton et al. 2009a). Substantially higher nest success rates occur within the early portion of the breeding season (approximately 60% prior to June 1) followed by a decline

in success as the breeding season progresses to a low of approximately 21% after June 1 (Baiser et al. 2008; Boulton et al. 2009a; Virzi et al. 2009). In most years, June 1 is a good division between the early high success period and the later, lower success period (Dr. Julie Lockwood email correspondence to USFWS, October 15, 2009). Nearly all nests that fail appear to fail due to predation, and predation rates appear to increase as water level increases (Lockwood et al. 1997, 2001; Baiser et al. 2008). A complete array of nest predators has not been determined. However, raccoons (Procyon lotor), rice rats (Oryzomys palustris), and snakes, including exotic pythons, may be the chief predators (Lockwood et al. 1997; Dean and Morrison 1998; Post 2007).

A dietary generalist, CSSS feed by gleaning food items from low-lying vegetation (Ehrlich et al. 1992; Pimm et al. 2002). Common components of their diet include soft-bodied insects such as grasshoppers, spiders, moths, caterpillars, beetles, dragonflies, wasps, marine worms, shrimp, grass, and sedge seeds (Stevenson and Anderson 1994). The importance of individual food items appears to shift in response to their availability (Pimm et al. 2002).

CSSS are non-migratory with males displaying high site fidelity, defending the same territory for two to three years (Werner 1975). CSSS are capable of both short-distance and longer-range movements, but appear to be restricted to short hydroperiod prairie habitat (Dean and Morrison 1998). Large expanses of deep water or wooded habitat act as barriers to long-range movements (Dean and Morrison 1998). Recent research by Julie Lockwood, Ph.D. of Rutgers University and her students have revealed substantial movements between subpopulations east of Shark River Slough (Lockwood et al. 2008; Virzi et al. 2009), suggesting that CSSS has considerable capacity to colonize unoccupied suitable habitat (Sustainable Ecosystems Institute 2007).

Presently, the known distribution of CSSS is restricted to two areas of marl prairies east and west of Shark River Slough in the Everglades region (within ENP and BCNP) and the edge of Taylor Slough in the Southern Glades Wildlife and Environmental Area in Miami-Dade County. CSSS presently inhabit six separate subpopulations, labeled as A through F (**Figure D.2-51**), with subpopulation A (CSSS-A) as the only subpopulation west of Shark River Slough. The CSSS-A expansion area (i.e. CSSS-Ax) is illustrated adjacent to CSSS-A and is highlighted in green. Monitoring conducted in recent years have identified this area, as a location where birds current reside and/or are thought to be able to expand to. CSSS-A is now referred to as CSSS-Ax. CSSS-B, CSSS-C, CSSS-D, CSSS-E, and CSSS-F are designated as critical habitat units U1-U5, respectively.

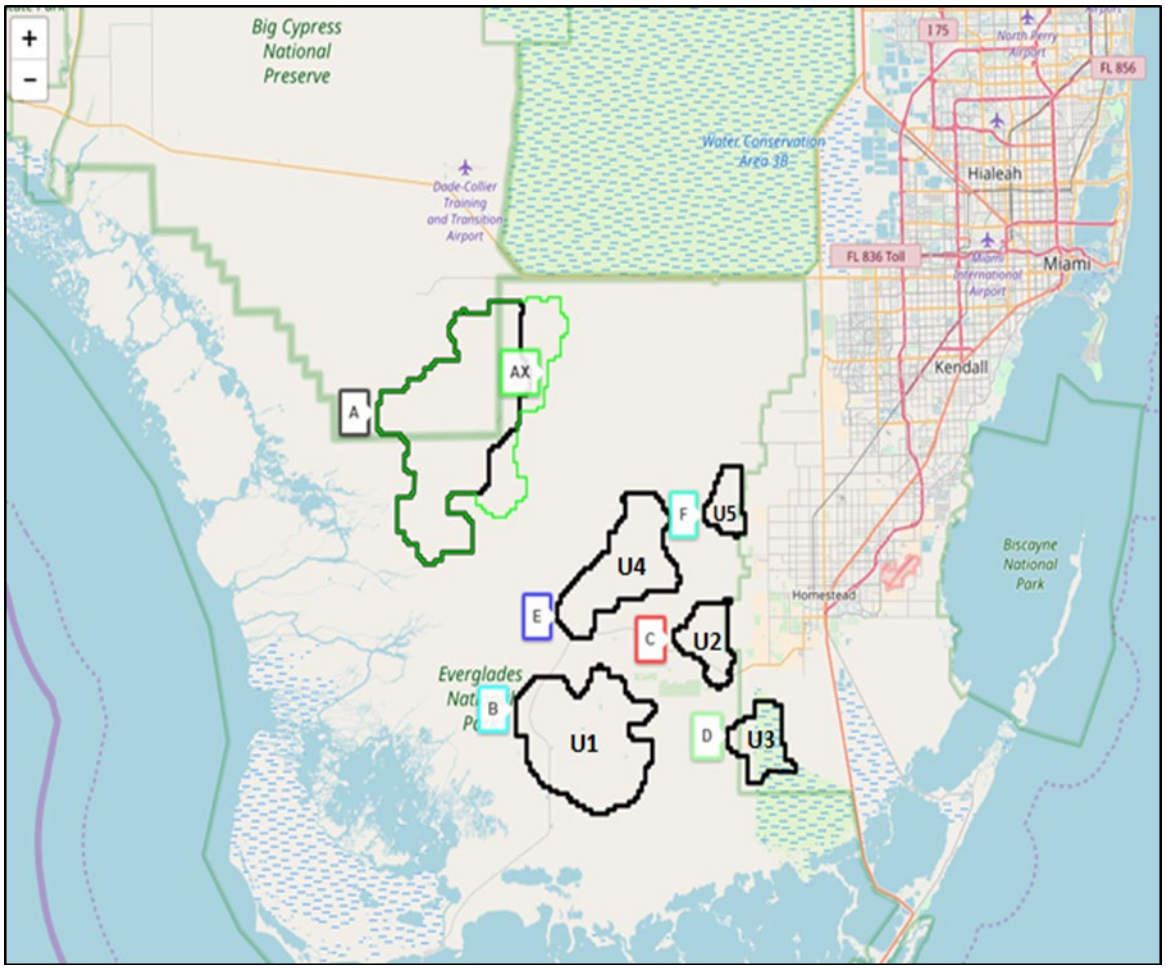


Figure D.2-50. Location of CSSS subpopulations. CSSS-B (Unit 1), CSSS-C (Unit 2), CSSS-D (Unit 3), CSSS-E (Unit 4), and CSSS-F (Unit 5) are designated critical habitat.

The two most critical performance metrics for maintaining and enhancing the chances for CSSS survival are the number of consecutive days during the CSSS nesting season (March 1 – July 15) when there is no surface water (i.e. dry nesting days) and the total number of days when there is water above ground surface during the year (i.e. annual discontinuous hydroperiod) (USFWS 2016). Since it takes the CSSS, a ground nesting bird (nests on average are 17 cm above ground), approximately 45 days to nest and fledge young, the 2016 ERTP BO RPA has set a target of providing at least 90 consecutive dry nesting days between March 1 and July 15, over at least 24,000 acres (equates to 40%) within and adjacent to CSSS-Ax, and across at least 40% of each of the eastern subpopulations (B-F) every year, to allow for multiple broods during each nesting season in order to stabilize and potentially increase the population. Since, an average annual discontinuous hydroperiod of between 90 and 210 days, which normally occurs outside of the nesting season, is required to maintain suitable marl prairie habitat for the CSSS (USFWS 2016), the 2016 ERTP BO has set a target of providing a four year running average discontinuous hydroperiod of 90-210 days over at least 24,000 acres (equates to 40%) within and adjacent to CSSS-AX (with no 2 consecutive years failing to meet this target), and across at least 40% of each of the eastern subpopulations (B-F). If the number of days with surface water is consistently more than 210 days, the habitat will convert to sawgrass. If it is consistently too dry (less than 90 days) woody vegetation encroaches on the habitat and there is an increased risk of fire and predation on CSSS from aerial

predators (raptors). To evaluate potential effects on the CSSS for COP, the above mentioned metrics (i.e. dry nesting days and annual discontinuous hydroperiod) were evaluated at the request of the USFWS.

Table D.2-9 through **Table D.2-14** depicts the percentage of habitat within each of the six CSSS subpopulations (CSSS-Ax, CSSS-B, CSSS-C, CSSS-D, CSSS-E, and CSSS-F) that experienced > 90 consecutive dry days during the nesting season (defined as March 1 through July 15) for each year in the period of record (1965-2005). The average percentage over the period of record is shown as well as the number of individual years the target (40%) is met. The number of times ALTQ was observed to be greater than or equal to ECB19RR, as well as the number of times ALTQ was observed to be less than ECB19RR in a given year is also shown. An average percentage of greater than 40% was achieved over the period of record in CSSS-Ax and in the eastern subpopulations (CSSS-B, CSSS-C, CSSS-D, CSSS-E, and CSSS-F) under ECB19RR and ALTQ. Across the sub-populations, the difference in average percentage over the period of record for ALTQ relative to ECB19RR, ranged from a minimum difference of -7.7% (CSSS-E) to a maximum difference of 3.4% (CSSS-C). Generally, ALTQ was observed to score equal to or slightly less than ECB19RR. ALTQ+ is expected to be very similar to ALTQ with no significant change.

Table D.2-9. CSSS-Ax Nesting Season Statistics: Percent of Habitat within CSSS-Ax that met > 90 consecutive dry days during March 1 through July 15 of each year (USGS CSSS Viewer). Green coloration denotes target (40%) was met.

Year	ECB19RR (CSSS-Ax)	ALTQ (CSSS-Ax)
1965	48.3%	42.6%
1966	28.6%	25.0%
1967	65.9%	54.9%
1968	2.3%	2.1%
1969	23.0%	19.6%
1970	3.6%	4.0%
1971	96.9%	96.9%
1972	16.7%	16.8%
1973	61.7%	61.2%
1974	98.1%	98.1%
1975	67.1%	67.3%
1976	29.5%	29.9%
1977	91.3%	91.4%
1978	40.6%	42.8%
1979	35.1%	31.4%
1980	14.3%	13.8%
1981	98.2%	98.0%
1982	21.4%	20.4%
1983	0.4%	0.5%
1984	37.8%	31.4%
1985	96.3%	96.1%
1986	47.0%	34.2%
1987	20.9%	18.8%

Year	ECB19RR (CSSS-Ax)	ALTQ (CSSS-Ax)
1988	57.3%	59.3%
1989	99.1%	99.2%
1990	91.0%	90.9%
1991	17.8%	17.9%
1992	60.9%	50.7%
1993	15.4%	16.5%
1994	32.4%	28.2%
1995	0.0%	0.0%
1996	21.8%	19.2%
1997	40.5%	36.3%
1998	13.4%	13.8%
1999	21.9%	18.3%
2000	22.3%	17.9%
2001	94.9%	95.3%
2002	56.4%	50.4%
2003	27.9%	27.7%
2004	80.8%	76.8%
2005	94.9%	95.8%
Average (Diff ECB19RR)	**46.2%**	**44.2% (-2.0%)**
Number of Times Period of Record Target (40%) Met	**20**	**18**
Number of Times ALT ≥ ECB19RR	**-**	**17**
Number of Times ALT < ECB19RR	**-**	**24**

Table D.2-10. CSSS-B Nesting Season Statistics: Percent of Habitat within CSSS-B that met > 90 consecutive dry days during March 1 through July 15 of each year (USGS CSSS Viewer). Green coloration denotes target (40%) was met.

Year	ECB19RR (CSSS-B)	ALTQ (CSSS-B)
1965	92.0%	91.8%
1966	82.8%	80.6%
1967	97.0%	94.9%
1968	3.7%	3.6%
1969	42.0%	39.6%
1970	60.8%	60.1%
1971	100.0%	100.0%
1972	62.4%	62.4%
1973	68.1%	67.3%
1974	100.0%	100.0%

Year	ECB19RR (CSSS-B)	ALTQ (CSSS-B)
1975	88.1%	87.9%
1976	96.3%	96.5%
1977	90.8%	89.7%
1978	41.6%	42.1%
1979	43.4%	39.7%
1980	91.7%	90.1%
1981	100.0%	100.0%
1982	17.6%	17.2%
1983	15.7%	15.5%
1984	86.4%	83.2%
1985	97.7%	97.6%
1986	91.3%	89.4%
1987	89.0%	87.4%
1988	92.0%	92.3%
1989	100.0%	100.0%
1990	100.0%	100.0%
1991	80.0%	80.0%
1992	95.8%	92.7%
1993	68.2%	67.0%
1994	77.4%	72.6%
1995	34.3%	32.4%
1996	71.3%	68.3%
1997	75.4%	74.0%
1998	66.2%	65.7%
1999	78.8%	77.9%
2000	78.5%	75.4%
2001	99.5%	99.7%
2002	91.8%	89.2%
2003	71.4%	71.4%
2004	100.0%	100.0%
2005	100.0%	100.0%
Average (Diff ECB19RR)	**76.6%**	**75.5% (-1.1%)**
Number of Times Period of Record Target (40%) Met	**37**	**35**
Number of Times ALT ≥ ECB19RR	**-**	**14**
Number of Times ALT < ECB19RR	**-**	**27**

Table D.2-11. CSSS-C Nesting Season Statistics: Percent of Habitat within CSSS-C that met > 90 consecutive dry days during March 1 through July 15 of each year (USGS CSSS Viewer). Green coloration denotes target (40%) was met.

Year	ECB19RR (CSSS-C)	ALTQ (CSSS-C)
1965	100.0%	100.0%
1966	100.0%	100.0%
1967	100.0%	100.0%
1968	1.6%	2.0%
1969	98.0%	96.4%
1970	62.5%	95.2%
1971	100.0%	100.0%
1972	96.0%	95.6%
1973	100.0%	100.0%
1974	100.0%	100.0%
1975	100.0%	100.0%
1976	100.0%	100.0%
1977	57.3%	55.2%
1978	95.6%	95.6%
1979	27.4%	37.1%
1980	100.0%	100.0%
1981	100.0%	100.0%
1982	91.9%	94.4%
1983	10.5%	33.5%
1984	90.7%	90.3%
1985	100.0%	100.0%
1986	83.9%	94.8%
1987	98.8%	98.8%
1988	100.0%	100.0%
1989	100.0%	100.0%
1990	97.6%	97.6%
1991	18.5%	21.8%
1992	100.0%	100.0%
1993	94.4%	99.2%
1994	63.7%	71.8%
1995	11.7%	21.4%
1996	85.5%	81.5%
1997	99.2%	96.8%
1998	56.5%	99.6%
1999	100.0%	100.0%
2000	100.0%	99.6%
2001	100.0%	100.0%

Year	ECB19RR (CSSS-C)	ALTQ (CSSS-C)
2002	100.0%	100.0%
2003	99.6%	99.2%
2004	100.0%	100.0%
2005	100.0%	100.0%
Average (Diff ECB19RR)	**83.9%**	**87.3% (3.4%)**
Number of Times Period of Record Target (40%) Met	**36**	**36**
Number of Times ALT ≥ ECB19RR	**-**	**33**
Number of Times ALT < ECB19RR	**-**	**8**

Table D.2-12. CSSS-D Nesting Season Statistics: Percent of Habitat within CSSS-D that met > 90 consecutive dry days during March 1 through July 15 of each year (USGS CSSS Viewer). Green coloration denotes target (40%) was met.

Year	ECB19RR (CSSS-D)	ALTQ (CSSS-D)
1965	93.8%	93.1%
1966	26.5%	26.2%
1967	94.2%	75.4%
1968	0.4%	0.4%
1969	20.4%	14.6%
1970	21.9%	14.2%
1971	100.0%	100.0%
1972	10.8%	10.4%
1973	88.1%	88.1%
1974	97.7%	96.2%
1975	88.8%	86.2%
1976	19.6%	21.5%
1977	7.7%	5.8%
1978	13.1%	10.8%
1979	0.0%	0.0%
1980	54.6%	32.7%
1981	95.4%	95.8%
1982	8.5%	8.5%
1983	15.0%	4.2%
1984	10.4%	6.2%
1985	47.7%	50.8%
1986	32.7%	14.6%
1987	78.5%	53.5%
1988	87.3%	83.1%
1989	86.2%	86.2%

Year	ECB19RR (CSSS-D)	ALTQ (CSSS-D)
1990	46.2%	50.4%
1991	1.5%	1.2%
1992	89.6%	63.8%
1993	47.3%	25.4%
1994	12.3%	7.3%
1995	10.4%	4.6%
1996	63.8%	21.9%
1997	92.7%	91.5%
1998	66.2%	51.5%
1999	89.2%	68.8%
2000	86.9%	77.3%
2001	88.1%	93.8%
2002	89.2%	50.8%
2003	14.2%	15.8%
2004	93.5%	92.7%
2005	89.6%	89.6%
Average (Diff ECB19RR)	**53.2%**	**46.0% (-7.2%)**
Number of Times Period of Record Target (40%) Met	**24**	**21**
Number of Times ALT ≥ ECB19RR	**-**	**23**
Number of Times ALT < ECB19RR	**-**	**28**

Table D.2-13. CSSS-E Nesting Season Statistics: Percent of Habitat within CSSS-E that met > 90 consecutive dry days during March 1 through July 15 of each year (USGS CSSS Viewer). Green coloration denotes target (40%) was met.

Year	ECB19RR (CSSS-E)	ALTQ (CSSS-E)
1965	88.9%	82.6%
1966	56.6%	34.3%
1967	93.3%	71.9%
1968	0.0%	0.0%
1969	34.0%	11.6%
1970	5.8%	5.5%
1971	100.0%	100.0%
1972	32.6%	26.8%
1973	72.1%	69.9%
1974	100.0%	100.0%
1975	99.5%	99.1%
1976	79.3%	74.5%
1977	65.0%	58.3%

Year	ECB19RR (CSSS-E)	ALTQ (CSSS-E)
1978	54.9%	52.0%
1979	15.0%	9.4%
1980	51.7%	42.8%
1981	100.0%	100.0%
1982	34.3%	25.9%
1983	0.2%	0.2%
1984	22.4%	11.6%
1985	99.5%	99.4%
1986	43.7%	20.2%
1987	63.0%	53.9%
1988	82.3%	70.5%
1989	100.0%	100.0%
1990	100.0%	100.0%
1991	10.0%	10.7%
1992	74.9%	46.7%
1993	32.8%	25.1%
1994	28.8%	12.1%
1995	0.2%	0.0%
1996	43.4%	22.6%
1997	14.7%	8.8%
1998	8.8%	13.6%
1999	71.8%	54.2%
2000	51.6%	29.0%
2001	100.0%	100.0%
2002	79.0%	58.6%
2003	54.7%	50.3%
2004	99.7%	96.1%
2005	100.0%	100.0%
Average (Diff ECB19RR)	**57.7%**	**50.0% (-7.7%)**
Number of Times Period of Record Target (40%) Met	**27**	**23**
Number of Times ALT ≥ ECB19RR	**-**	**11**
Number of Times ALT < ECB19RR	**-**	**30**

Table D.2-14. CSSS-F Nesting Season Statistics: Percent of Habitat within CSSS-F that met > 90 consecutive dry days during March 1 through July 15 of each year (USGS CSSS Viewer). Green coloration denotes target (40%) was met.

Year	ECB19RR (CSSS-F)	ALTQ (CSSS-F)
1965	100.0%	100.0%

Year	ECB19RR (CSSS-F)	ALTQ (CSSS-F)
1966	100.0%	70.2%
1967	100.0%	100.0%
1968	0.0%	0.0%
1969	86.8%	57.0%
1970	0.0%	7.9%
1971	100.0%	100.0%
1972	64.2%	31.8%
1973	100.0%	100.0%
1974	100.0%	100.0%
1975	100.0%	100.0%
1976	100.0%	100.0%
1977	100.0%	100.0%
1978	100.0%	100.0%
1979	0.0%	0.0%
1980	94.0%	76.8%
1981	100.0%	100.0%
1982	74.2%	68.9%
1983	0.0%	1.3%
1984	0.7%	0.7%
1985	100.0%	100.0%
1986	0.0%	2.6%
1987	97.4%	92.1%
1988	100.0%	100.0%
1989	100.0%	100.0%
1990	100.0%	100.0%
1991	0.0%	0.0%
1992	100.0%	90.1%
1993	4.6%	23.2%
1994	6.0%	50.3%
1995	0.0%	0.0%
1996	90.1%	60.3%
1997	100.0%	100.0%
1998	7.3%	35.8%
1999	94.0%	78.8%
2000	98.7%	90.7%
2001	100.0%	100.0%
2002	100.0%	100.0%
2003	86.1%	94.0%
2004	100.0%	100.0%
2005	100.0%	100.0%

Year	ECB19RR (CSSS-F)	ALTQ (CSSS-F)
Average (Diff ECB19RR)	**70.8%**	**69.1% (-1.7%)**
Number of Times Period of Record Target (40%) Met	**30**	**30**
Number of Times ALT ≥ ECB19RR	**-**	**31**
Number of Times ALT < ECB19RR	**-**	**10**

Table D.2-15 through **Table D.2-20** depicts the percentage of habitat within each of the six CSSS subpopulations (CSSS-Ax, CSSS-B, CSSS-C, CSSS-D, CSSS-E, and CSSS-F) that experienced a four year running average discontinuous hydroperiod between 90 and 210 days for each year in the period of record (1965-2005). The mean four year hydroperiod for a named year is the average yearly days where the water level is > 0 for the previous four years (e.g. 1969 mean four year hydroperiod is the mean of 1965-1968). The average percentage of the four year running average over the period of record is shown as well as the number of times ECB19RR and ALTQ failed to meet the target (40%) in two consecutive years. The number of times ALTQ was observed to be greater than or equal to ECB19RR, as well as the number of times ALTQ was observed to be less than ECB19RR in a given year is also shown.

An average percentage of greater than 40% was not met in CSSS-Ax, however it was achieved in CSSS-B, CSSS-C, and CSSS-F for ECB19RR and ALTQ. Across the sub-populations, the difference in average percentage over the period of record for ALTQ relative to ECB19RR, ranged from a minimum of -20.0% less (CSSS-D) to a maximum of 4.0% more (CSSS-C). ALTQ+ is expected to be very similar to ALTQ with no significant change.

Table D.2-15. CSSS-Ax Discontinuous Annual Hydroperiod Statistics: Percent of habitat within CSSS-Ax to meet a four year running average discontinuous hydroperiod between 90 and 210 days. Green coloration denotes target (40%) was met in individual year.

Year	ECB19RR (CSSS-Ax)	ALTQ (CSSS-Ax)
1965	-	-
1966	-	-
1967	-	-
1968	-	-
1969	16%	14%
1970	12%	12%
1971	8%	9%
1972	14%	14%
1973	18%	17%
1974	30%	30%
1975	47%	46%
1976	39%	41%
1977	45%	47%
1978	52%	52%
1979	49%	50%
1980	38%	33%

Year	ECB19RR (CSSS-Ax)	ALTQ (CSSS-Ax)
1981	28%	24%
1982	28%	25%
1983	30%	27%
1984	25%	26%
1985	22%	24%
1986	18%	20%
1987	18%	20%
1988	28%	23%
1989	27%	25%
1990	32%	30%
1991	47%	45%
1992	60%	61%
1993	61%	58%
1994	25%	23%
1995	11%	12%
1996	5%	6%
1997	5%	6%
1998	4%	5%
1999	3%	4%
2000	5%	6%
2001	11%	10%
2002	14%	14%
2003	18%	17%
2004	23%	21%
2005	30%	28%
2006	28%	26%
Average (Diff ECB19RR)	**26%**	**25% (-1%)**
Threshold not met in 2 Consecutive Years	**27**	**27**
Number of Times ALT ≥ ECB19RR	**-**	**20**
Number of Times ALT < ECB19RR	**-**	**18**

Table D.2-16. CSSS-B Discontinuous Annual Hydroperiod Statistics: Percent of habitat within CSSS-B to meet a four year running average discontinuous hydroperiod between 90 and 210 days. Green coloration denotes target (40%) was met in individual year.

Year	ECB19RR (CSSS-B)	ALTQ (CSSS-B)
1965	-	-
1966	-	-
1967	-	-
1968	-	-
1969	62%	62%

Year	ECB19RR (CSSS-B)	ALTQ (CSSS-B)
1970	47%	46%
1971	43%	43%
1972	53%	52%
1973	47%	46%
1974	44%	44%
1975	58%	59%
1976	55%	55%
1977	66%	66%
1978	67%	67%
1979	58%	56%
1980	44%	42%
1981	42%	41%
1982	46%	44%
1983	54%	52%
1984	54%	54%
1985	56%	56%
1986	54%	53%
1987	55%	53%
1988	40%	38%
1989	50%	49%
1990	32%	31%
1991	47%	47%
1992	66%	66%
1993	62%	62%
1994	55%	54%
1995	53%	52%
1996	49%	48%
1997	49%	48%
1998	47%	45%
1999	27%	27%
2000	36%	35%
2001	43%	42%
2002	50%	49%
2003	53%	54%
2004	50%	50%
2005	52%	53%
2006	46%	45%
Average (Diff ECB19RR)	**50%**	**50% (0%)**
Threshold not met in 2 Consecutive Years	**1**	**1**

Year	ECB19RR (CSSS-B)	ALTQ (CSSS-B)
Number of Times ALT ≥ ECB19RR	**-**	**16**
Number of Times ALT < ECB19RR	**-**	**22**

Table D.2-17. CSSS-C Discontinuous Annual Hydroperiod Statistics: Percent of habitat within CSSS-C to meet a four year running average discontinuous hydroperiod between 90 and 210 days. Green coloration denotes target (40%) was met in individual year.

Year	ECB19RR (CSSS-C)	ALTQ (CSSS-C)
1965	NA	NA
1966	NA	NA
1967	NA	NA
1968	NA	NA
1969	94%	96%
1970	95%	68%
1971	92%	85%
1972	95%	94%
1973	78%	79%
1974	22%	18%
1975	6%	7%
1976	14%	15%
1977	18%	21%
1978	14%	17%
1979	14%	18%
1980	10%	27%
1981	2%	4%
1982	2%	7%
1983	10%	23%
1984	86%	85%
1985	89%	89%
1986	86%	82%
1987	76%	71%
1988	11%	12%
1989	18%	23%
1990	11%	12%
1991	2%	4%
1992	34%	45%
1993	54%	70%
1994	79%	85%
1995	86%	82%
1996	69%	65%
1997	63%	68%

Year	ECB19RR (CSSS-C)	ALTQ (CSSS-C)
1998	50%	52%
1999	23%	34%
2000	78%	76%
2001	89%	90%
2002	85%	88%
2003	63%	77%
2004	20%	60%
2005	9%	38%
2006	5%	17%
Average (Diff ECB19RR)	**46%**	**50% (4%)**
Threshold not met in 2 Consecutive Years	**15**	**12**
Number of Times ALT ≥ ECB19RR	**-**	**28**
Number of Times ALT < ECB19RR	**-**	**10**

Table D.2-18. CSSS-D Discontinuous Annual Hydroperiod Statistics: Percent of habitat within CSSS-D to meet a four year running average discontinuous hydroperiod between 90 and 210 days. Green coloration denotes target (40%) was met in individual year.

Year	ECB19RR (CSSS-D)	ALTQ (CSSS-D)
1965	-	-
1966	-	-
1967	-	-
1968	-	-
1969	62%	24%
1970	33%	13%
1971	37%	14%
1972	50%	20%
1973	56%	27%
1974	73%	69%
1975	77%	81%
1976	81%	83%
1977	82%	84%
1978	80%	81%
1979	68%	51%
1980	56%	26%
1981	56%	21%
1982	64%	23%
1983	75%	28%
1984	52%	21%
1985	54%	23%
1986	37%	16%

Year	ECB19RR (CSSS-D)	ALTQ (CSSS-D)
1987	40%	16%
1988	70%	32%
1989	70%	35%
1990	75%	62%
1991	78%	84%
1992	85%	87%
1993	85%	84%
1994	45%	22%
1995	28%	11%
1996	20%	10%
1997	21%	10%
1998	23%	12%
1999	22%	10%
2000	28%	11%
2001	36%	16%
2002	42%	24%
2003	64%	30%
2004	70%	34%
2005	79%	63%
2006	77%	54%
Average (Diff ECB19RR)	**57%**	**37% (-20%)**
Threshold not met in 2 Consecutive Years	**7**	**23**
Number of Times ALT ≥ ECB19RR	**-**	**6**
Number of Times ALT < ECB19RR	**-**	**32**

Table D.2-19. CSSS-E Discontinuous Annual Hydroperiod Statistics: Percent of habitat within CSSS-E to meet a four year running average discontinuous hydroperiod between 90 and 210 days. Green coloration denotes target (40%) was met in individual year.

Year	ECB19RR (CSSS-E)	ALTQ (CSSS-E)
1965	-	-
1966	-	-
1967	-	-
1968	-	-
1969	50%	36%
1970	22%	10%
1971	22%	16%
1972	35%	27%
1973	44%	35%
1974	54%	51%
1975	71%	71%

Year	ECB19RR (CSSS-E)	ALTQ (CSSS-E)
1976	69%	70%
1977	77%	80%
1978	80%	78%
1979	54%	55%
1980	44%	38%
1981	34%	33%
1982	36%	35%
1983	45%	41%
1984	50%	44%
1985	34%	28%
1986	34%	28%
1987	36%	28%
1988	51%	35%
1989	57%	42%
1990	63%	49%
1991	60%	57%
1992	86%	86%
1993	87%	86%
1994	47%	37%
1995	28%	16%
1996	14%	9%
1997	12%	8%
1998	8%	6%
1999	4%	4%
2000	9%	8%
2001	24%	17%
2002	33%	27%
2003	50%	42%
2004	48%	44%
2005	56%	54%
2006	50%	48%
Average (Diff ECB19RR)	**44%**	**39% (-5%)**
Threshold not met in 2 Consecutive Years	**13**	**17**
Number of Times ALT ≥ ECB19RR	**-**	**6**
Number of Times ALT < ECB19RR	**-**	**32**

Table D.2-20. CSSS-F Discontinuous Annual Hydroperiod Statistics: Percent of habitat within CSSS-F to meet a four year running average discontinuous hydroperiod between 90 and 210 days. Green coloration denotes target (40%) was met in individual year.

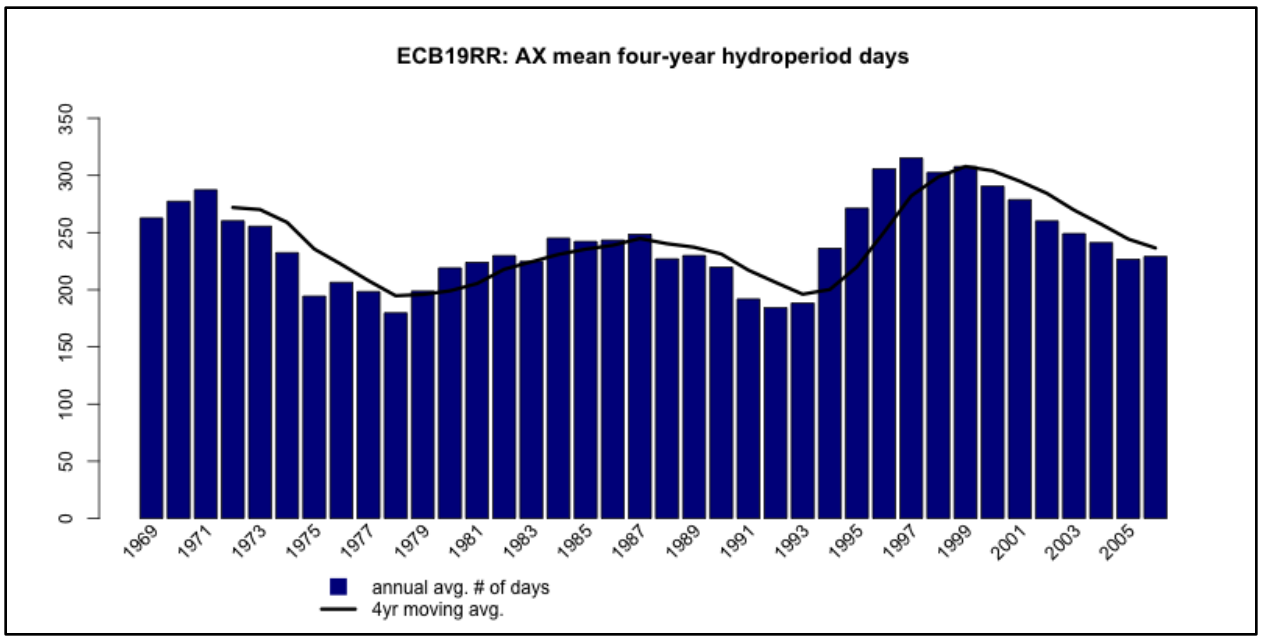
Year	ECB19RR (CSSS-F)	ALTQ (CSSS-F)
1965	-	-
1966	-	-
1967	-	-
1968	-	-
1969	100%	79%
1970	65%	25%
1971	47%	25%
1972	91%	67%
1973	99%	87%
1974	64%	66%
1975	5%	7%
1976	9%	12%
1977	11%	11%
1978	12%	15%
1979	22%	30%
1980	38%	58%
1981	12%	38%
1982	18%	51%
1983	57%	64%
1984	95%	85%
1985	85%	60%
1986	85%	66%
1987	84%	47%
1988	65%	65%
1989	64%	68%
1990	62%	74%
1991	18%	28%
1992	59%	71%
1993	76%	89%
1994	86%	59%
1995	33%	22%
1996	10%	11%
1997	9%	9%
1998	9%	16%
1999	11%	14%
2000	43%	34%
2001	89%	58%

Year	ECB19RR (CSSS-F)	ALTQ (CSSS-F)
2002	91%	80%
2003	78%	81%
2004	60%	74%
2005	52%	67%
2006	54%	69%
Average (Diff ECB19RR)	**52%**	**50% (-2%)**
Threshold not met in 2 Consecutive Years	**11**	**10**
Number of Times ALT ≥ ECB19RR	**-**	**24**
Number of Times ALT < ECB19RR	**-**	**14**

Figure D.2-52 through **Figure D.2-57** shows the mean four year hydroperiod in days for ECB19RR and ALTQ. For each subpopulation the average of the mean four year hydroperiod over the period of record fell within the range of 90 to 210 days for CSSS B and D, except for CSSS-Ax under ECB19RR (242 ± 56 days) and ALTQ (243 ± 57 days) where the mean four year hydroperiod fell above the desired range. Reference **Table D.2-21.** CSSS-D and CSSS-E also fell above the desired range under ALTQ (CSSS-D 214 ± 50 days; CSSS-E 217 ± 65 days).

Table D.2-21. Average mean four year hydroperiod days over the period of record for each CSSS subpopulation ± standard deviation. Green coloration denotes hydroperiod fell within desired range of 90-210 days.

CSSS Sub-Population	ECB19RR	ALTQ
CSSS-Ax	242 ± 56	243 ± 57
CSSS-B	146 ± 52	148 ± 52
CSSS-C	102 ± 57	109 ± 55
CSSS-D	188 ± 46	214 ± 50
CSSS-E	204 ± 64	217 ± 65
CSSS-F	136 ± 72	152 ± 75



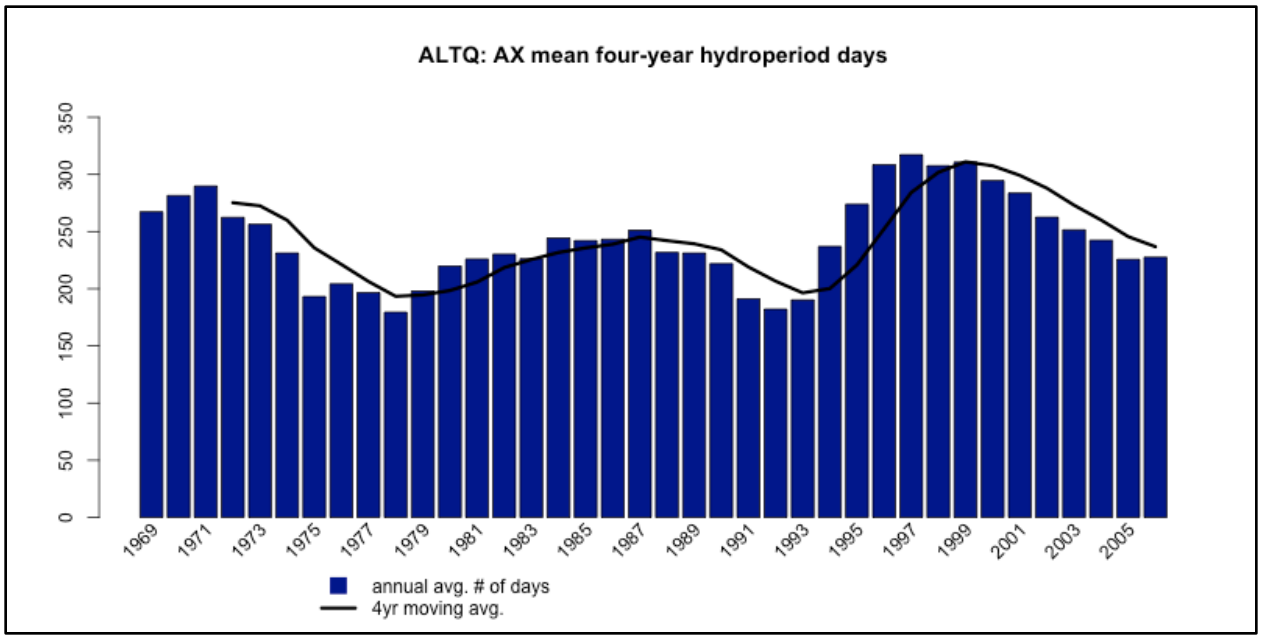
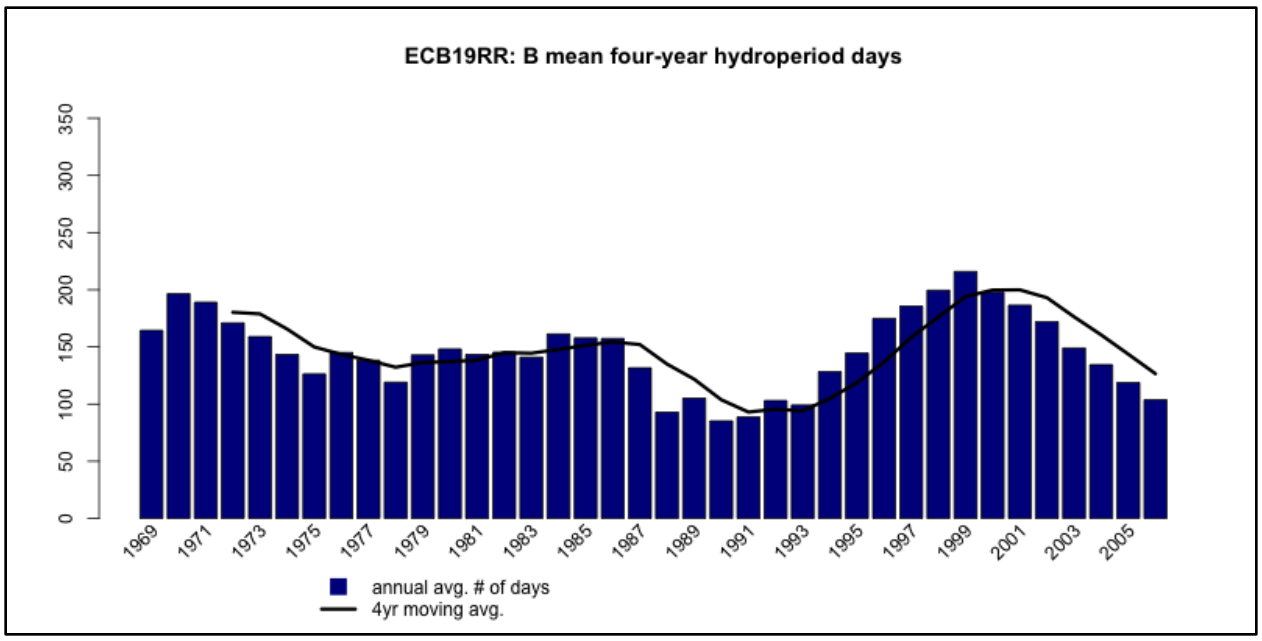


Figure D.2-51. CSSS-Ax mean four year hydroperiod days (ECB19RR Top: ECB19RR Bottom).



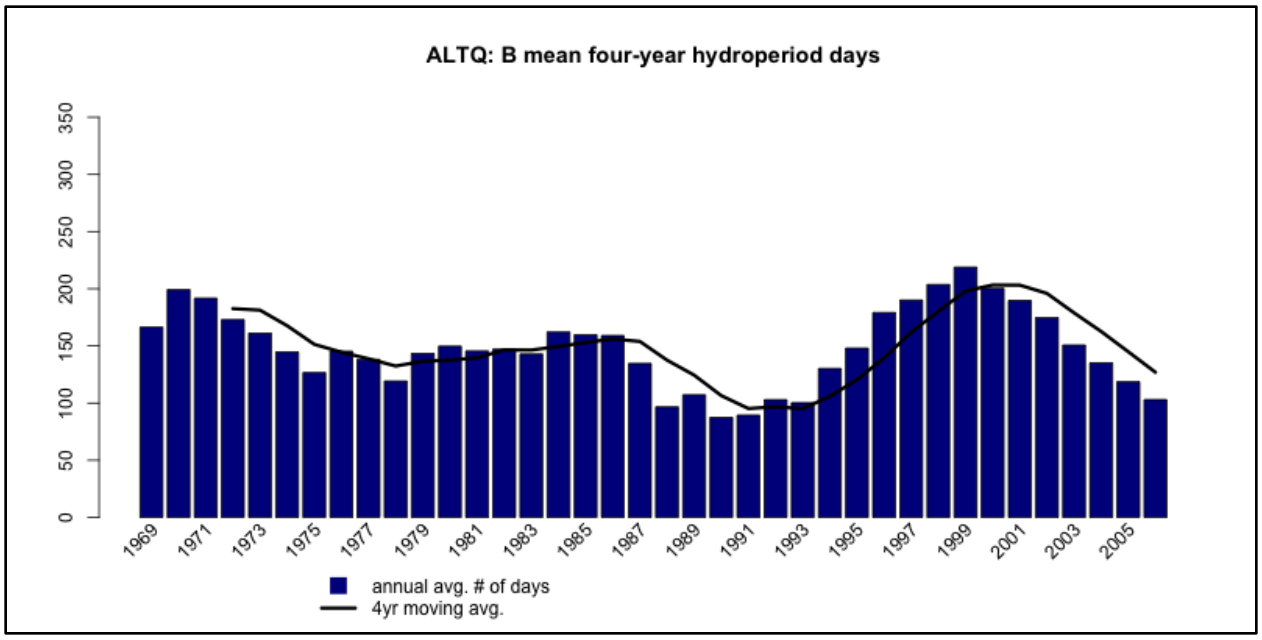
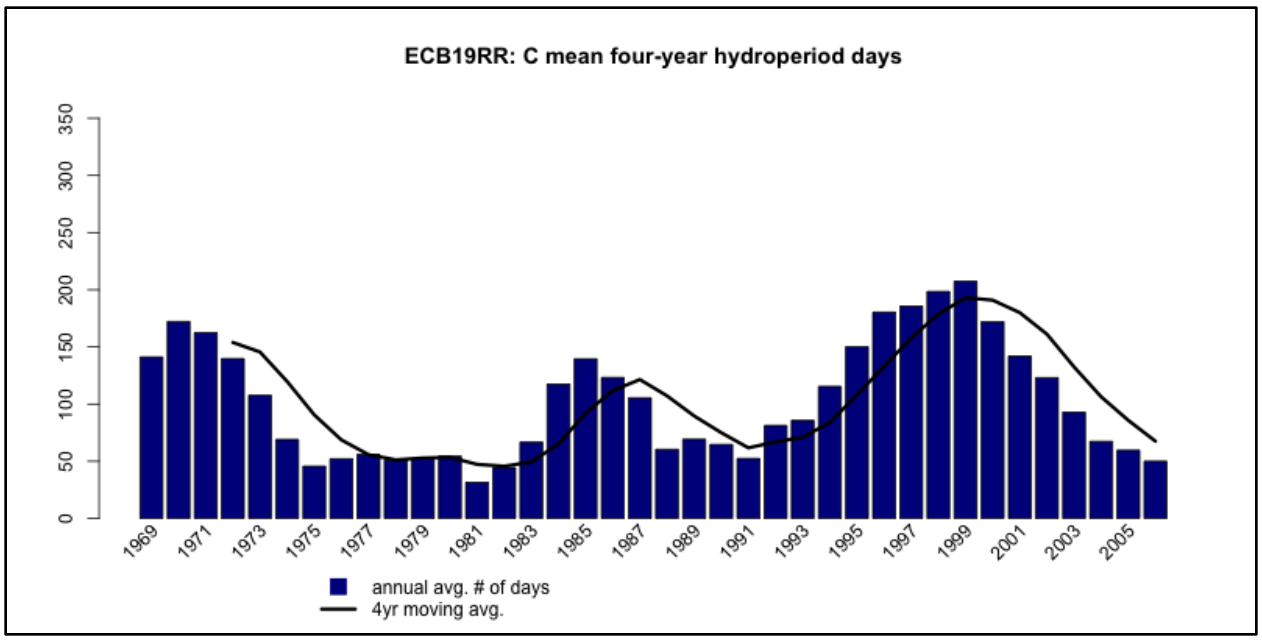


Figure D.2-52. CSSS-B mean four year hydroperiod days (ECB19RR Top: ECB19RR Bottom).



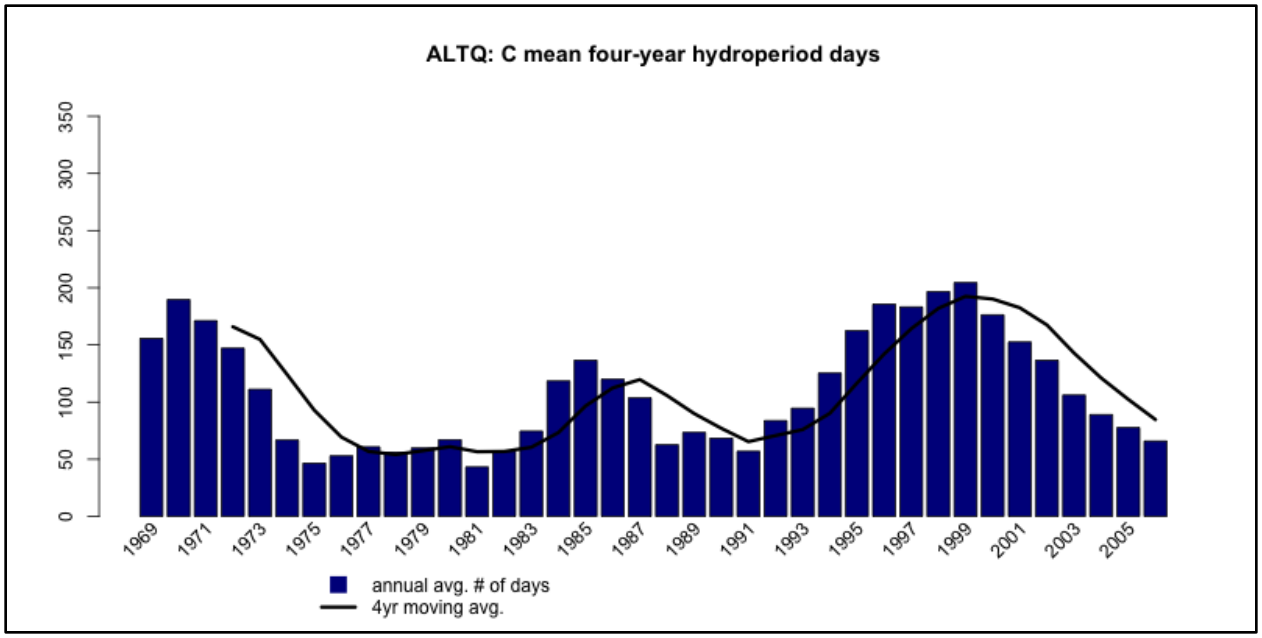
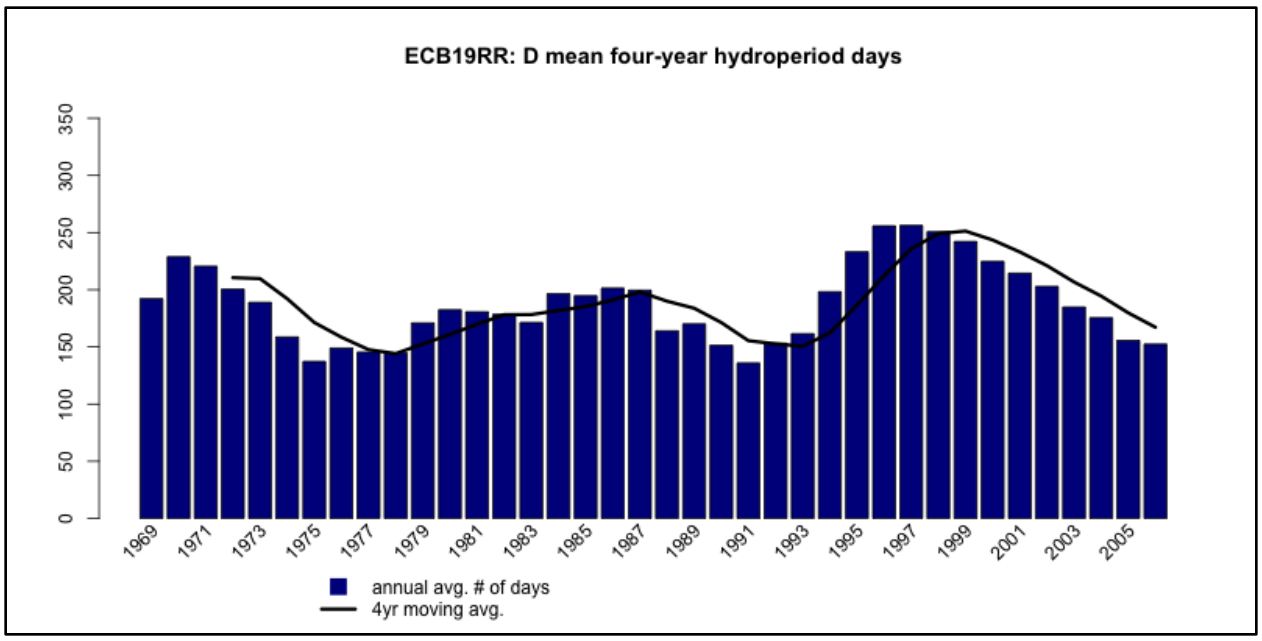


Figure D.2-534. CSSS-C mean four year hydroperiod days (ECB19RR Top: ECB19RR Bottom).



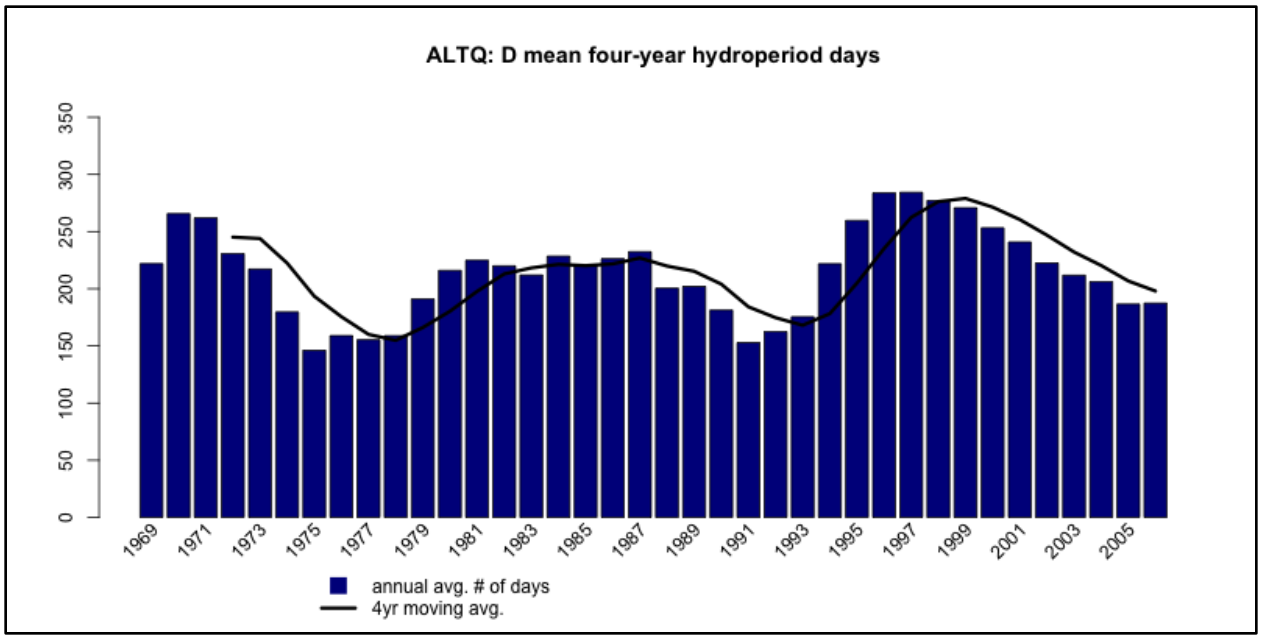
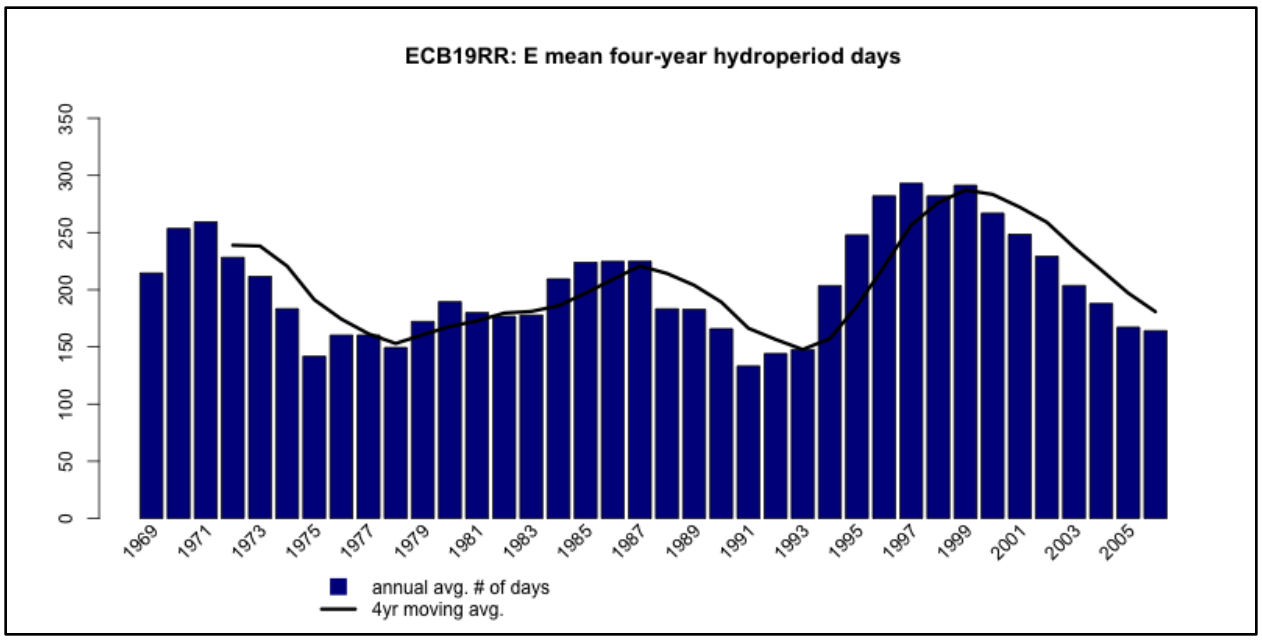


Figure D.2-545. CSSS-D mean four year hydroperiod days (ECB19RR Top: ECB19RR Bottom).



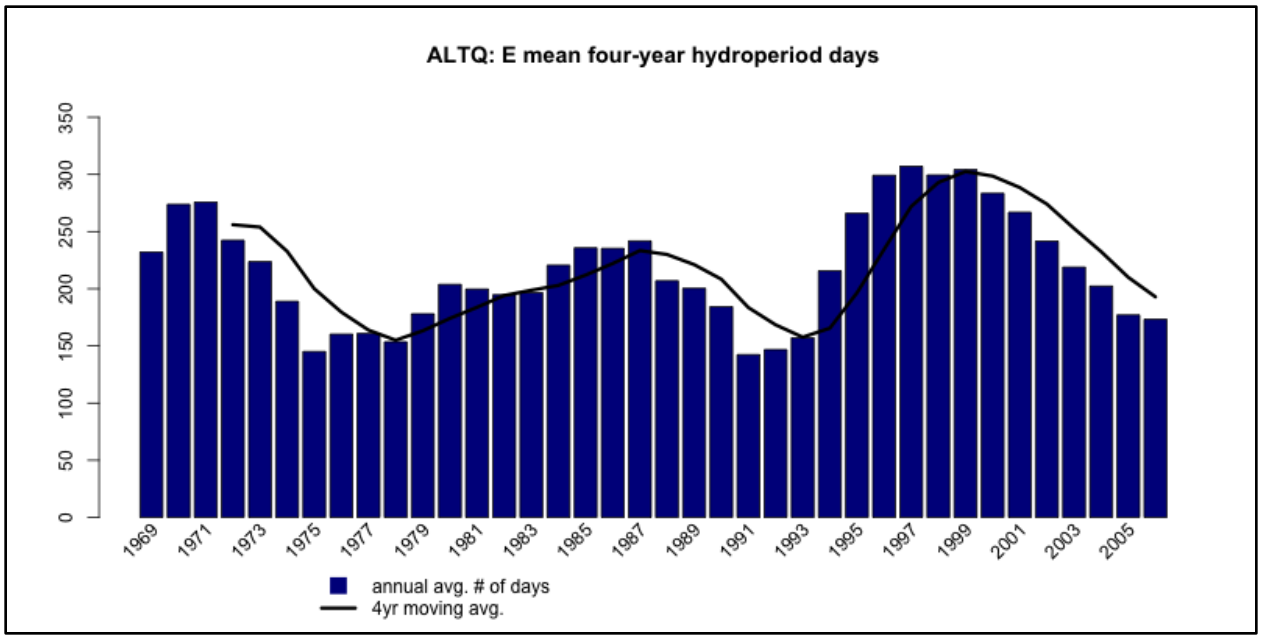


Figure D.2-55. CSSS-E mean four year hydroperiod days (ECB19RR Top: ECB19RR Bottom).

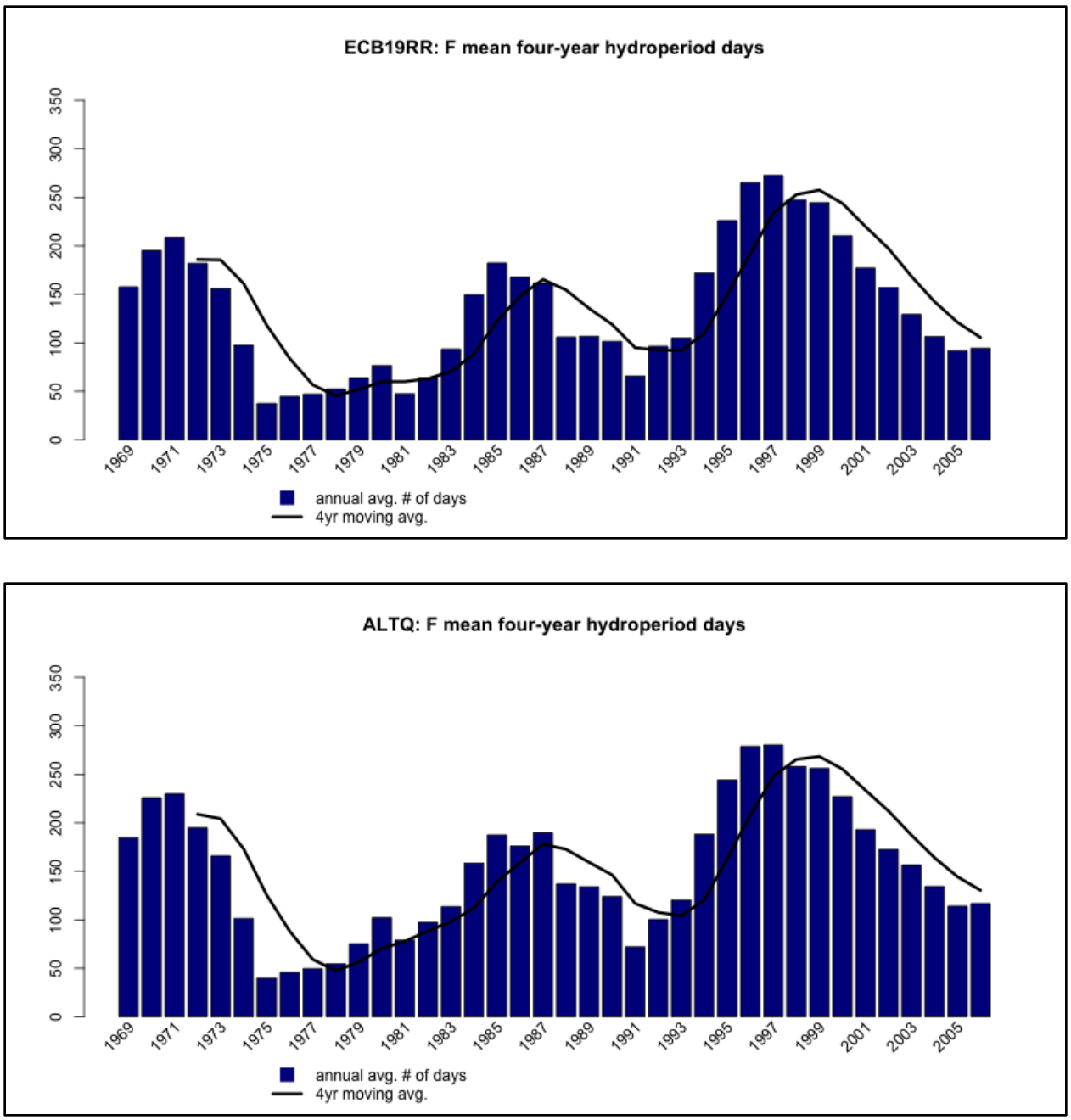


Figure D.2-567. CSSS-F mean four year hydroperiod days (ECB19RR Top: ECB19RR Bottom).

Marl prairie communities have short-hydroperiods and contain a mosaic of moderately dense, clumped grasses. Areas within the western marl prairies between the boundary of BCNP and ENP are currently considered to be too wet. Areas within the eastern marl prairies along the boundary of ENP suffer from over-drainage, reduced water flow, exotic tree invasion and frequent human-induced fires. To alleviate the perpetually drier conditions and associated problems, increased water flows within this area are required. **Table D.2-22** lists the average annual overland flow volume in thousand acre feet across the period of record (1965-2005) for the WCA 3A outlet structures and across transects in ENP. Results for SRQ1 and SRQ4 are also shown. Reference **Section D.2.4.2** for information on these sensitivity runs with respect to ATLQ+.

Flows through S-343A/B, S-344, and S-12A, S-12B, S-12C, and S-12D were significantly reduced by 131,200 acre feet per year on average under ALTQ relative to ECB19RR. Decreased flow (67,000 acre feet) was observed across Transect T17 for ALTQ which is located west of the L-67 Extension in ENP. The observed decrease was coupled with an observed increase in flow across Transect T18 into NESRS (229,000 acre feet); however, the observed increase in flows across Transect T20 (127,000 acre feet) which represents the historic southwesterly flow into north central ENP along the Shark River Slough, may potentially affect western marl prairies and CSSS-Ax. Increased flows to NESRS and Taylor Slough have the potential to affect the eastern marl prairies. Similar patterns were observed for SR1 and SRQ4 relative to ALTQ, however the magnitude of observed increase (NESRS) or decrease (western SRS) was greater under SRQ1. SRQ4 was more similar to ALTQ.

Table D.2-22. Average annual overland flow (K-ACFT) for ECB19RR and ALTQ. Differences in average annual overland flow between ECB19RR and ALTQ relative to ECB19RR for WCA 3A outflow structures and across transects in ENP over the period of record (1965-2005).

Structure or Transect	ECB19RR	ALTQ	SRQ1	SRQ4	Difference ECB19RR - ALTQ	Difference ECB19RR – SRQ1	Difference ECB19RR – SRQ4
S-343 A/B	14.9	4.1	3.9	4.1	10.8	11	10.8
S-344	7.0	2.1	1.9	6.0	4.9	5.1	1
S-12A	29.8	21.4	18.8	21.2	8.4	11	8.6
S-12A Weir*	5.9	5.0	4.8	4.9	0.9	1.1	1
S-12B	34.9	24.9	22.5	24.7	10	12.4	10.2
S-12B Weir*	4.7	4.0	3.9	4.0	0.7	0.8	0.7
S-12C	142.9	93.1	83.6	92.1	49.8	59.3	50.8
S-12D	218.6	172.9	150.3	171.8	45.7	68.3	46.8
Total	-	-	-	-	131.2	169	129.9
T17	239	172	156	171	67	83	68
T18	332	561	604	560	-229	-272	-228
T20	118	245	271	245	-127	-153	-127
TSH1	20	24	25	26	-4	-5	-6
TSH2	21	24	25	26	-3	-4	-5
T23A	24	24	24	24	0	0	0
T23B	86	92	93	94	-6	-7	-8
T23C	113	143	145	144	-30	-32	-31

*S-12A/B weir is for flow over the top of the gates when the gates are closed.

In addition to the above evaluation, the CSSS Marl Prairie ecological planning tool was utilized to evaluate the potential effects of ALTQ on marl prairie habitat in relation to the CSSS. The CSSS Marl Prairie ecological planning tool was developed to simulate hydrologic suitability of marl prairie habitat based on CSSS survey presence data thresholds. The CSSS Marl Prairie ecological planning tool scores specifically target hydrologic indicators of suitable marl prairies inhabited by the CSSS. Output is provided as a percent to target met by the hydrologic scenario (Pearlstein et. al. 2016). **Figure D.2-58** shows the results of the ecological planning tool overlaid with CSSS critical habitat for ALTQ relative to ECB19RR over the period of record (1965-2005). ALTQ was observed to increase flow to NESRS and the eastern marl prairies

relative to ECB19RR (**Table D.2-22**); however, changes to the eastern marl prairies generally fell within a range of +/- 10% in those subpopulations currently inhabited by CSSS-B through CSSS-F. Marl prairie habitat suitability increased in the northern portion of CSSS-Ax under ALTQ. Areas of decreased suitability were observed in portions of CSSS-E and CSSS-D; however, these observed decreases were coupled with observed increases in suitability in areas directly east of CSSS-E and north and south of CSSS-F and CSSS-C. Minor to moderate, long term beneficial effects may potentially occur in portions of the western and eastern marl prairies as a result of COP. The CSSS Marl Prairie ecological planning tool was not available for ALTQ+, since this alternative was not simulated with the COP modeling tools as previously described. ALTQ+ would result in similar effects as discussed under ALTQ.

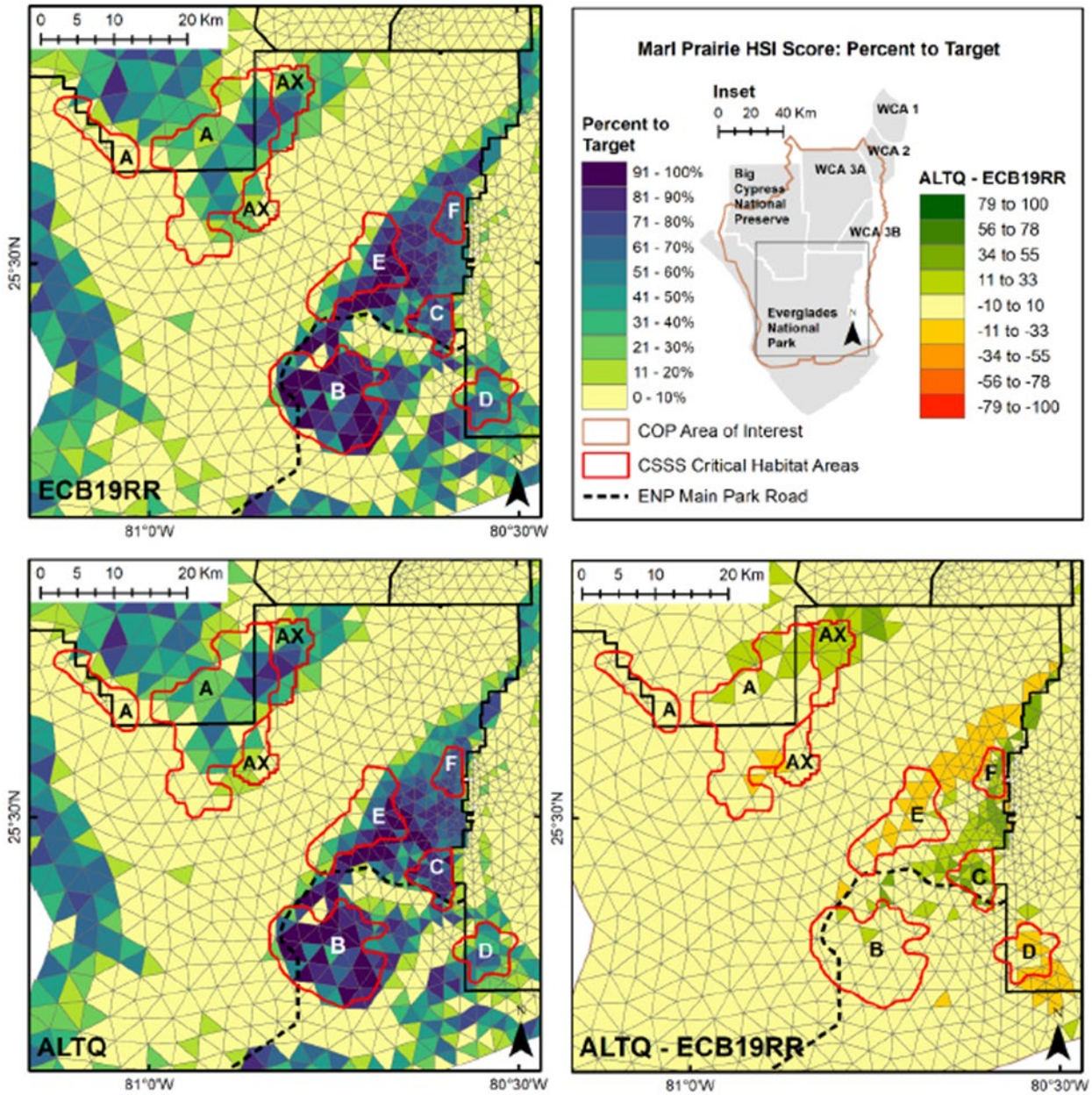


Figure D.2-57. Marl prairie habitat suitability in ENP for ALTQ.

Potential effects to CSSS critical habitat units expected under COP are as follows.

Subpopulation B (CSSS-B/Unit 1) –

Dry Nesting Days: Unit 1 was predicted to meet the target habitat percentage (40%) that experienced > 90 consecutive dry days during the nesting season under ALTQ for 35 years out of the 41 year period of record as compared to 37 years under ECB19RR. ALTQ was observed to score higher than or equal to ECB19RR for 14 years out of the period of record. ALTQ was observed to score less than ECB19RR for 27 years out of the period of record; however when the

difference in average percentage over the period of record was calculated it was less than 10% (-1.1%). An average percentage of greater than 40% was still achieved over the period of record in CSSS-B.

Annual Discontinuous Hydroperiod: In Unit 1, ALTQ failed to meet the target habitat percentage (40%) that experienced a four year running average discontinuous hydroperiod between 90 and 210 days in two consecutive years only one time, which was equivalent to ECB19RR. ALTQ was observed to score higher than or equal to ECB19RR in meeting the target habitat percentage (40%) in a given year 16 times over the period of record. ALTQ was observed to score less than ECB19RR 22 times over the period of record. An average habitat target percentage (40%) was achieved for both ECB19RR and ALTQ with no difference between the two. For Unit 1, the average of the mean four year hydroperiod over the period of record fell within the range of 90 to 210 days under ECB19RR (146 ± 52 days) and ALTQ (148 ± 52 days).

Hydrological conditions within this Critical Habitat Unit would support hospitable conditions for nesting sparrows under implementation of the Proposed Action.

Subpopulation D (CSSS-D/Unit 3) –

Dry Nesting Days: Unit 3 was predicted to meet the target habitat percentage (40%) that experienced > 90 consecutive dry days during the nesting season under ALTQ for 21 years out of the 41 year period of record as compared to 24 years under ECB19RR. ALTQ was observed to score higher than or equal to ECB19RR for 23 years out of the period of record. ALTQ was observed to score less than ECB19RR for 28 years out of the period of record; however when the difference in average percentage over the period of record was calculated it was less than 10% (-7.2%). An average percentage of greater than 40% was still achieved over the period of record in CSSS-D.

Annual Discontinuous Hydroperiod: In Unit 3, ALTQ failed to meet the target habitat percentage (40%) that experienced a four year running average discontinuous hydroperiod between 90 and 210 days in two consecutive years 23 times compared to ECB19RR with 7 times. ALTQ was observed to score higher than or equal to ECB19RR in meeting the target habitat percentage (40%) in a given year 6 times over the period of record. ALTQ was observed to score less than ECB19RR 32 times over the period of record. An average habitat target percentage (40%) was achieved for ECB19RR (50%); however ALTQ achieved an average of only 37%, a difference of -20%. For Unit 3 , the average of the mean four year hydroperiod over the period of record fell within the range of 90 to 210 days under ECB19RR (188 ± 46 days) and slightly above the range for ALTQ (214 ± 50 days).

Hydrological conditions within this Critical Habitat Unit would support hospitable conditions for nesting sparrows under implementation of the Proposed Action.

Subpopulation E (CSSS-E/Unit 4) –

Dry Nesting Days: Unit 4 was predicted to meet the target habitat percentage (40%) that experienced > 90 consecutive dry days during the nesting season under ALTQ for 23 years out of the 41 year period of record as compared to 27 years under ECB19RR. ALTQ was observed to score higher than or equal to ECB19RR for 11 years out of the period of record. ALTQ was

observed to score less than ECB19RR for 30 years out of the period of record; however when the difference in average percentage over the period of record was calculated it was less than 10% (-7.7%). An average percentage of greater than 40% was still achieved over the period of record in CSSS-E.

Annual Discontinuous Hydroperiod: In Unit 4, ALTQ failed to meet the target habitat percentage (40%) that experienced a four year running average discontinuous hydroperiod between 90 and 210 days in two consecutive years 17 times compared to ECB19RR with 13 times. ALTQ was observed to score higher than or equal to ECB19RR in meeting the target habitat percentage (40%) in a given year 6 times over the period of record. ALTQ was observed to score less than ECB19RR 32 times over the period of record. An average habitat target percentage (40%) was achieved for ECB19RR (44%); however ALTQ achieved an average of only 39%, a difference of -5%. For Unit 4 , the average of the mean four year hydroperiod over the period of record fell within the range of 90 to 210 days under ECB19RR (204 ± 64 days) and slightly above the range for ALTQ (217 ± 65 days).

Hydrological conditions within this Critical Habitat Unit would support hospitable conditions for nesting sparrows under implementation of the Proposed Action.

Subpopulation F (CSSS-F/Unit 5) –

Dry Nesting Days: Unit 5 was predicted to meet the target habitat percentage (40%) that experienced > 90 consecutive dry days during the nesting season under ALTQ for 30 years out of the 41 year period of record which was equivalent to ECB19RR. ALTQ was observed to score higher than or equal to ECB19RR for 31 years out of the period of record. ALTQ was observed to score less than ECB19RR for only 10 years out of the period of record. When the difference in average percentage over the period of record was calculated it was minimal (-1.7%). An average percentage of greater than 40% was achieved over the period of record in CSSS-E.

Annual Discontinuous Hydroperiod: In Unit 5, ALTQ failed to meet the target habitat percentage (40%) that experienced a four year running average discontinuous hydroperiod between 90 and 210 days in two consecutive years 10 times compared to ECB19RR with 11 times. ALTQ was observed to score higher than or equal to ECB19RR in meeting the target habitat percentage (40%) in a given year 24 times over the period of record. ALTQ was observed to score less than ECB19RR 14 times over the period of record. An average habitat target percentage (40%) was achieved for both the ECB19RR (52%) and ALTQ (50%), a difference of -2%. For Unit 5, the average of the mean four year hydroperiod over the period of record fell within the range of 90 to 210 days under ECB19RR (136 ± 72 days) and ALTQ (152 ± 75 days).

USACE has determined that the proposed action may affect the CSSS and its designated critical habitat. The implementation of COP is expected to influence wetland hydroperiods causing changes in nesting and marl prairie suitability for the CSSS. USACE proposes specific minimization measures as part of COP including species and habitat monitoring to identify population trends for the CSSS currently being conducted in compliance with the 2016 ERTP BO (USFWS 2016). Under COP, USACE will continue to implement PSC to provide real-time assessment of conditions within the action area to ensure wildlife recommendations are considered during the water management decision process. Under COP, USACE

will also continue to evaluate how water management operations within the flexibility available to USACE may be conducted to maximize beneficial effects for the CSSS.

D.2.6.2.5 American Alligator and "May Affect Not Likely to Adversely Affect" Determination

The American alligator is listed as threatened due to similarity of appearance to American crocodile, an endangered species. A keystone species within the Everglades ecosystem, the American alligator is dependent on spatial and temporal patterns of water fluctuations that affect courtship and mating, nesting, and habitat use (Brandt and Mazzotti 2000). Historically, American alligators were most abundant in the peripheral Everglades marshes and freshwater mangrove habitats, but are now most abundant in canals and the deeper slough habitats of the central Everglades. Water management practices including drainage of peripheral wetlands and increasing salinity in mangrove wetlands as a result of decreased freshwater flows has limited occurrence of American alligators in these habitats (Craighead 1968, Mazzotti and Brandt 2000).

For COP, an ecological planning tool was available to evaluate potential effects on the American alligator a keystone species within the Greater Everglades marsh systems, acting as predator and prey and structuring plant communities (Brandt and Mazzotti, 2000). Alligators are dependent on spatial and temporal patterns of water fluctuations that affect courtship and mating, nesting, and habitat use. Water management practices and other anthropogenic changes to the region have affected alligators, which historically were abundant in peripheral marshes of the Everglades (Craighead 1968) and are now most abundant in central sloughs (Kushlan 1990). Water management practices including drainage of peripheral wetlands has limited occurrence of American alligators in these habitats (Craighead 1968, Kushlan 1990, Mazzotti and Brandt 1994). A Habitat Suitability Index (HSI) for alligators was employed to predict potential effects of ALTQ relative to ECB19RR. The HSI measures habitat suitability annually for five components of alligator production: (1) land cover suitability, (2) breeding potential (female growth and survival from April 16 of the previous year - April 15 of the current year), (3) courtship and mating (April 16 – May 31), (4) nest building (June 15 – July 15), and egg incubation (nest flooding from July 01 – September 15). (Shinde et al. 2014). For more details please reference Brandt et al. 2000, Craighead 1968, Kushlan 1990 and Shinde et. al. 2014.

COP is expected to benefit ENP by increasing flows to NESRS and Taylor Slough and hydrating existing wetlands. **Figure D.2-59** through **Figure D.2-61** illustrates the difference in alligator breeding potential for ALTQ relative to ECB19RR for a representative average year (1978), dry year (1989), and wet year (1995) within the period of record (1965-2005). During a dry year, observed differences relative to ECB19RR were most often not more than a ± 10% change across the majority of WCA 3 and ENP. During a wet year, increases in alligator habitat suitability greater than 10% were observed for ALTQ in southern WCA 3A and in portions of southern ENP on the flanks of eastern SRS. Areas of decreased suitability by more than 10% were observed in areas of ENP directly east and west of the L-67 Extension. During an average year areas of decreased suitability were also observed in these areas in addition to southern WCA 3A. **Figure D.2-62** shows percent change in mean annual alligator habitat suitability against ECB19RR. ALTQ improved conditions for alligators in 17 years out of the 41 year period of record. Performance ranged from a maximum percent change of ~7% observed in given year to a minimum percent change of ~-19% and an average percent change of ~ -2% across years.

Implementation of COP may produce a variety of wetland habitats that would support conditions conducive to alligators and other aquatic reptiles. Based on the above information, USACE has

determined that the Proposed Action may affect, but is not likely to adversely affect the American alligator.

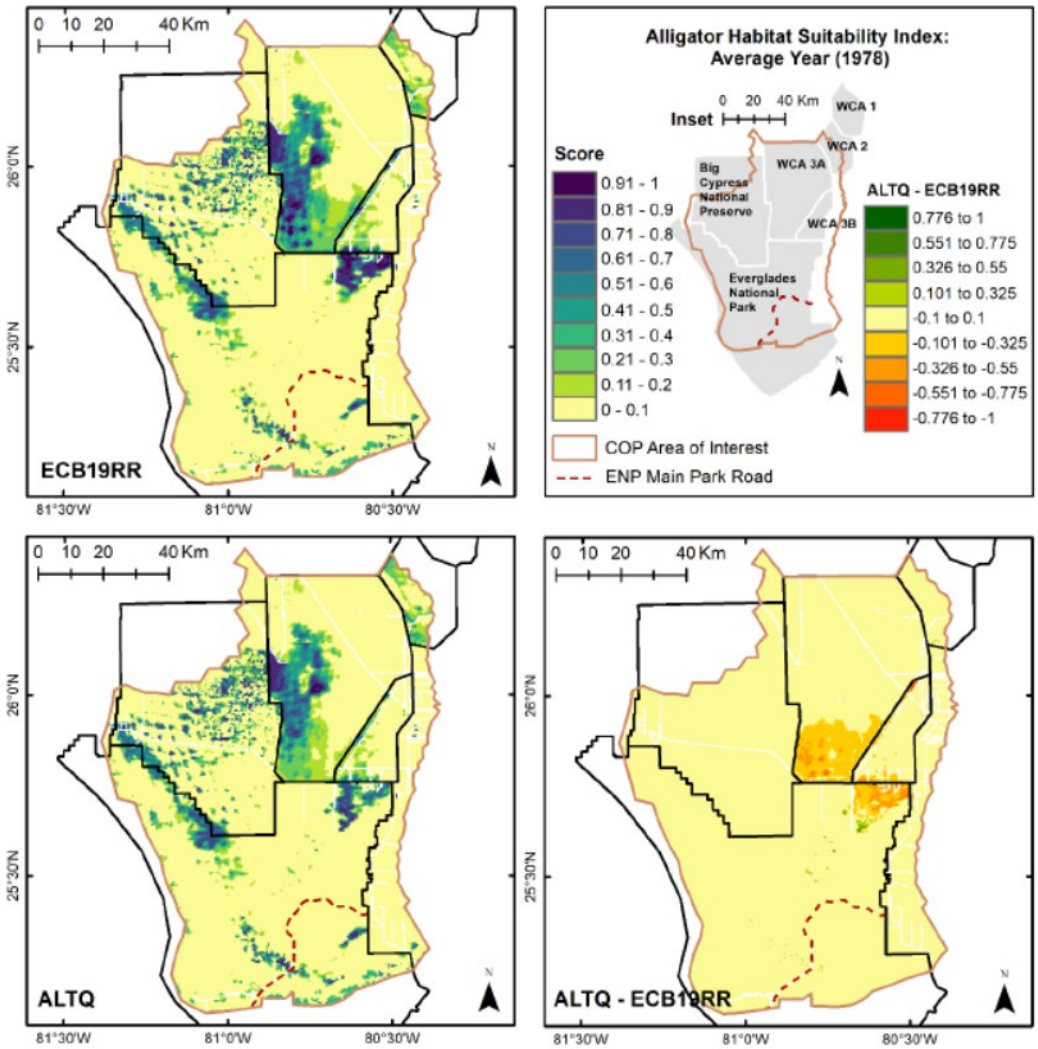


Figure D.2-59. Alligator habitat Suitability index for an average year (1978) for ALTQ.

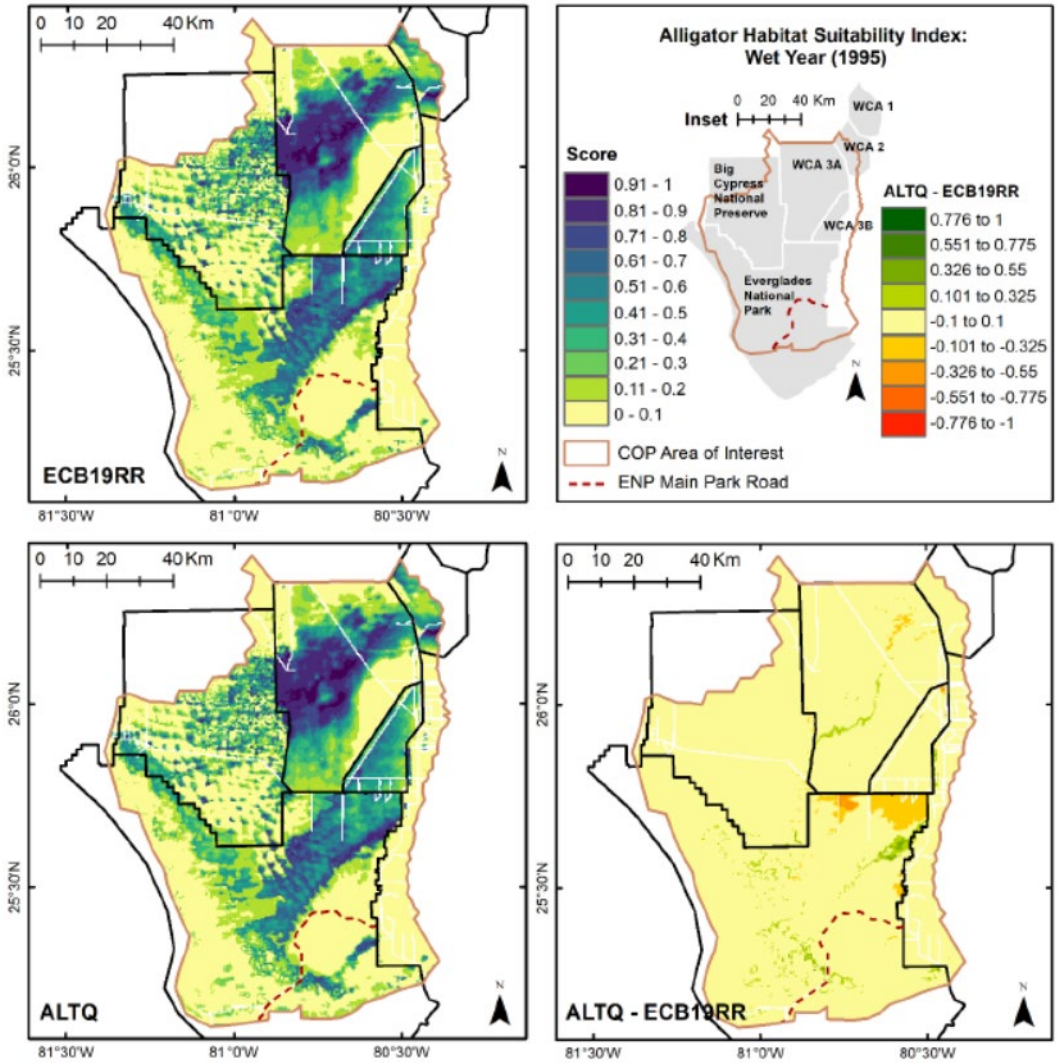


Figure D.2-60. Alligator Habitat Suitability Index for a wet year (1995) for ALTQ.

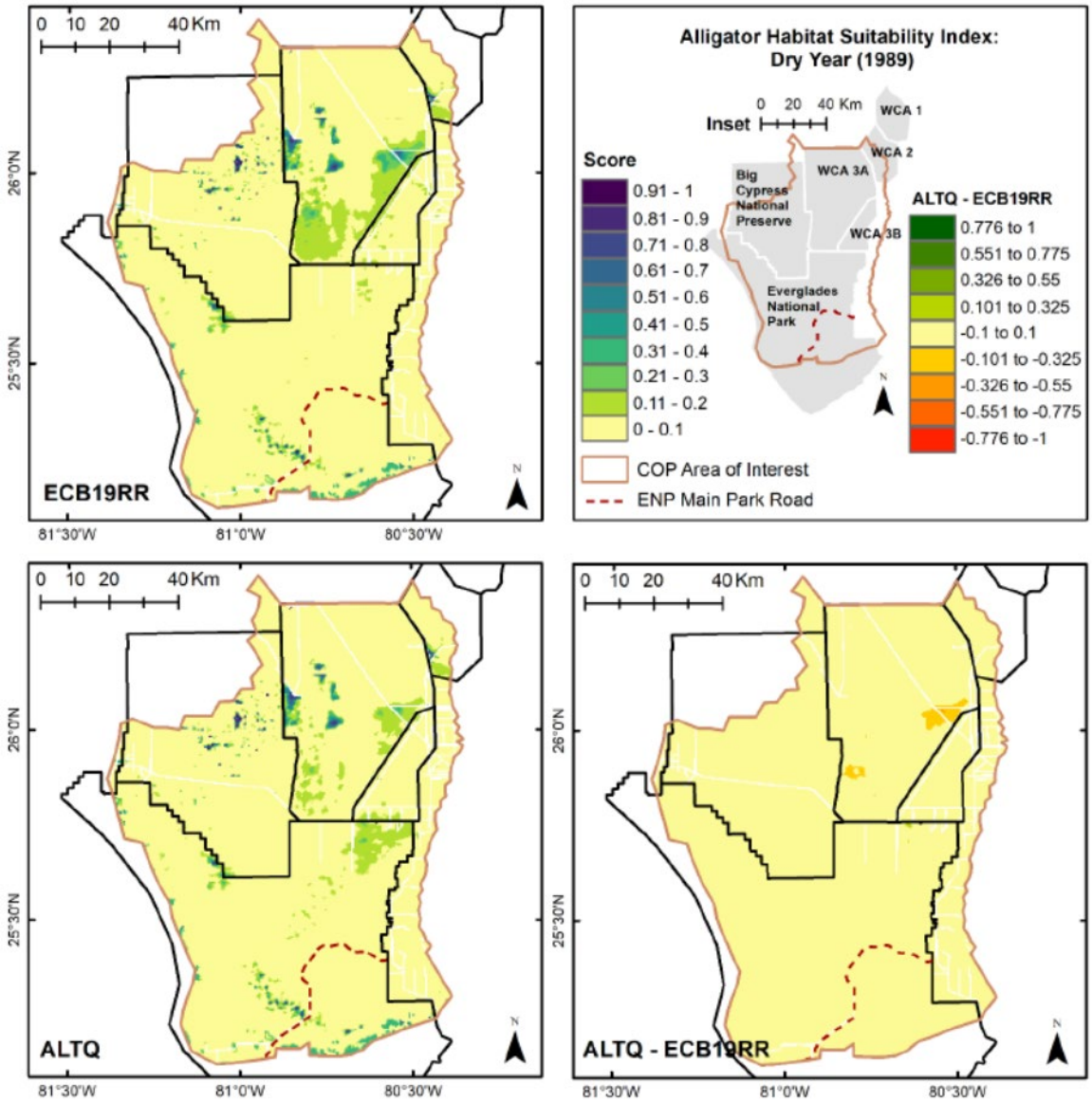


Figure D.2-58. Alligator Habitat Suitability Index for a dry year (1989) for ALTQ.

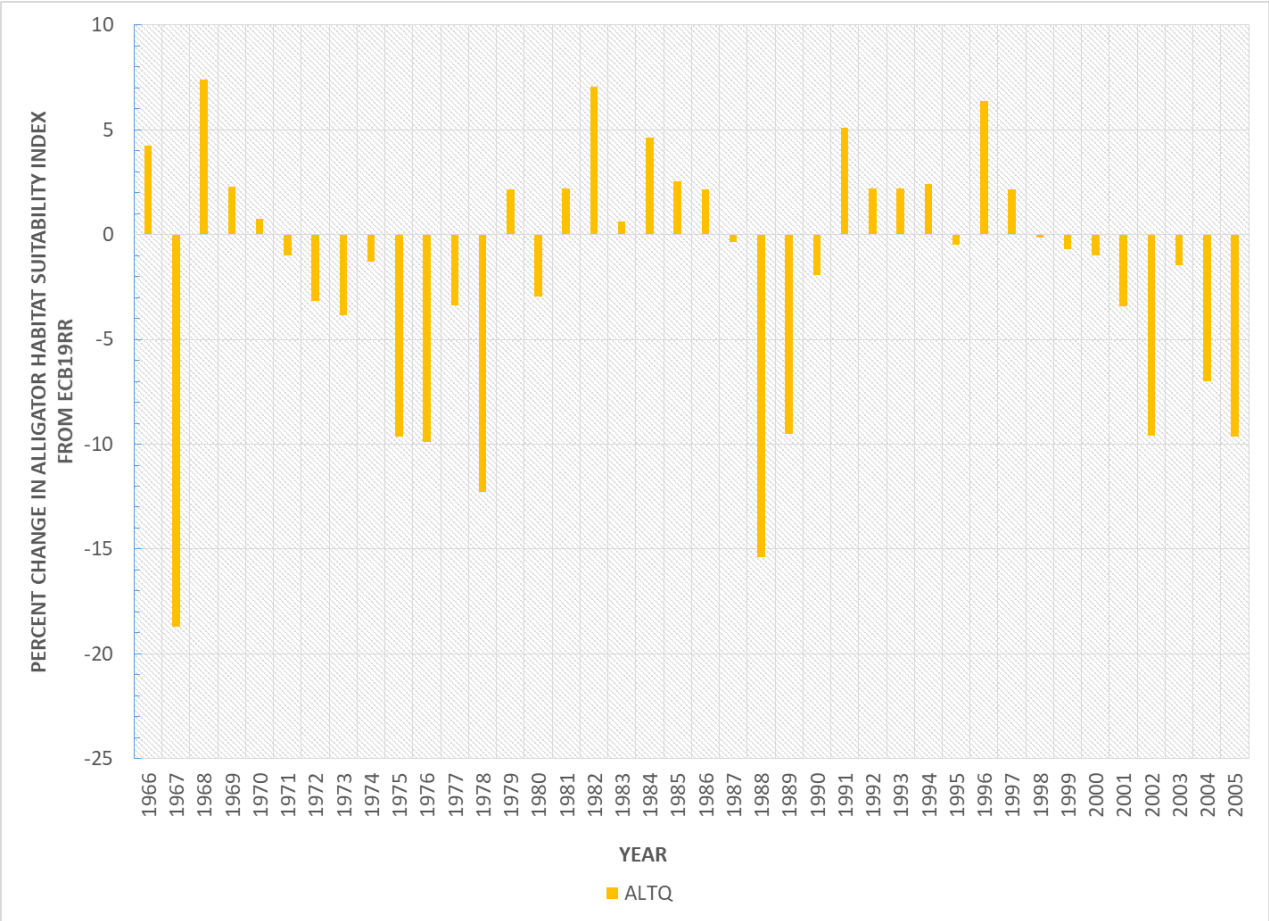


Figure D.2-59. Percent change in alligator habitat suitability index from ECB19RR.

D.2.6.2.6 American Crocodile and "May Affect Not Likely to Adversely Affect" Determination

The American crocodile is found primarily in mangrove swamps and along low-energy mangrove lined bays, creeks, and inland swamps. Natural nesting habitat includes sites with sandy shorelines or raised marl creek banks adjacent to deep water. Crocodiles also nest on elevated man-made structures such as canal berms and other places where fill has been introduced. The current distribution of the American crocodile is limited to extreme South Florida, including coastal areas of Miami-Dade, Monroe, Collier, and Lee counties. Along Florida's southwest coast, several small groups and individual crocodiles have been documented from Sanibel Island, Lee County, south to Collier Seminole State Park, Collier County. Crocodiles are regularly seen in ENP along the mainland shoreline of Florida Bay from the Cape Sable peninsula east to U.S. Highway 1, in mangrove habitats on North Key Largo from Blackwater Sound north to Ocean Reef Club, and at Florida Power and Light's Turkey Point Nuclear Electrical Generating Facility. There are three primary nesting populations in South Florida: (1) Florida Bay; (2) Turkey Point on Biscayne Bay and (3) Key Largo. The cooling canals of Florida Power and Light's Turkey Point Nuclear Electrical Generating Facility support the most successful crocodile nesting population in South Florida (Mazzotti et al. 2007). These cooling canals offer premium nesting habitat because they satisfy the crocodile's two primary nesting requirements – suitable substrate above the normal high water level and adjacent deep-water refugia. While crocodiles prefer sandy substrates, they will often utilize canal spoil banks (Kushlan and Mazzotti 1989).

Growth and survival of hatchling and juvenile crocodiles is influenced by salinity. Optimal salinity for these life stages is 0 to 20 psu in the wetlands and coastal creeks during the wet season and partway through the dry season (approximately June through January) (Moler 1992, Mazzotti 1999, Mazzotti et al. 2007). Changes in hydrology that would increase existing salinity conditions in the crocodile reproduction areas would degrade juvenile habitat for the American crocodile.

Critical habitat for the American crocodile includes but is not limited to both Florida Bay and Biscayne Bay. Reference **Figure D.2-31**. Changes in freshwater flow in the headwaters of designated critical habitat for the American crocodile were variable for each alternative depending upon the location. COP modeling evaluations showed that the proposed action has the potential to improve freshwater flows to Florida Bay. ALTQ increased flows toward Florida Bay across Transect T23 relative to ECB19RR. ALTQ increased average annual flows by 36,000 acre feet. Small increases in average annual flows were also observed across the more northerly Taylor Slough headwater transects TSH1 and TSH2 (**Table D.2-22**) An assessment on potential changes in hydrology and resulting salinities to the estuarine communities of Florida Bay is summarized in **Section D.2.6.2.2** (**Florida Manatee**).

Results from the RECOVER southern coastal systems performance measure indicate that significant adverse effects to Florida Bay are not anticipated due to the degree of observed salinity changes. Decreases in mean wet salinity for ALTQ relative to ECB19RR were small in all Florida Bay zones. For every case (each zone and alternative combination) decreases in dry season salinity exceeded decreases in wet season salinity. Reference **Table D.2-5** and **Table D.2-6**. These differences may be ecologically significant because they reflect long-term seasonal means. Also, the timing of lowered salinity, being more in the dry season, may be ecologically significant because salinity peaks associated with harm are most common in the late dry season and early wet season if precipitation delays occur. The differences in salinity between ALTQ was less than 5% compared to ECB19RR. Such a difference is far less than the tolerance range of seagrass beds, however each alternative may have the potential to improve salinity conditions in Florida Bay. Furthermore, releases at S-197 have the potential to decrease flows to Taylor Slough, and subsequently Florida Bay (**Table D.2-7**). ALTQ+ is expected to be very similar to ALTQ with no significant change.

Improvements in seasonal inflow deliveries to Florida Bay has the potential to improve salinity conditions that are more favorable for juvenile crocodile growth and survival. Nearshore salinity conditions within the coastal estuaries are elevated much of the year as a result of the less than adequate freshwater flow deliveries. USACE has determined that the proposed action may affect, but is not likely to adversely affect the American crocodile and its critical habitat.

D.2.6.2.7 Eastern Indigo Snake and "May Affect Not Likely to Adversely Affect" Determination

The Eastern indigo snake is the largest native non-venomous snake in North America. It is an isolated subspecies occurring in southeastern Georgia and throughout peninsular Florida. The Eastern indigo snake prefers drier habitats, but may be found in a variety of habitats including pine flatwoods, scrubby flatwoods, floodplain edges, sand ridges, dry glades, tropical hammocks, edges of freshwater marshes, muck land fields, coastal dunes, cabbage palm hammocks, and xeric sandhill communities (Schaefer and Junkin 1990, USFWS 1999). Eastern indigo snakes need relatively large areas of undeveloped land to maintain their population. In general, adult males have larger home ranges than females or juveniles. In Florida, Smith (2003) indicated that female and male home ranges extend from 5 to 371 acres and 4 to 805 acres, respectively. In South Florida, the Eastern indigo snake is thought to be widely distributed. Given their preference for upland habitats (Steiner et al. 1983). Eastern indigo snakes are not commonly

found in great numbers in the wetland complexes of the Everglades region, even though they may be found in pinelands, tropical hardwood hammocks, and mangrove forests in extreme South Florida (Duellman and Schwartz 1958, Steiner et al. 1983). They prefer dry, well drained sandy soils, and commonly use burrows and other natural holes as dens. Steiner et al. (1983) also reported that Eastern indigo snakes inhabit abandoned agricultural land and human-altered habitats in South Florida which could include levees within the C&SF system.

Due to increased water flow and changes in water distribution it is anticipated that currently over drained areas in ENP would be rehydrated. This increase in hydroperiod is unlikely to significantly affect the higher elevations. The proposed action is not expected to have significant effects on the upland habitats preferred by this species. Reference **Section D.2.4.2** for a description of expected differences in water depths and hydroperiods under ALTQ+ in WCA 3 and ENP in comparison to ECB19RR and **Section D.2.6.2.1** for expected differences in inundation duration across the period of record. No construction is proposed. Since Eastern indigo snakes occur primarily in upland areas, their presence within Everglades is somewhat limited, except within existing levees throughout the project area. Based on this information, the USACE has determined that the Proposed Action may affect, but is not likely to adversely affect the Eastern indigo snake.

D.2.6.2.8 Everglade Snail Kite and Critical Habitat and "May Affect" Determination

A wide-ranging, New World raptor, the snail kite is found primarily in lowland freshwater marshes in tropical and subtropical America from Florida, Cuba, and Mexico, and south to Argentina and Peru (USFWS 1999). The Florida and Cuban subspecies of the Everglade snail kite, R. sociabilis plumbeus, was initially listed as endangered in 1967 due to its restricted range and highly specific diet (USFWS 1999). Its survival is directly tied to the hydrology, water quality, vegetation composition and structure within the freshwater marshes that it inhabits (Martin et al. 2008, Cattau et al. 2008).

Everglade snail kite habitat consists of freshwater marshes and the shallow vegetated edges of lakes where the apple snail (*Pomacea paludosa*), the Everglade snail kite's main food source, can be found. Snail kite populations in Florida are highly nomadic and mobile; tracking favorable hydrologic conditions and food supplies, and thus avoiding local droughts. Snail kites move widely throughout the primary wetlands of the central and southern portions of Florida. Recent snail kite nesting locations within South Florida are depicted in **Figure D.2-27**. The Everglades snail kite is threatened primarily by habitat loss and destruction. Widespread drainage has permanently lowered the water table in some areas. This drainage permitted development in areas that were once Everglade snail kite habitat. In addition to loss of habitat through drainage, large areas of marsh are heavily infested with water hyacinth, which inhibits the Everglade snail kite's ability to see its prey. Critical habitat is depicted in **Figure D.2-30**.

The Everglade snail kite has a highly specialized diet typically composed of apple snails, which are found in palustrine, emergent, long-hydroperiod wetlands. As a result, the Everglade snail kite's survival is directly dependent on the hydrology and water quality of its habitat (USFWS 1999). Snail kites require foraging areas that are relatively clear and open in order to visually search for apple snails. Suitable foraging habitat for the Everglade snail kite is typically a combination of low profile marsh and a mix of shallow open water. Shallow wetlands with emergent vegetation such as spike rush (*Eleocharis spp.),* maidencane, sawgrass, and other native emergent wetland plant species provide good Everglade snail kite foraging habitat as long as the vegetation is not too dense to locate apple snails. Dense growth of plants reduces the ability of the Everglade snail kite to locate apple snails and their use of these areas is limited even when snails are in relatively high abundance (Bennetts et al. 2006). Areas of sparse emergent

vegetation enable apple snails to climb near the surface to feed, breathe, and lay eggs and thus they are easily seen from the air by foraging Everglade snail kites. Suitable foraging habitats are often interspersed with tree islands or small groups of scattered shrubs and trees which serve as perching and nesting sites.

Snail kite nesting primarily occurs from December to July, with a peak in February-June, but can occur year-round. Nesting substrates include small trees such as willow, cypress (*Taxodium spp.*), and pond apple, and herbaceous vegetation such as sawgrass, cattail, bulrush (*Scirpus validus*), and reed (*Phragmites australis*). Snail kites appear to prefer woody vegetation for nesting when water levels are adequate to inundate the site (USFWS 1999). Nests are more frequently placed in herbaceous vegetation during periods of low water when dry conditions beneath willow stands (which tend to grow to at higher elevations) prevent Everglade snail kites from nesting in woody vegetation (USFWS 1999). Nest collapse is rare in woody vegetation but common in non-woody vegetation, especially on lake margins (USFWS 1999). In order to deter predators, nesting almost always occurs over water (Sykes et al. 1995).

Snail kites construct nests using dry plant material and dry sticks, primarily from willow and wax myrtle (Sykes 1987), with a lining of green plant material that aids in incubation (USFWS 1999). Courtship includes male displays to attract mates and pair bonds form from late November through early June (USFWS 1999). Snail kites will lay between one and five eggs with an average of about three eggs per nest (Sykes 1995, Beissinger 1988). Each egg is laid at about a two-day interval with incubation generally commencing after the second egg is laid (Sykes 1987). Both parents incubate the eggs for a period of 24 to 30 days (Beissinger 1983). Hatching success is variable between years and between watersheds, but averages 2.3 chicks/nest (USFWS 1999, Cattau et al. 2008). February, March, and April have been identified as the most successful months for hatching (Sykes 1987). Snail kites may nest more than once within a breeding season and have been documented to re-nest after both failed and successful nesting attempts (Sykes 1987, Beissinger 1988). Chicks are fed by both parents through the nestling period although ambisexual mate desertion has been documented (USFWS 1999). Young fledge at approximately 9 to 11 weeks of age (Beissenger 1988). Adults forage no more than 6 kilometers from the nest, and generally less than a few hundred meters (Beissenger 1988, USFWS 1999). When food is scarce or ecological and hydrologic conditions are unfavorable, adults may abandon the nest altogether (Sykes et al. 1995).

The persistence of the Everglade snail kite in Florida depends upon maintaining hydrologic conditions that support the specific vegetative communities that compose their habitat along with sufficient apple snail availability across their range each year (Martin et al. 2008). Historically, WCA 3A has been a critical component within the Everglade snail kites' wetland network for foraging and reproduction. High water levels during the wet season are important in maintaining quality wet prairie and emergent slough habitat (USFWS 2010). High water levels and extended hydroperiods have resulted in vegetation shifts within WCA 3A, degrading Everglade snail kite critical habitat. This vegetation transition directly affects Everglade snail kites in several ways, most importantly by reducing the amount of suitable foraging and nesting habitat, and reducing prey abundance and availability. Wetter conditions reduce the amount of woody vegetation within the area upon which Everglade snail kites rely for nesting and perch hunting. In addition, prolonged hydroperiods reduce habitat structure in the form of emergent vegetation, which is critical for apple snail aerial respiration and egg deposition (Turner 1996, Darby et al. 1999). Drying events are essential in maintaining the mosaic of vegetation types needed by a variety of wetland fauna (Sklar et al. 2002), including the Everglade snail kite (USFWS 2010) and its primary food source, the apple snail (Karunaratne et al. 2006, Darby et al. 2008). However, little annual variation in water depths has occurred within WCA 3A since 1993, virtually eliminating the drying events necessary to maintain this mosaic. This

is particularly apparent in southwestern WCA 3A, which has experienced excessive ponding in recent years.

Low water levels have an effect on Everglade snail kite nest success in WCA 3A (Cattau et al. 2008). If water levels become too low and food resources become too scarce, adults will abandon their nest sites and young (Sykes et al. 1995). Predation on nests is also higher when water levels are low. A strong relationship exists between annual minimum stage and juvenile Everglade snail kite survival rate (Martin et al. 2007, Cattau et al. 2008). Due to their inability to move large distances, juvenile Everglade snail kites rely upon the marshes surrounding their nests for foraging. If water levels within these marshes become too low to support foraging (due to low apple snail availability), juvenile survival will be diminished.

Recent scientific information has indicated that apple snail egg production is maximized when dry season low water levels are less than 50 cm (was previously 40 centimeters) but greater than 10 cm (Darby et al. 2002, USFWS 2010). Water depths outside this range can significantly affect apple snail recruitment and survival. If water levels are less than 10 cm, apple snails cease movement and may become stranded, hence they are not only unavailable to foraging Everglade snail kites; they are also unable to successfully reproduce. Depending upon the timing and duration of the dry down, apple snail recruitment can be significantly affected by the truncation of annual egg production and stranding of juveniles (Darby et al. 2008). Since apple snails have a 1.0 to 1.5-year life span (Hanning 1979, Ferrer et al. 1990, Darby et al. 2008), they only have one opportunity (i.e. one dry season) for successful reproduction. Egg cluster production may occur from February to November (Odum 1957, Hanning 1979, Darby et al. 1999); however, approximately 77% of all apple snail egg cluster production occurs between April and June (Darby et al. 2008). Dry downs during peak apple snail egg cluster production substantially reduce recruitment (Darby et al. 2008). The length of the dry down, age, and size of the apple snail are all important factors in apple snail recruitment and survival. Larger apple snails can survive dry downs better than smaller apple snails (Kushlan 1975, Darby et al. 2008).

For COP, an ecological planning tools was available to evaluate potential effects on the Everglade snail kite within the study area. The purpose of the ecological planning tool is to describe the dynamics of the apple snail population as a function of hydrology and temperature. The numbers and size distribution of snails are simulated and can be calculated for any day of a year with input data. Adult snails during a given year are a product of egg production, and thus environmental conditions, from the previous year. The ecological planning tool was developed using the Everglades Depth Estimation Network (EDEN) and therefore outputs begin starting in 1992. For more information on the apple snail population model, refer to Darby et al. 2015).

Figure D.2-63 through **Figure D.2-64** depicts apple snail adult population numbers for a wet year (1995) and a dry year (2004). Results are shown for adult snails (>20 mm) during the spring of a dry year (April 20), before that year's reproductive period. End of spring results are shown as this is the population of snails of the size class consumed by the Everglade snail kite. The top left panel of each graphic depicts ECB19RR. The bottom left panel depicts ALTQ, and the bottom right panel depicts the difference between each alternative relative to ECB19RR. Changes in apple snail population numbers were observed within the boundaries of designated critical habitat for the Everglade snail kite. Snail kite nesting is currently concentrated in southern portions of WCA 3A (**Figure D.2-27**). During a wet year, ALTQ would increase apple snail population numbers in portions of southern WCA 3A and ENP on the flanks of NESRS; however decreases were observed within portions of eastern WCA 3B. During a dry year, similar pattern were observed; however potential decreases in apple snail population numbers appeared to be more severe, where they occurred within the study area.

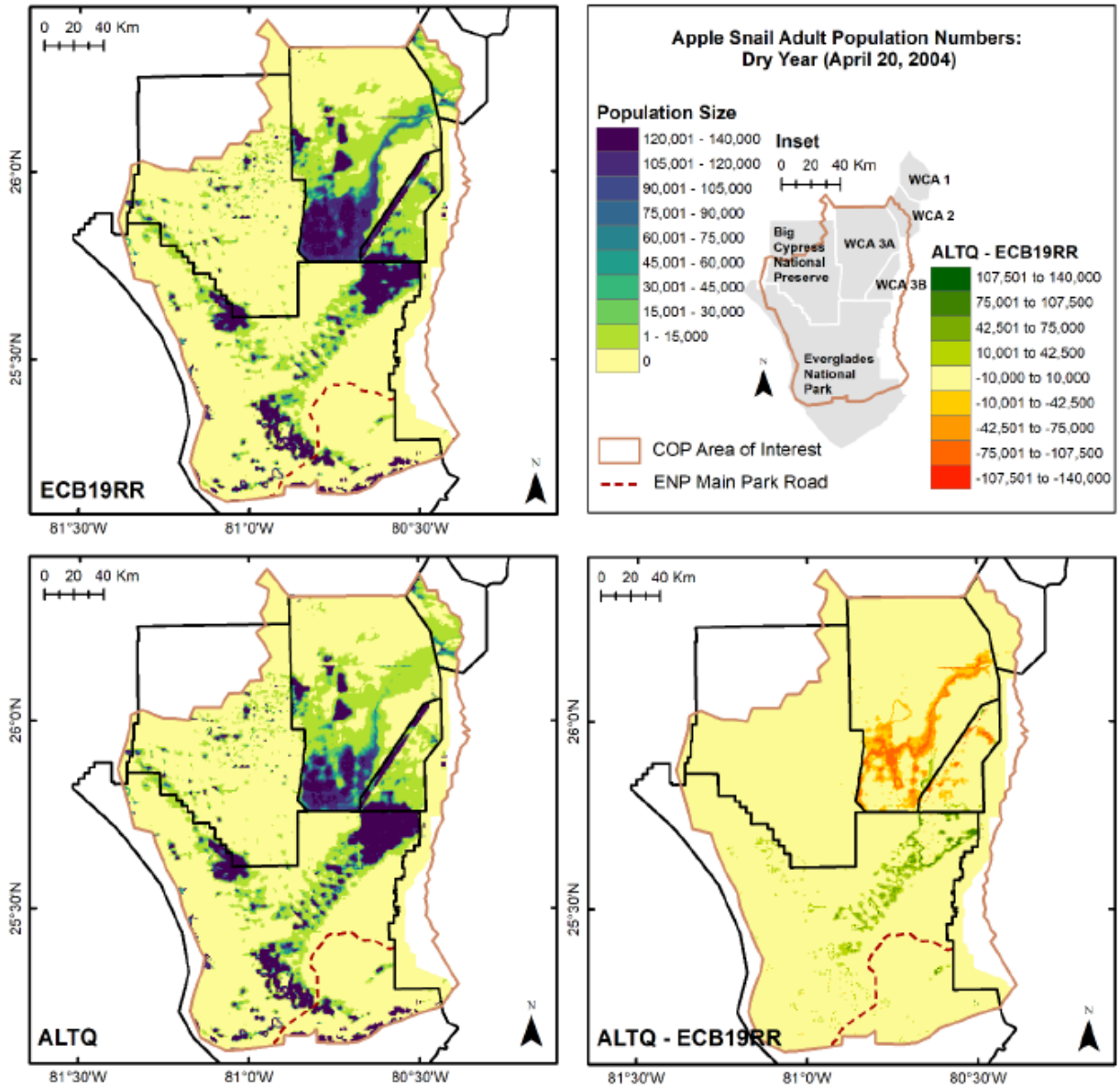


Figure D.2-60. Apple snail adult population numbers for a dry year (April 20, 2004) ALTQ.

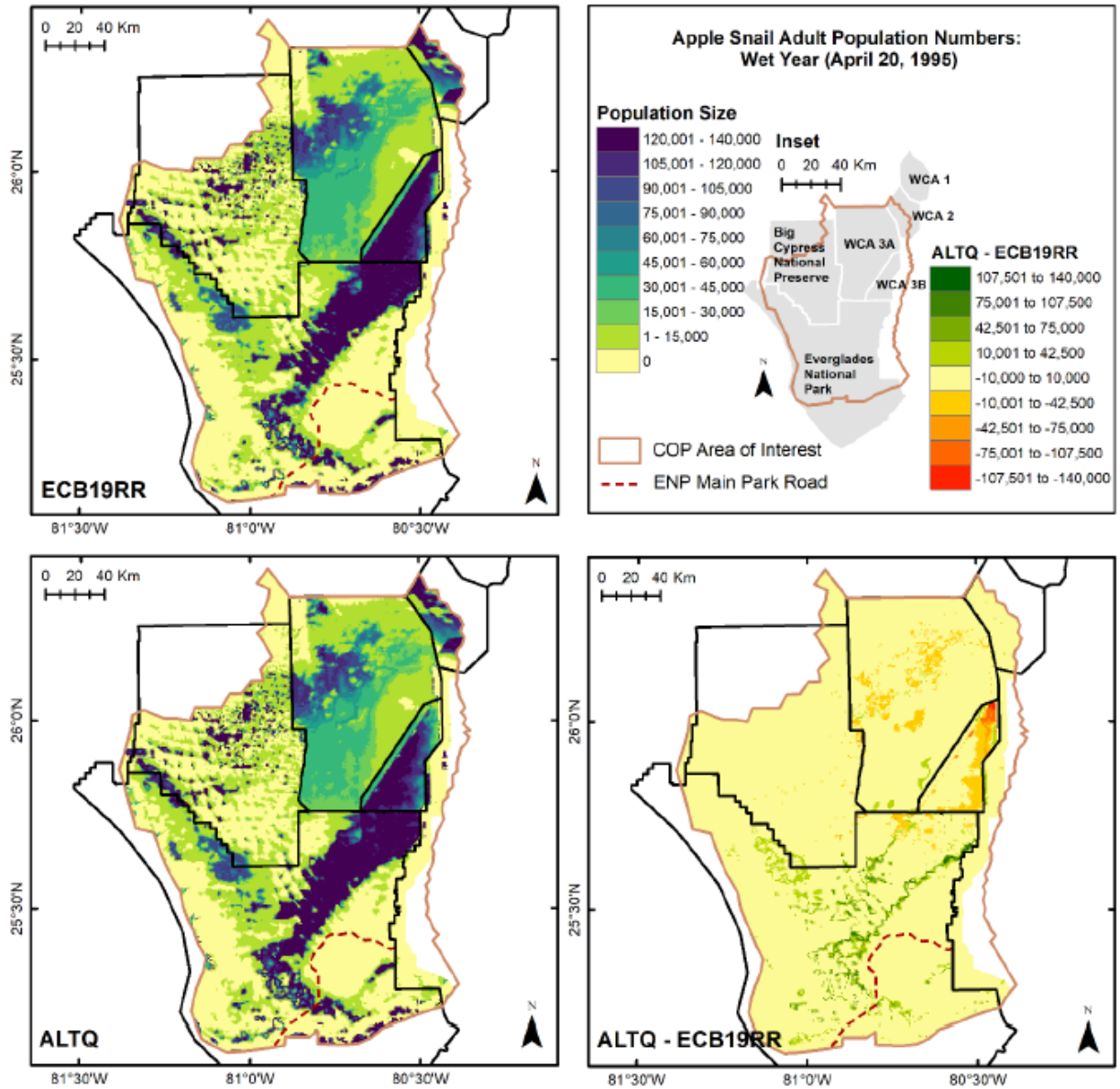


Figure D.2-614. Apple snail adult population numbers for a wet year (April 20, 1995) ALTQ.

Figure D.2-64 illustrates means of daily percent change in total apple snail population relative to ECB19RR by year for the COP area of interest (i.e. light brown line in **Figure D.2-63** through **Figure D.2-64**). Values start in 1995, giving the model three years to calibrate. ALTQ improved apple snail production in six out of the 11 years, respectively. Observed differences between ALTQ and ECB19RR were most often not more than a ± 10% change (ALTQ minimum to maximum percent change of -13.60% to 3.61% with an average of -2%).

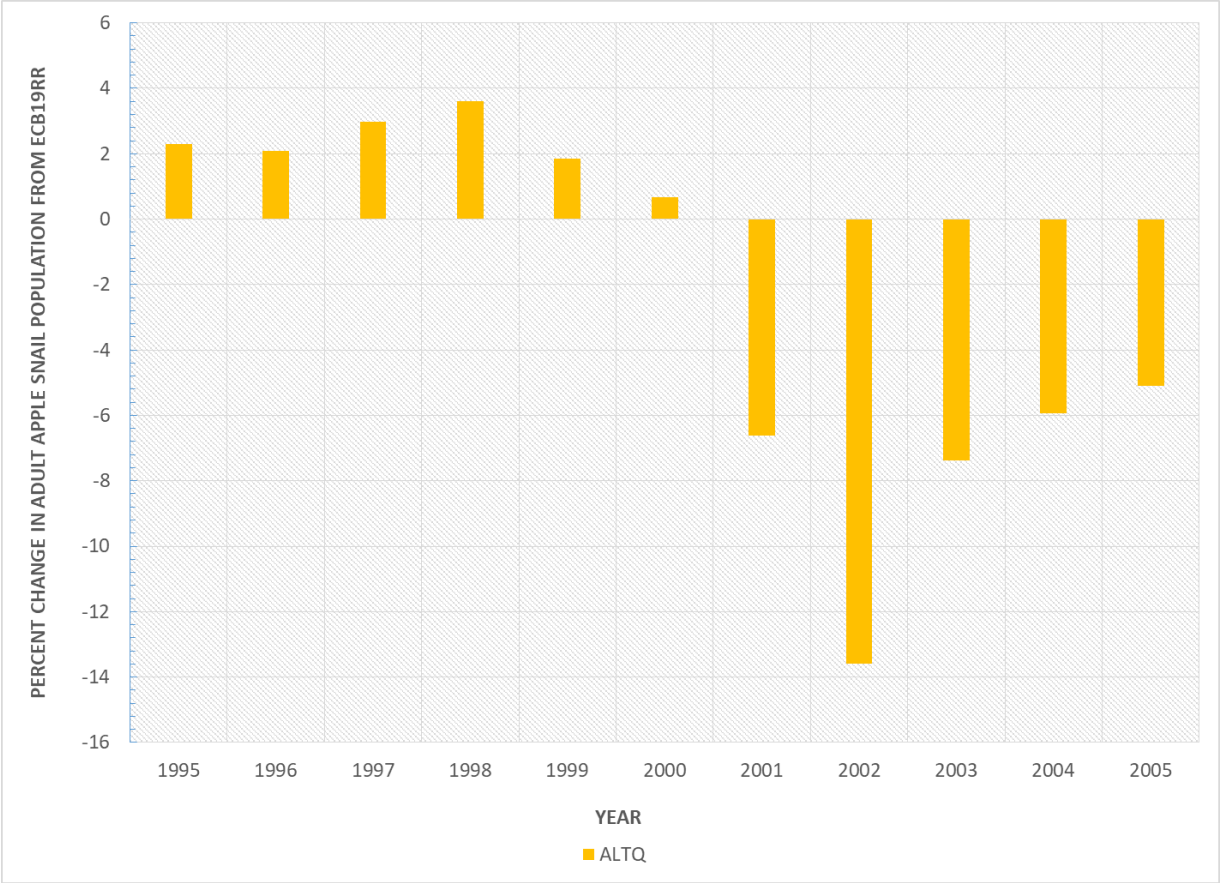


Figure D.2-62. Mean percent change in adult apple snail population for each modeled year.

The Everglades Landscape Vegetation Succession Model (ELVes) was used to predict vegetation community change over time in response to environmental conditions. The model uses empirically based probabilistic functions of vegetation community niche space and temporal lags to evaluate expected community response within the model's domain. For the evaluation, ELVes was run with ten vegetation communities (1) sawgrass; (2) sawgrass short; (3) open marsh; (4) cattail; (5) floating emergent marsh; (6) marl prairie (drier); (7) marl prairie (wetter); (8) swamp shrub land; (9) willow shrub cattail; (10) cypress shrub sawgrass; (11) bay head shrub; and (12) rockland pine. **Table D.2-23** provides a description of the vegetation classes used in ELVes as shown in **Figure D.2-65** through **Figure D.2-71.** For more details reference Pearlstine et al 2011.

Table D.2-23. Description of vegetation classes utilized in ELVes.

Vegetation Class	Description
Sawgrass	Sawgrass (*Cladium jamaicense*) dominated marsh
Sawgrass-Short	Sawgrass dominated marsh with average height less than 2.5 meters.
Open Marsh	Open water dominated freshwater marsh often with a mix of sparse graminoids, herbaceous, and/or emergent freshwater vegetation, such as Spikerush (*Eleocharis spp.*), Panicgrass (*Panicum spp.*), low stature sawgrass, Cattail (*Typha spp.*), Arrowhead (*Sagittaria spp.*), Pickerelweed (*Pontederia cordata*), Waterlily (*Nymphaea spp.*), Green Arum (*Peltandra virginica*),

Vegetation Class	Description
	Swamp-Lily (*Crinum americanum*), Spiderlilies (*Hymenocallis spp*.), among others.
Cattail	Greater than or equal to 50% areal coverage of Cattail.
Floating Emergent Marsh	Typically Nuphar or Nymphaea. Also Lemna, Salvinia
Drier Marl Prairie	Short hydroperiod marsh characterized primarily by graminoids that includes low-stature sawgrass, Muhly Grass (*Muhlenbergia capillaris var. filipes*),
Wetter Marl Prairie	Short hydroperiod marsh characterized by a mix of graminoids that includes low-stature sawgrass, Little Bluestem (*Schizachyrium scoparium*), Gulfdune Paspalum (*Paspalum monostachyum*), Beakrush (*Rhynchospora spp*.), Black Sedge (*Schoenus nigricans*), among others.
Swamp Shrubland	Primrose willow and wax myrtle
Willow Shrub Cattail	Willow (*Salix caroliniana*) dominant shrub land with freshwater marsh species. Cattail may be prominent.
Cypress Shrub Sawgrass	Dwarf Cypress (*Taxodium spp*.) with freshwater marsh species. Dwarf cypress may be in a sawgrass matrix.
Bayhead Shrubland	Mix of Cocoplum (*Chrysobalanus icaco*), Swamp Bay (*Persea palustris*), Red Bay (*Persea borbonia*), Dahoon Holly (*Ilex cassine*), Willow (*Salix caroliniana*), Wax Myrtle (*Myrica cerifera*), Sweetbay (*Magnolia virginiana*), Cypress (*Taxodium spp*.), Pond Apple (*Annona glabra*), among others.
Pine Rockland	Pine upland found on low ridges of oolitic limestone. Found on the Miami rock ridge, in the Florida Keys, ENP, and in BCNP.

Figure D.2-66 through **Figure D.2-68** illustrate change in vegetation communities relative to ECB19RR for a representative wet year (1995), dry year (1989) and an average year (1978). Results of the modeling indicated that at the broad landscape scale there were few large community changes predicted to occur within most of the action area. The largest changes were predicted to occur during a representative dry year (1989) and average year (1978). Suitable foraging habitat for the Everglade snail kite is typically a combination of low profile marsh and a mix of shallow open water. The lower right quadrant in these figures shows areas that were changed in each alternative (green = change). The light brown line noted as the COP area of interest in these figures was identified at the start of the planning efforts for COP and was used to define the maximum acreage that could be potentially affected by COP. Changes in vegetation primarily were observed to occur in northern WCA 3A east of the Miami Canal, in portions of WCA 3B, in southern WCA 3A and in portions of ENP including NESRS and Taylor Slough. Decreases in floating emergent marsh were observed in portions of WCA 3A adjacent to the L-67A/C levee. ELVes was not available for ALTQ+. ALTQ+ would result in similar effects as discussed under ALTQ.

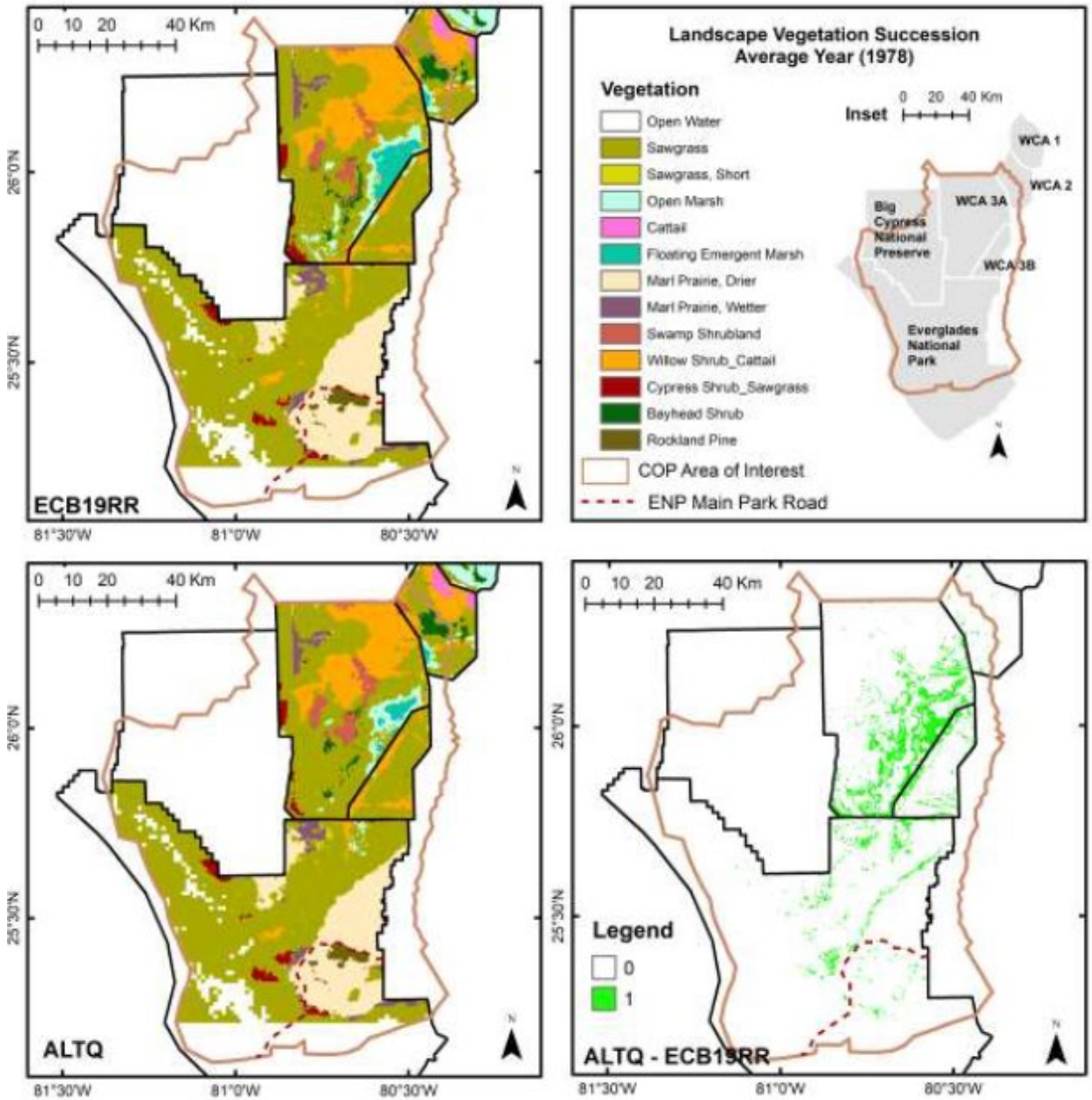


Figure D.2-63. Landscape vegetation succession for an average year (1978) for ALTQ.

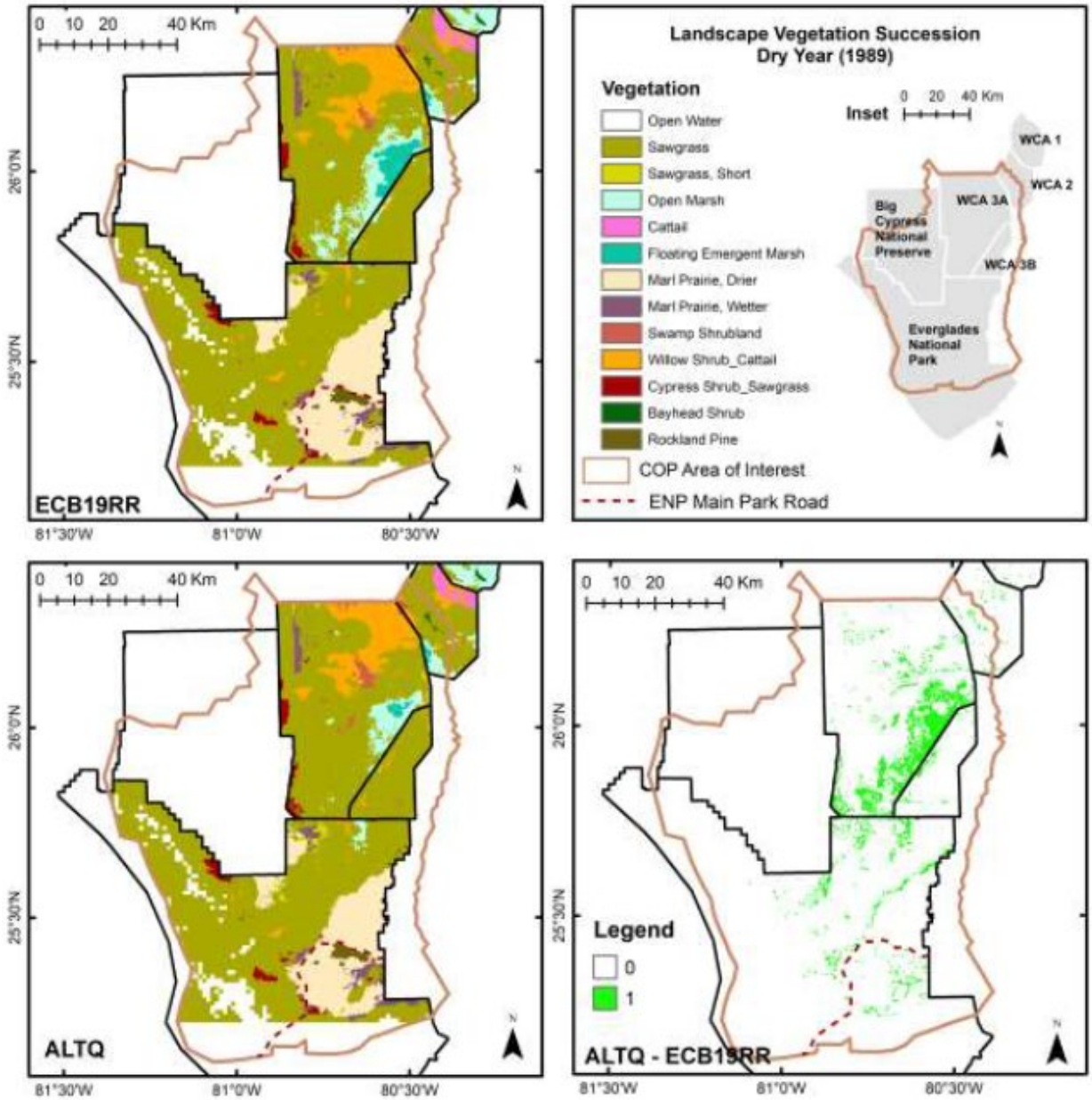


Figure D.2-67. Landscape vegetation succession for a dry year (1989) for ALTQ.

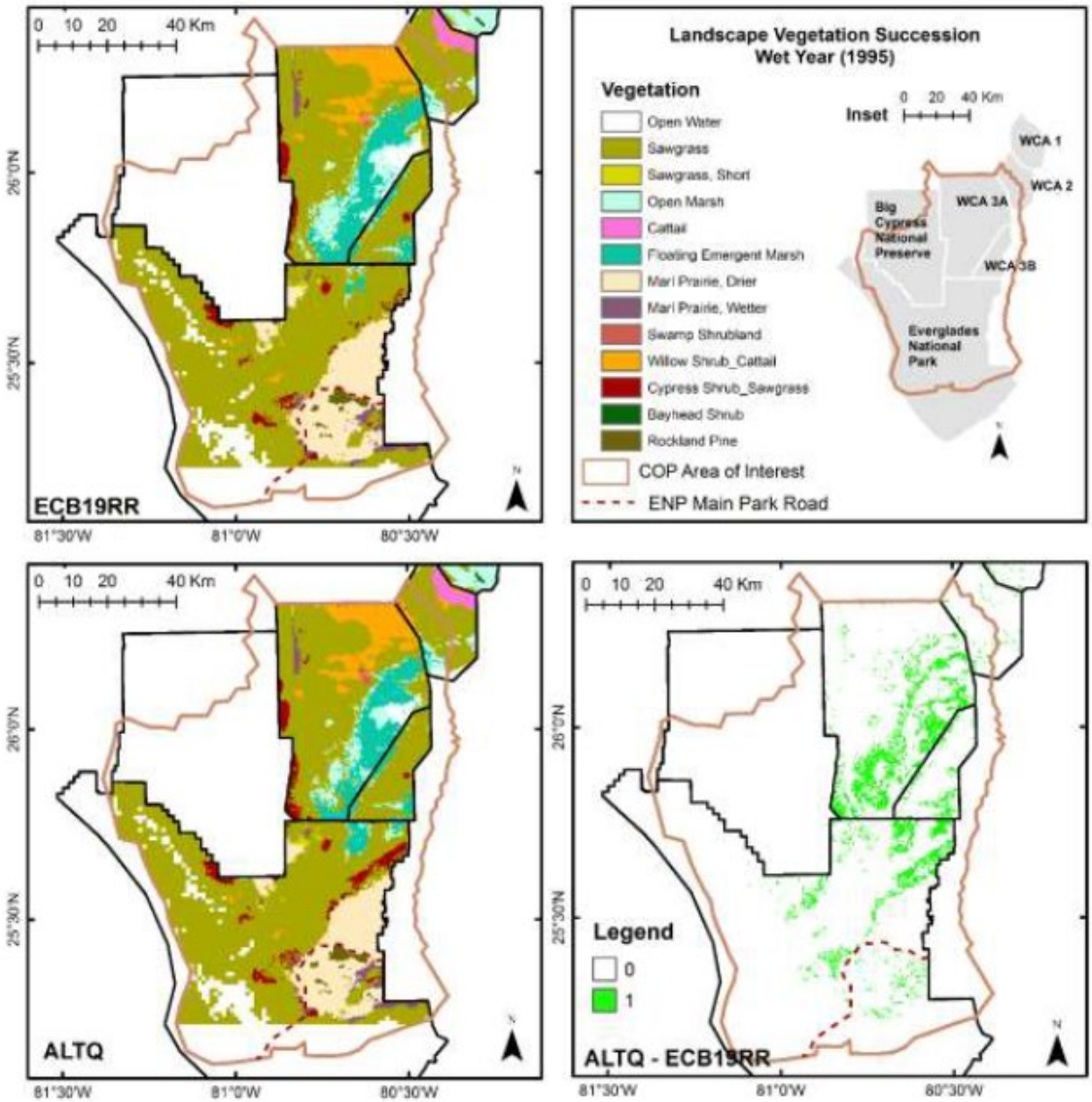


Figure D.2-68. Landscape vegetation succession for a wet year (1995) for ALTQ.

In addition to the apple snail population model, an ESA incidental take trigger developed during consultation between USACE and USFWS for the 2016 ERTP BO was also used to evaluate potential effects on the Everglade snail kite for COP. The 2016 ERTP BO includes exceedance criteria that are linked to habitat quality as a surrogate for incidental take of snail kites. Per the 2016 ERTP BO, those exceedance criteria are as follows: (1) Dry Season High Water: Number of days when maximum water levels exceed 9.2 feet, NGVD at gauge 3AS3W1 on or after April 15 in two consecutive years; (2) Wet Season High Water: Number of days maximum water levels exceed 10.5 feet, NGVD at gauge 3AS3W1 for 60 days in two consecutive years (June 1 – December 31); and (3) Recession Dry Season Amplitude: WCA 3A stage difference as measured at specific gages should not recede by more than 1.7 feet, NGVD from January 1 through May 31 or the onset of the wet season, whichever is sooner as measured in two consecutive years.

USFWS requested that these exceedance criteria be utilized during COP to understand potential effects on the Everglade snail kite within WCA 3A. High water stages may reduce the abundance, growth, and reproduction of apple snails and reduce woody vegetation that kites use for nesting and perch-hunting. Depending on the amount of lost snail productivity and the initial snail population size, a single year of high water during the dry season can result in long-term impacts to apple snail populations and decrease numbers of snail kite nest initiations, nest success, and juvenile survival in an area, as has been observed in WCA 3A. Rapid recession rates during the breeding season can also result in decreased nest success (through increased predation or decreased forage availability) and decreased juvenile survival (due to decreased forage availability) (USFWS 2016). **Table D.2-26** shows the number of times in the period of record (1965-2005) when maximum water levels exceed 9.2 feet, NGVD at gage 3AS3W1 on or after April 15 in two consecutive years. ALTQ reduced the number of years the threshold was exceeded relative to ECB19RR by three events. The number of times in the period of record (1965-2005) when maximum water levels exceed 10.5 feet, NGVD at gage 3AS3W1 for 60 days (June 1-December 31) in two consecutive years for ALTQ did not deviate from ECB19RR. ALTQ performed equivalent to ECB19RR. ALTQ reduced the number of years over the period of record (1965-2005) the WCA 3A stage difference receded by more than 1.7 feet, NGVD from January 1 through May 31 in a given year at gages 3A-4 and 3AS3W1, however the exceedance criteria was increased under ALTQ at gages 3A28 and W2. ALTQ+ is expected to be very similar to ALTQ with no significant change. Reference **Figure D.2-15** for depth durations at gage 3A28, **Figure D.2-14** for gage 3A4 and **Figure D.2-69** for gage W2.

Table D.2-24. Snail Kite exceedance criteria for ECB19RR and ALTQ.

-	ECB19RR	ALTQ
Dry Season High Water	7	4
Wet Season High Water	2	2
Recession: Dry Season Amplitude Gage 3A28	6	8
Recession: Dry Season Amplitude Gage 3A4	7	5
Recession: Dry Season Amplitude Gage 3AS3W1	8	5
Recession: Dry Season Amplitude Gage W2	4	8

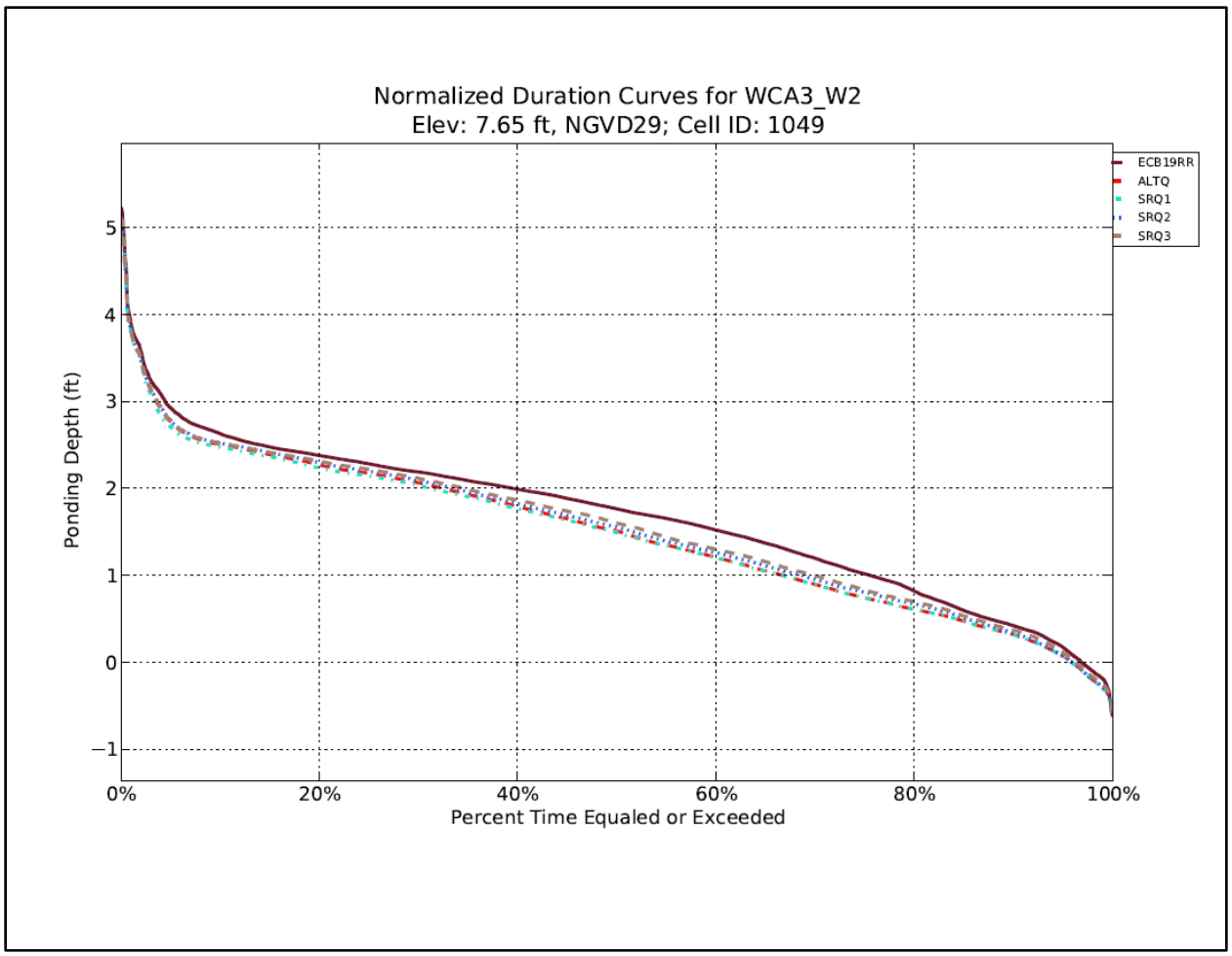


Figure D.2-69. Depth duration curves for gauge WCA 3_W2.

USACE has determined that the Proposed Action may affect the Everglade snail kite and its designated critical habitat. Implementation of COP may produce a variety of wetland habitats that would support conditions conducive to apple snail production. During a wet year, each COP alternative increased apple snail population numbers in the study area thereby increasing the spatial extent of suitable foraging opportunities for snail kites providing a minor long term beneficial effect. However, decreases in apple snail population numbers were observed during a dry year. In general, ALTQ reduced the number of times exceedance criteria (2016 ERTP BO ESA incidental take trigger) for the snail kite were met. A potential increase in hydroperiods within ENP may provide an overall net benefit for Everglade snail kites and apple snail habitat. Increases in volume into NESRS provide an opportunity for improved vegetation, including expansion of sloughs and wet prairies, and contraction of sawgrass ridges which would provide increased foraging and nesting habitat for Everglade snail kite and apple snail.

COP is expected to influence wetland hydroperiods causing changes in potential nesting and apple snail production. USACE proposes specific minimization as part of COP including species and habitat monitoring to identify population trends for the Everglade snail kite currently being conducted in compliance with the 2016 ERTP BO (USFWS 2016). PSC will allow USACE and its Tribal and governmental partners to discuss ecological, hydrological, and meteorological conditions to achieve the objective of managing water levels and releases for the protection of multiple species and their habitats, including the

Everglade snail kite. Regularly scheduled interagency PSCs allow USACE to gather input on desired long-term (annual and/or seasonal) conditions within the system. In addition, the PSCs occur on an as needed basis with the frequency of the calls determined based upon ongoing or anticipated conditions within the WCAs, SDCS, and ENP. The PSC focus on the status of a suite of species to allow for adaptive management of the system based upon the needs of multiple species and their habitats. Under COP, USACE will continue to implement PSC to provide real-time assessment of conditions within the action area to ensure wildlife recommendations are considered during the water management decision process.

D.2.6.2.9 Wood Stork and "May Affect" Determination

The wood stork is a large, white, long-legged wading bird that relies upon shallow, freshwater wetlands for foraging. Black primary and secondary feathers, a black tail and a blackish, featherless neck distinguish the wood stork from other wading birds species. This species was federally listed as endangered under the ESA on February 28, 1984. On June 30, 2014, USFWS reclassified the status of wood stork from endangered to threatened due to improvement in the species overall status. Although habitat loss and fragmentation continue to impact the species, the USFWS cited that due to increases in abundance of the breeding population as well as a significant expansion of its breeding range, there is a decrease in the severity and magnitude of these threats. Therefore, this species is no longer in danger of extinction throughout their range and has been reclassified as threatened. No critical habitat has been designated for the wood stork; therefore, none will be affected.

The wood stork is found from northern Argentina, eastern Peru and western Ecuador north to Central America, Mexico, Cuba, Hispaniola, and the southeastern United States (AOU 1983). Only the population segment that breeds in the southeastern United States is listed as threatened. In the United States, this species is historically known to nest in all coastal states from Texas to South Carolina (Wayne 1910; Bent 1926; Howell 1932; Oberholser 1938; Dusi and Dusi 1968; Cone and Hall 1970; Oberholser and Kincaid 1974). Dahl (1990) estimates these states lost about 38 million acres, or 45.6 percent, of their historic wetlands between the 1780s and the 1980s. However, it is important to note wetlands and wetland losses are not evenly distributed in the landscape. Hefner et al. (1994) estimated 55 percent of the 2.3 million acres of the wetlands lost in the southeastern United States between the mid-1970s and mid-1980s were located in the Gulf-Atlantic coastal flats. These wetlands were strongly preferred by wood storks as nesting habitat.

The decline in the United States population of the wood stork is thought to be related to one or more of the following factors: (1) reduction in the number of available nesting sites; (2) lack of protection at nesting sites; and (3) loss of an adequate food base during the nesting season (Ogden and Nesbitt 1979). Ogden and Nesbitt (1979) indicate a reduction in nesting sites is not the cause in the population decline, because the number of nesting sites used from year to year is relatively stable. Ogden and Nesbitt suggest loss of an adequate food base is a cause of wood stork declines. The primary cause of the wood stork population decline in the United States is loss of wetland habitats or loss of wetland function resulting in reduced prey availability. Almost any shallow wetland depression where fish become concentrated, either through local reproduction or receding water levels, may be used as feeding habitat by the wood stork during some portion of the year; but only a small portion of the available wetlands support foraging conditions (high prey density and favorable vegetation structure) that wood storks need to maintain growing nestlings. Browder et al. (1976) and Browder (1978) documented the distribution and the total acreage of wetland types occurring south of Lake Okeechobee, Florida, for the period 1900 through 1973. They combined their data for habitat types known to be important foraging habitat for wood storks (cypress domes and strands, wet prairies, scrub cypress, freshwater marshes and sloughs, and saw grass

marshes) and found these habitat types have been reduced by 35 percent since 1900. Currently, wood stork nesting occurs in Florida, Georgia, South Carolina, and North Carolina.

Wood storks forage primarily within freshwater marsh and wet prairie vegetation types, but can be found in a wide variety of wetland types, as long as prey are available and the water is shallow and open enough to hunt successfully (Ogden et al. 1978; Browder 1984; Coulter 1987; Gawlik and Crozier 2004; Herring and Gawlik 2007). Calm water, about 5 to 25 centimeters in depth, and free of dense aquatic vegetation is ideal, however, wood storks have been observed foraging in ponds up to 40 centimeters in depth (Coulter and Bryan 1993; Gawlik 2002). Typical foraging sites include freshwater marshes, ponds, hardwood and cypress swamps, narrow tidal creeks or shallow tidal pools, and artificial wetlands such as stock ponds, shallow, seasonally flooded roadside or agricultural ditches, and managed impoundments (Coulter et al. 1999; Coulter and Bryan 1993; Herring and Gawlik 2007). During nesting, these areas must also be sufficiently close to the colony to allow wood storks to efficiently deliver prey to nestlings.

Wood storks feed almost entirely on fish between 2 and 25 centimeters (1 to 10 inches) in length (Kahl 1964; Ogden et al. 1976; Coulter 1987) but may occasionally consume crustaceans, amphibians, reptiles, mammals, birds, and arthropods. Wood storks generally use a specialized feeding behavior called tactilocation, or grope feeding, but also forage visually under some conditions (Kushlan 1979). Wood storks typically wade through the water with their beaks immersed and open about 7 to 8 centimeters (2.5 to 3.5 inches). When the wood stork encounters prey within its bill, the mandibles snap shut, the head is raised, and the food swallowed (Kahl 1964). Occasionally, wood storks stir the water with their feet in an attempt to startle hiding prey (Rand 1956; Kahl 1964; Kushlan 1979). This foraging method allows them to forage effectively in turbid waters, at night, and under other conditions when other wading birds that employ visual foraging may not be able to forage successfully.

Studies on fish consumed by wood storks have shown that wood storks are highly selective in their feeding habits with sunfish and four other species of fish comprising the majority of their diet (Ogden et al. 1976). Ogden et al. (1976, 1978) noted that the key species consumed by wood storks included sunfishes (*Centrarchidae*), yellow bullhead (*Italurus natalis*), marsh killifish *(Fundulus confluentus*), flagfish (*Jordenella floridae*) and sailfin molly (*Poecilia latipinna*).

These species were also observed to be consumed in much greater proportions than they occur at feeding sites, and abundant smaller species (e.g., mosquitofish (*Gambusia spp*.), least killifish (*Heterandria formosa*), bluefin killifish (*Lucania goodei*) are under-represented, which the researchers believed was probably because their small size does not elicit a bill-snapping reflex in these tactile feeders (Coulter et al. 1999). Their studies also showed that in addition to selecting larger species of fish, wood storks consumed individuals that are significantly larger (greater than 3.5 centimeters) than the mean size available (2.5 centimeters), and many were greater than one-year old (Ogden et al. 1976; Coulter et al. 1999).

Hydrologic and environmental characteristics have strong effects on fish density, and these factors may be some of the most significant in determining foraging habitat suitability, particularly in southern Florida. Within the wetland systems of southern Florida, the annual hydrologic pattern is very consistent, with water levels rising over three feet during the wet season (June-November), and then receding gradually during the dry season (December-May). Wood storks nest during the dry season, and rely on the drying wetlands to concentrate prey items in the ever-narrowing wetlands (Kahl 1964). Because of the continual change in water levels during the wood stork nesting period, any one site may only be suitable for wood stork foraging for a narrow window of time when wetlands have sufficiently dried to begin concentrating

prey and making water depths suitable for storks to access the wetlands (Gawlik 2002; Gawlik et al. 2004). Once the wetland has dried to where water levels are near the ground surface, the area is no longer suitable for wood stork foraging, and will not be suitable until water levels rise and the area is again repopulated with fish. Consequently, there is a general progression in the suitability of wetlands for foraging based on their hydroperiods, with the short hydroperiod wetlands being used early in the season, the mid-range hydroperiod sites being used during the middle of the nesting season, and the longest hydroperiod areas being used later in the season (Kahl 1964; Gawlik 2002).

Dense submerged and emergent vegetation may reduce foraging suitability by preventing wood storks from moving through the habitat and interfering with prey detection (Coulter and Bryan 1993). Some submerged and emergent vegetation does not detrimentally affect wood stork foraging, and may be important to maintaining fish populations. Wood storks tend to select foraging areas that have an open canopy, but occasionally use sites with 50 to 100 percent canopy closure (Coulter and Bryan 1993; Coulter et al. 1999). Foraging sites with open canopies are more easily detected from overhead as wood storks are searching for food. Gawlik (2002) characterized wood storks as "searchers" that employ a foraging strategy of seeking out areas of high density prey and optimal (shallow) water depths, and abandoning foraging sites when prey density begins to decrease below a particular efficiency threshold, but while prey was still sufficiently available that other wading bird species were still foraging in large numbers (Gawlik 2002). Wood stork choice of foraging sites was significantly related to both prey density and water depth (Gawlik 2002). Because of this strategy, wood stork foraging opportunities are more constrained than many of the other wading bird species (Gawlik 2002).

Wood storks generally forage in wetlands between 0.5 kilometer and 74.5 kilometer away from the colony site (Bryan and Coulter 1987; Herring and Gawlik 2007), but forage most frequently within 10-20 kilometer (12 miles) of the colony (Coulter and Bryan 1993; Herring and Gawlik 2007). Maintaining this wide range of feeding site options ensures sufficient wetlands of all sizes and varying hydroperiods are available, during shifts in seasonal and annual rainfall and surface water patterns, to support wood storks. Adults feed farthest from the nesting site prior to laying eggs, forage in wetlands closer to the colony site during incubation and early stages of raising the young, and then farther away again when the young are able to fly. Wood storks generally use wet prairie ponds early in the dry season then shift to slough ponds later in the dry season thus following water levels as they recede into the ground (Browder 1984).

Wood stork nesting habitat consists of mangroves as low as 1 meter (3 feet), cypress as tall as 30.5 meters (100 feet), and various other live or dead shrubs or trees located in standing water (swamps) or on islands surrounded by relatively broad expanses of open water (Palmer 1962; Rodgers et al. 1987; Ogden 1991; Coulter et al. 1999). Wood storks nest colonially, often in conjunction with other wading bird species, and generally occupy the large-diameter trees at a colony site (Rodgers et al. 1996). The same colony site will be used for many years as long as the colony is undisturbed and sufficient foraging habitat remains in the surrounding wetlands. However, not all wood storks nesting in a colony will return to the same site in subsequent years (Kushlan and Frohring 1986). Natural wetland nesting sites may be abandoned if surface water is removed from beneath the trees during the nesting season (Rodgers et al. 1996). In response to this type of change to nest site hydrology, wood storks may abandon that site and establish a breeding colony in managed or impounded wetlands (Ogden 1991). Wood storks that abandon a colony early in the nesting season due to unsuitable hydrological conditions may re-nest in other nearby areas (Borkhataria et al. 2004; Crozier and Cook 2004).

The wood stork life history strategy has been characterized as a "bet-hedging" strategy (Hylton et al. 2006) in which high adult survival rates and the capability of relatively high reproductive output under favorable

conditions allow the species to persist during poor conditions and capitalize on favorable environmental conditions. This life-history strategy may be adapted to variable environments (Hylton et al. 2006) such as the wetland systems of southern Florida. Nest initiation date, colony size, nest abandonment, and fledging success of a wood stork colony vary from year to year based on availability of suitable wetland foraging areas, which can be affected by local rainfall patterns, regional weather patterns, and anthropogenic hydrologic management (USFWS 1997; Frederick and Ogden 2001). While the majority of wood stork nesting occurs within traditional wood stork rookeries, a handful of new wood stork nesting colonies are discovered each year (Meyer and Frederick 2004; SFWMD 2004, 2009). These new colony locations may represent temporary shifts of historic colonies due to changes in local conditions, or they may represent formation of new colonies in areas where conditions have improved.

Breeding wood storks are believed to form new pair bonds every season. First age of breeding has been documented in 3- to 4-year-old birds but the average first age of breeding is unknown. Eggs are laid as early as October in South Florida and as late as June in north Florida (Rodgers 1990; USFWS 1999). A single clutch of two to five (average three) eggs is laid per breeding season but a second clutch may be laid if a nest failure occurs early in the breeding season (Coulter et al. 1999). There is variation among years in the clutch sizes, and clutch size does not appear to be related to longitude, nest data, nesting density, or nesting numbers, and may be related to habitat conditions at the time of laying (Frederick 2009; Frederick et al. 2009). Egg laying is staggered and incubation, which lasts approximately 30 days, begins after the first egg is laid. Therefore, the eggs hatch at different times and the nestlings vary in size (Coulter et al. 1999). In the event of diminished foraging conditions, the youngest birds generally do not survive.

The young fledge in approximately eight weeks but will stay at the nest for three to four more weeks to be fed. Adults feed the young by regurgitating whole fish into the bottom of the nest about three to ten times per day. Feedings are more frequent when the birds are young (Coulter et al. 1999). When wood storks are forced to fly great distances to locate food, feedings are less frequent (Bryan et al. 1995). The total nesting period from courtship and nest-building through independence of young, lasts approximately 100 to 120 days (Coulter et al. 1999). Within a colony, nest initiation may be asynchronous, and consequently, a colony may contain active breeding wood storks for a period significantly longer than the 120 days required for a pair to raise young to independence. Adults and independent young may continue to forage around the colony site for a relatively short period following the completion of breeding. Appropriate water depths for successful foraging are particularly important for newly fledged juveniles (Borkhataria et al. 2008).

Wood storks produce an average of 1.29 fledglings per nest and 0.42 fledglings per egg which is a probability of survivorship from egg laying to fledgling of 46 percent (Rodgers and Schwikert 1997). However, in 2009, which was a banner year for nesting, over 2.6 young fledged from successful nests (Frederick et al. 2009). The greatest losses occur from egg laying to hatching with a 30 percent loss of the nest productivity. From hatching to nestlings of two weeks of age, nest productivity loss is an additional 8 percent. Corresponding losses for the remainder of the nesting cycles are on the average of a six percent per two week increase in age of the nestling (Rodgers and Schwikert 1997).

Receding water levels are necessary in South Florida to concentrate suitable densities of forage fish (Kahl 1964; Kushlan 1979) to sustain successful wood stork nesting. During the period when a nesting colony is active, wood storks are dependent on consistent foraging opportunities in wetlands within their core foraging area (30 kilometer radius) surrounding a nest site. Recent wood stork nesting locations and core foraging areas within South Florida are depicted in **Figure D.2-27**. The greatest energy demands occur

during the middle of the nestling period, when nestlings are 23 to 45 days old (Kahl 1964). The average wood stork family requires 201 kilograms (443 pounds) of fish during the breeding season, with 50 percent of the nestling stork's food requirement occurring during the middle third of the nestling period (Kahl 1964). Although the short hydroperiod wetlands support fewer fish and lower fish biomass per unit area than long hydroperiod wetlands, these short hydroperiod wetlands were historically more extensive and provided foraging areas for wood storks during colony establishment, courtship and nest-building, egg-laying, incubation, and the early stages of nestling provisioning. This period corresponds to the greatest periods of nest failure (i.e. 30 % and 8%, respectively from egg laying to hatching and from hatching to nestling survival to two weeks) (Rodgers and Schwikert 1997).

The annual climatological pattern that appears to stimulate the heaviest nesting efforts by wood storks is a combination of the average or above-average rainfall during the summer rainy season prior to colony formation and an absence of unusually rainy or cold weather during the following winter-spring nesting season. This pattern produces widespread and prolonged flooding of summer marshes that maximizes production of freshwater fishes, followed by steady drying that concentrates fish during the dry season when storks nest (Kahl 1964; Frederick et al. 2009). However, frequent heavy rains during nesting can cause water levels to increase rapidly. The abrupt increases in water levels during nesting, termed reversals (Crozier and Gawlik 2004), may cause nest abandonment, re-nesting, late nest initiation, and poor fledging success.

Following the completion of the nesting season, both adult and fledgling wood storks generally begin to disperse away from the nesting colony. In southern Florida, both adult and juvenile wood storks consistently disperse northward following fledging in what has been described as a mass exodus (Kahl 1964). Both adult and juvenile wood storks return southward in the late fall and early winter months.

For COP, an ecological planning tools was available to evaluate potential effects on wading birds in the study area. The Wading Bird Distribution Evaluation Model (WADEM) was utilized to determine spatially-explicit changes in high quality foraging conditions for wading birds for ALTN2, ALTO, and ALTQ relative to ECB19RR. WADEM uses a spatiotemporal species distribution model (SDM) framework to evaluate the foraging responses of great egrets, white ibises, and wood storks. Using a multi-model approach, a spatial foraging conditions model (SFC) predicts wading bird abundance over time at a fixed spatial scale (400 meter) and a temporal foraging conditions model (TFC) predicts daily abundance across space. The resulting indices represent proxies for different components of patch dynamics: patch quality within suitable depths is reflected by TFC and landscape patch abundance by SFC. The product of these two indices (area × quality; or foraging index) provides a metric to account for both processes. To evaluate the effects of COP on wading bird patch quality and patch abundance, mean abundance (TFC) and mean quality (SFC) over the years 1975-2005 was calculated. For more detailed information on WADEM, refer to Beerens et al 2015a, Beerens et al 2015b, and Cook and Kobza 2009.

Figure D.2-70 shows the mean spatial foraging conditions index over the months of March and April over the years 1975-2005 and the percent change between ALTQ and ECB19RR for the wood stork. For the spatial foraging conditions index, the larger the value the better conditions for the specified wading bird. Observed differences between ALTQ and ECB19RR were most often not more than a ± 10% change across the majority of WCA 3 and ENP. Improvements in foraging conditions were observed in NESRS under ALTQ relative to ECB19RR. **Figure D.2-71** shows percent change in mean daily foraging index (SFC x TFC) for the wood stork for each year in the period of record. Yearly summaries were calculated such that a given year displays the mean value for the November – May breeding season (i.e., the value for 1999 shows the mean from November 1998 through May 1999). ALTQ improved the mean daily foraging index

with the exception of six years in the 31 year period of record (maximum percent change of ~5% in given year; average percent change ~2%; minimum percent change~-1%). An ecological planning tool was not available for ALTQ+. ALTQ+ would result in similar effects as discussed under ALTQ. Observed results indicate that ALTQ+ has the potential to provide minor to moderate beneficial long term effects on wood storks in portions of ENP with respect to foraging.

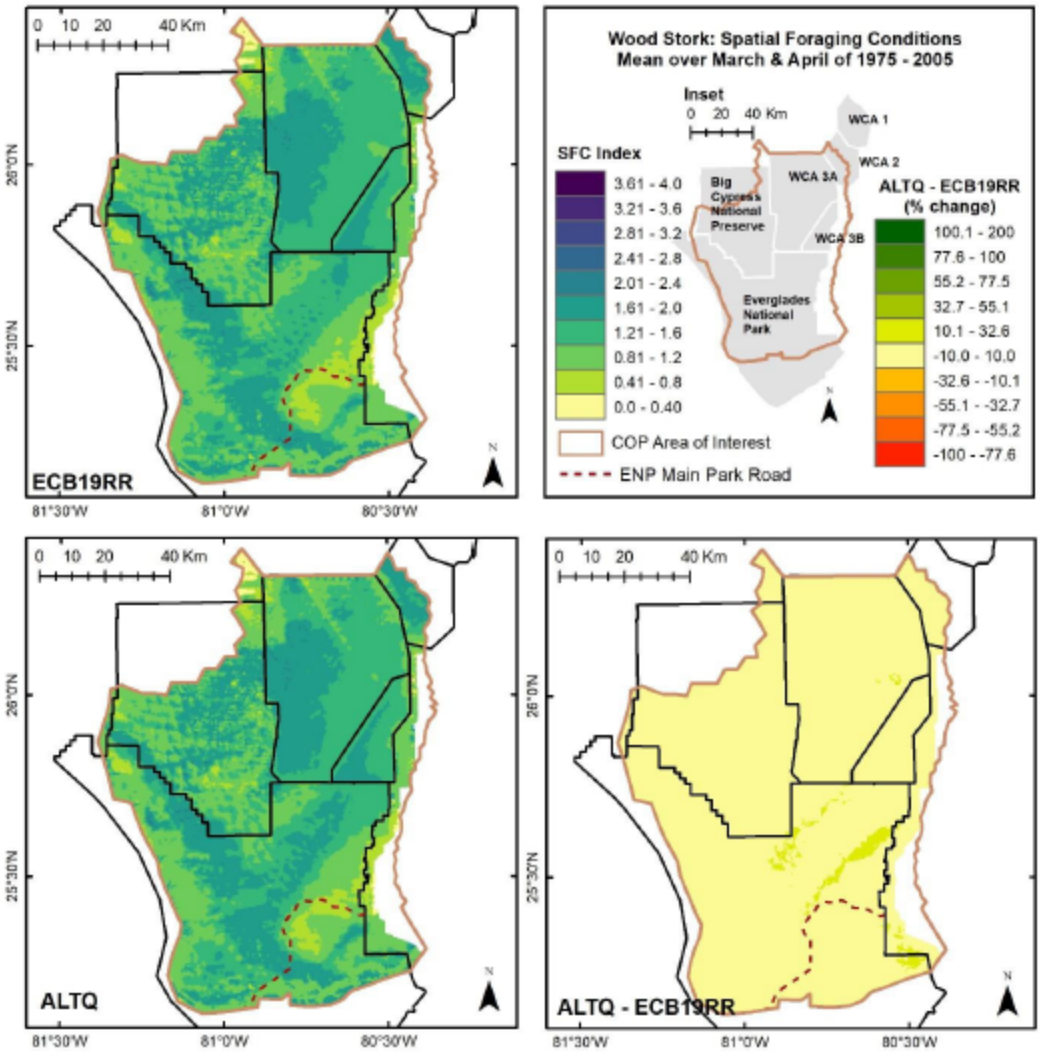


Figure D.2-64. Spatial foraging conditions index for the wood stork for ALTQ.

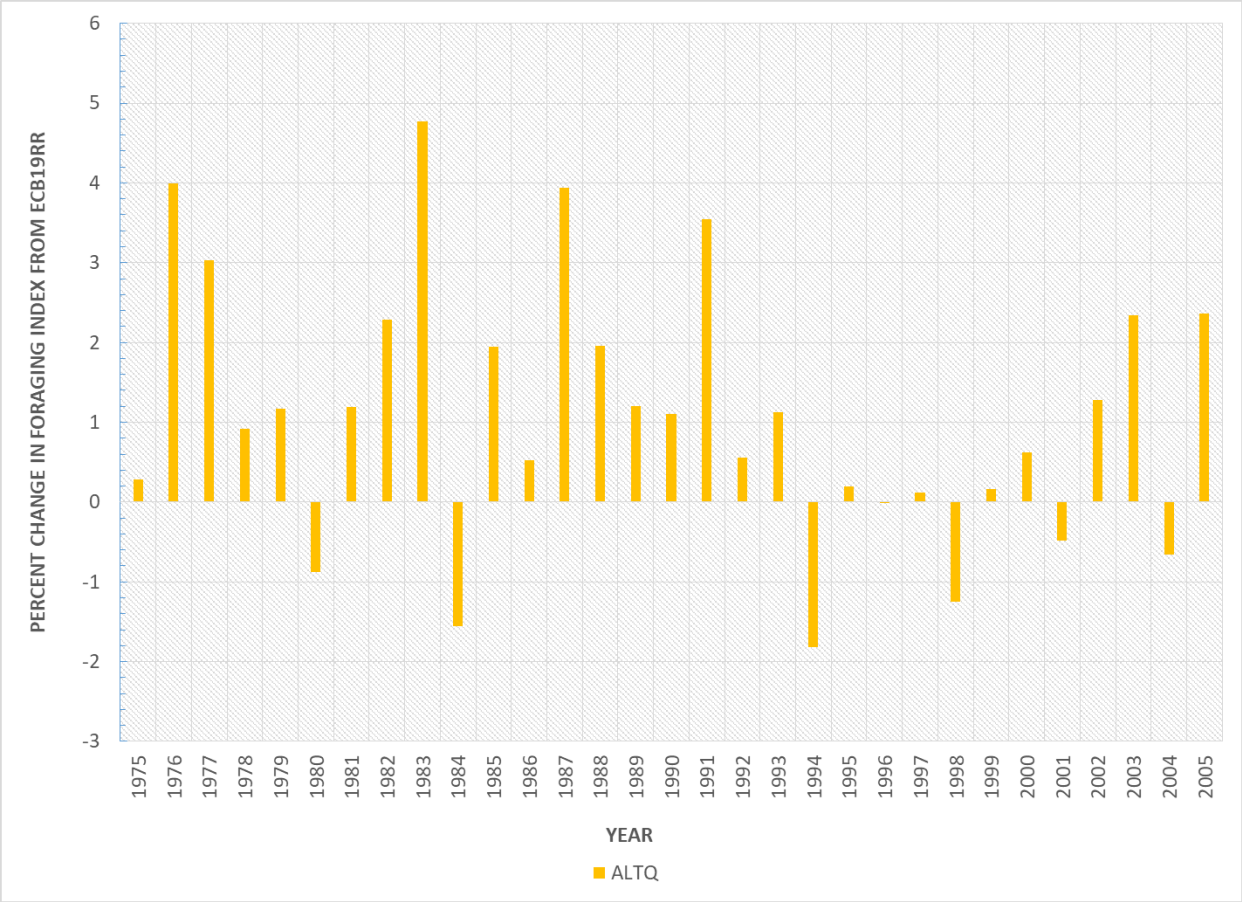


Figure D.2-65. Wood stork foraging index. Percent from ECB19RR.

For COP an ecological planning tool was also available to evaluate potential effects on small sized fish density (defined as less than eight centimeters adult standard length) within the study area. The ecological planning tool or prey based freshwater fish density model estimates the densities of small-sized freshwater fish, primarily livebearers (poeciliids) and killifishes (cyprinodontids and fundulids). High-densities of these fish characterized the pre-drainage central Everglades ecosystem. Maximizing densities is an objective of many restoration scenarios. Because prey fish dominate the prey community in both biomass and abundance, they are an important energy source for higher-trophic levels, such as wading birds. Thus ecological planning tool estimations of prey fish can be used as a general measure of trophic conditions within the central Everglades. For more details reference Donalson et al 2010. **Figure D.2-72** through **Figure D.2-73** illustrates the percent change in mean daily total fish density for ALTQ relative to ECB19RR for s wet year (1995) and dry year (1989). Observed differences between ALTQ and ECB19RR were most often not more than a ± 10% change. Differences greater than ± 10% were observed in a number of locations in portions of WCA 3B and NESRS. **Figure D.2-74** illustrates the annual percent change in mean daily total fish density relative to ECB19RR over all of the locations (i.e. circles) depicted in **Figure D.2-73.** The circles in these figures represent locations within the study area where small sized fish density is able to be predicted based on a long term monitoring data set. ALTQ improved mean daily total fish density in all years of the 41 year period of record.

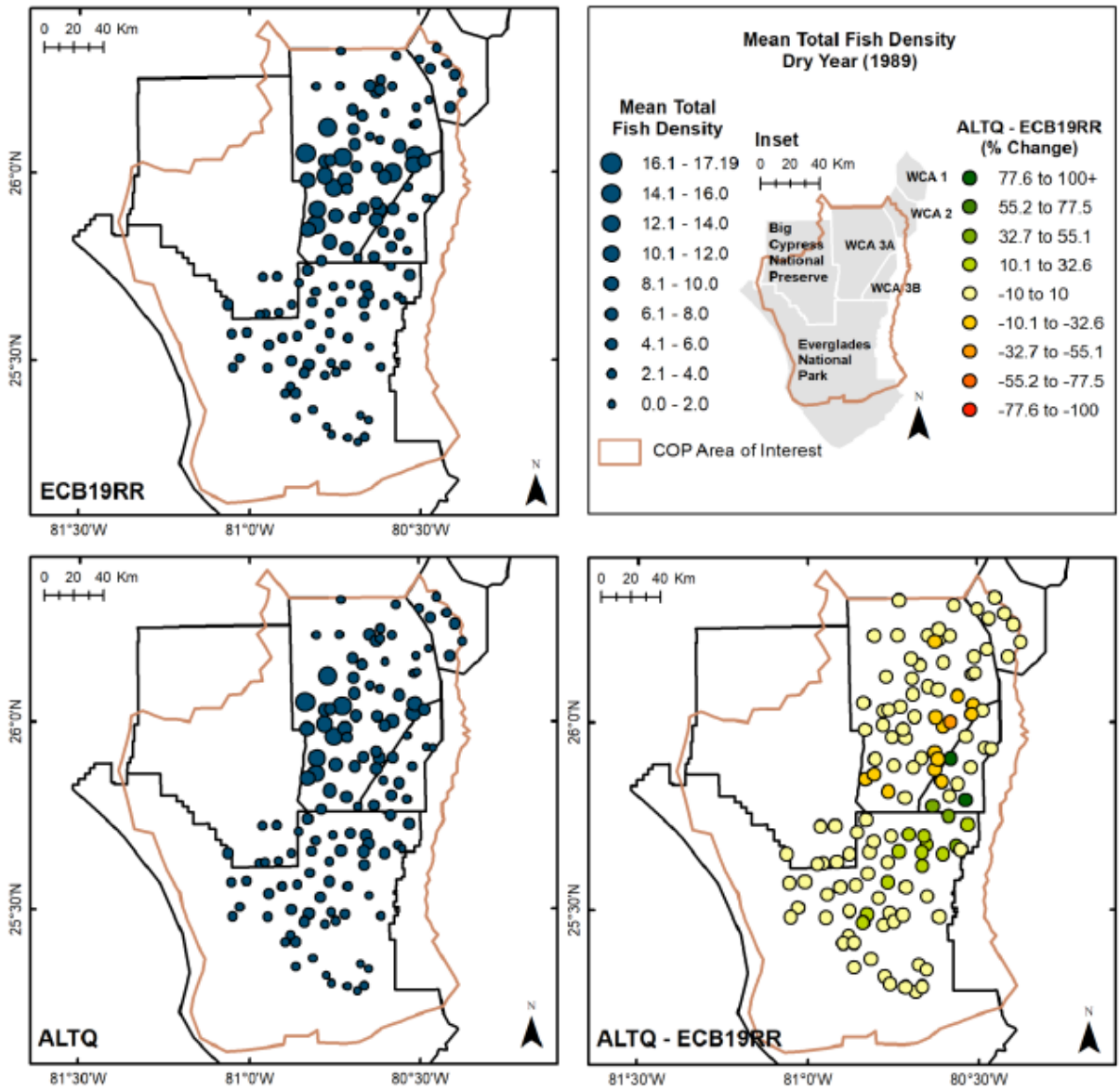


Figure D.2-66. Mean total fish density for a dry year (1989) for ALTQ.

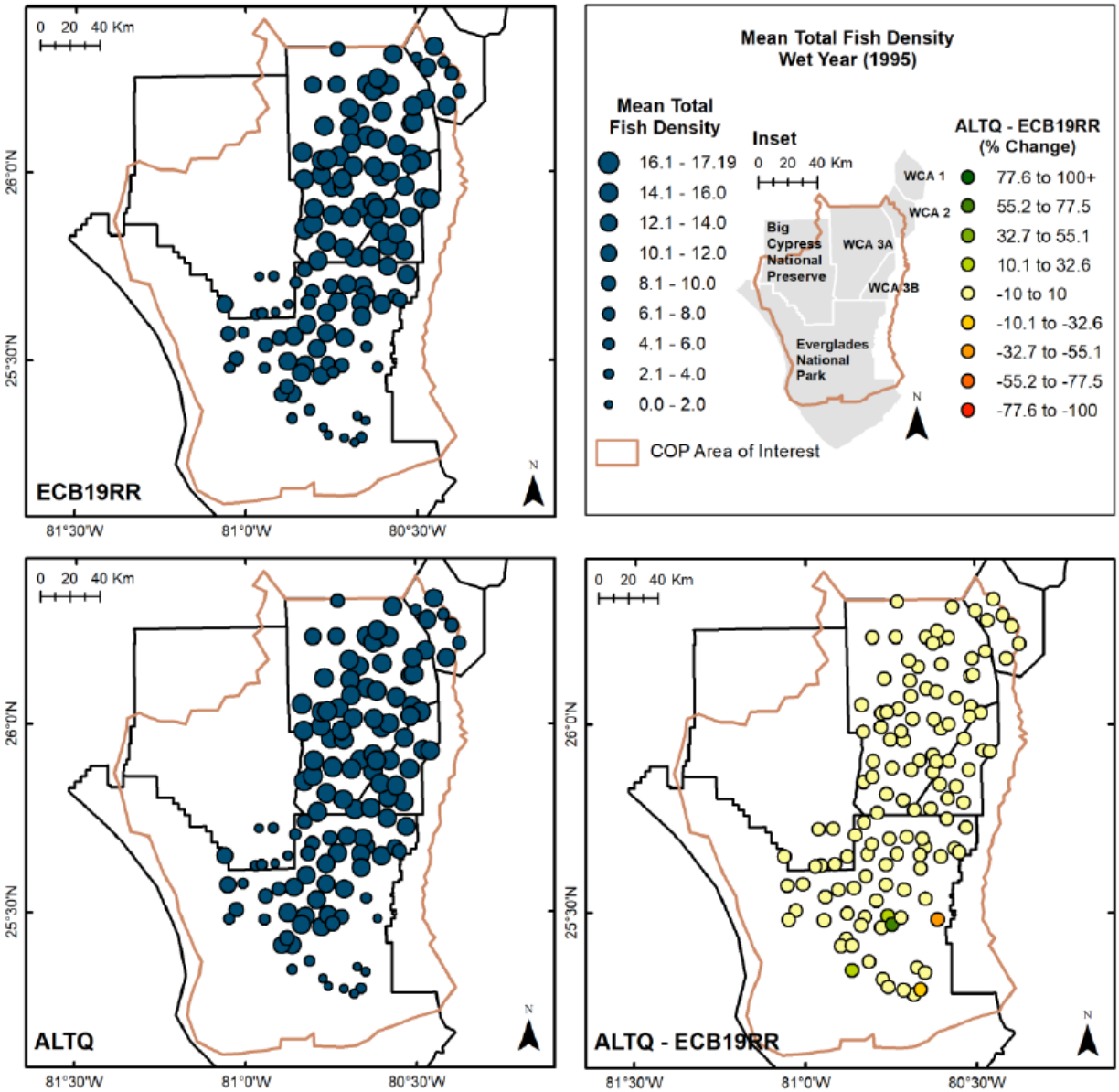


Figure D.2-67. Mean total fish density for a wet year (1995) for ALTQ.

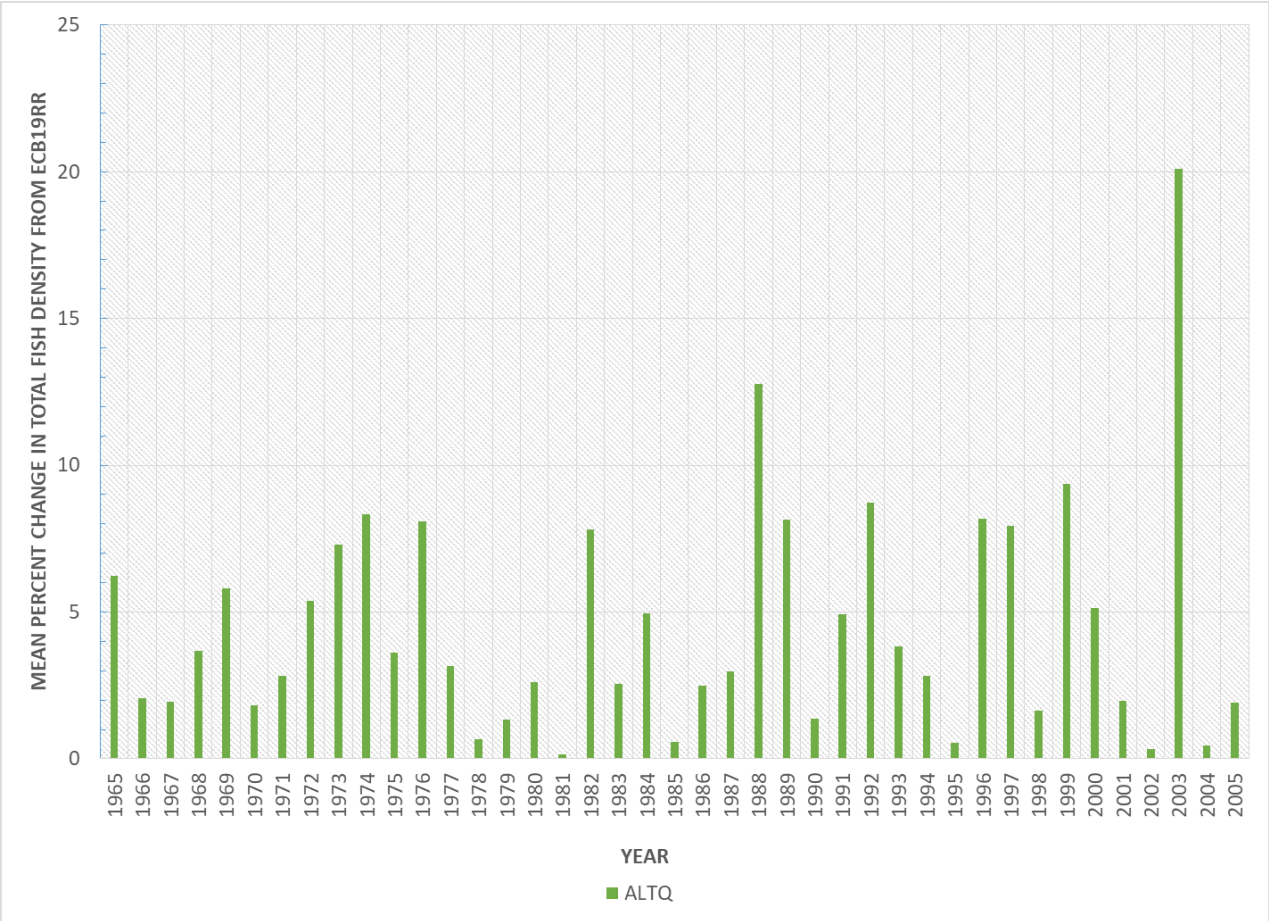


Figure D.2-68. Mean percent change in total fish density from ECB19RR for each year in the period of record (1965-2005).

In addition to WADEM, an ESA incidental take trigger developed during consultation between USACE and USFWS for the 2016 ERTP BO was utilized during plan formulation for COP to understand potential effects on wood storks in WCA 3A. The 2016 ERTP BO includes a reinitiation trigger that evaluates water depths greater than 16 inches (41 cm) from March 1 through May 31 throughout WCA 3A as measured by the two gauge average (based upon a ground surface elevation of 8.4 feet NGVD) at gauges 3A-3 (Site 63) and 3A-4 (Site 64). Per the 2016 ERTP BO, incidental take will be exceeded if operations results in a water depth greater than 16 inches (41 centimeters) from March 1 through May 31 throughout WCA 3A for two consecutive years. The annual hydrologic pattern in South Florida is consistent, with water levels rising during the wet season (June through October), then receding gradually during the dry season (November to May). Wood storks nest during the dry season and rely on the drying wetlands to concentrate prey items for optimal foraging. Once the wetland has dried to where water levels are near the ground surface, the area is no longer suitable for wood stork foraging and will not be suitable again until water levels rise and the area is repopulated with fish. Wood storks prefer calm water, approximately 2 to 16 inches deep and free of dense vegetation for foraging (Coulter and Bryan 1993). More recently, Beerens and Cook (2010) defined a foraging depth range of -0.31 to 1.34 feet (-9.33 to 41.26 cm) for wood storks feeding in WCA 3A. A water depth greater than 16 inches (41 cm) across WCA 3A during the nesting season would lower the suitability of foraging habitat to the point where the ability for wood storks to forage would be severely impaired and most likely result in widespread abandonment of nests and fledglings within the affected colony (USFWS 2016). **Table D.2-25** shows the number of times in the period of record (1965-

2005) when water depths exceeded 16 inches (41 cm) from March 1 through May 31 throughout WCA 3A in two consecutive years as measured by the two gage average (based upon a ground surface elevation of 8.4 feet NGVD) at gages 3A-3 and 3A-4. ALTQ reduced the number of times the threshold was exceeded relative to ECB19RR by six. Exceedance criteria were not available for ALTQ+. ALTQ+ would result in similar effects as discussed under ALTQ.

Table D.2-25. Wood Storks and Wading Birds: Number of times in the period of record (1965-2005) when water depths exceeds 16 inches (41 cm) from March 1 through May 31 throughout WCA 3A in two consecutive years as measured by the two gage average (based upon a ground surface elevation of 8.4 feet NGVD at gage 3A-3 and 3A-4).

Alternative	ECB19RR	ALTQ
Wood Stork Exceedance Criteria	12	6

USACE has determined that the Proposed Action may affect the wood stork. COP is expected to influence wetland hydroperiods causing changes in nesting and foraging suitability for the wood stork. Under COP, USACE will continue to evaluate how water management operations may be conducted to maximize beneficial effects for the wood stork. USACE proposes specific minimization as part of COP including species and habitat monitoring to identify population trends for the wood stork currently being conducted in compliance with the 2016 ERTP BO (USFWS 2016). Under COP, USACE will continue to implement PSC to provide real-time assessment of conditions in the study area to ensure wildlife recommendations are considered during the water management decision process.

D.2.7 Cumulative Effects

Cumulative effects include the effects of future Federal, State, Tribal, local, or private actions reasonably certain to occur in the action area considered in this BA. Cumulative effects are defined in 40 CFR 1508.7 as those effects that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. The following summarizes past, present, and projected Corps efforts that cumulatively affect the regional environment of South Florida **Table D.2-26**. In addition, there are efforts underway by other Federal, State, and local agencies, as well as non-governmental organizations that are all working to-wards similar restoration goals.

Beneficial effects to ENP have occurred through implementation of the incremental field tests conducted under the authority of the MWD Project. USACE signed a FONSI on February 21, 2018 for the MWD Increment 2 Field Test to raise the L-29 Canal maximum operating limit up to 8.5 feet NGVD subject to downstream constraints. Raising of the L-29 Canal constraint above 7.8 feet NGVD (the maximum operating limit under Increment 1.2) was dependent upon completion of critical features necessary to operate the C-111 South Dade Project NDA. Following completion of the C-111 South Dade Project construction (both the NDA and SDA components) in August 2018 and following recovery of the 8.5 SMA flood mitigation system from an early September 2018 rainfall event, the L-29 Canal maximum operating limit was incrementally increased from 8.3 feet NGVD to 8.5 feet NGVD on September 19, 2018. In 2018, 343,400 acre feet of water (inflow volume of S-333 plus S-356 minus S-334 outflows) was delivered to NESRS (fhfh). Increased flows have continued through 2019 and as of October 31, 2019, (at the time of this Draft EIS) 442,100 acre feet has been delivered. This is an increase of more than 235,725 acre feet of water into NESRS as compared to an average of 525,075 acre feet delivered per year from 2012 through 2015 prior to implementation of the MWD incremental field tests.

Table D.2-26. Past, present, and reasonably foreseeable actions and plans affecting the action area.

-	Past Actions and Authorized Plans	Current Actions and Operating Plans	Reasonably Foreseeable Future Actions and Plans
Status of Non-CERP Projects	- C&SF Project (1948) - ENP Protection and Expansion Act (1989) - MWD GDM and Final EIS (1992) - C-111 South Dade GRR (1994)	- SFWMD Restoration Strategies Project - MWD 8.5 SMA GRR (2000) - MWD Tamiami Trail Modifications Limited Reevaluation Report (2008) - C&SF C-51 West End Flood Control Project - Kissimmee River Restoration - Seepage Barrier near the L-31 N Levee (Miami-Dade Limestone Products Association) - Tamiami Trail Modifications Next Steps (TTMNS) Project, Phase 1 - SFWMD Florida Bay Initiatives - C-111 South Dade Project (Contracts 8, 8A, and 9)	- SFWMD Complete Restoration Strategies Project - MWD Closeout - Tamiami Trail Modifications Next Steps (TTMNS) Project, Phase 2
Operations Plan for Lake Okeechobee, WCA 3A, ENP and the SDCS	- Water Supply and Environment (WSE) Lake Okeechobee Regulation Schedule (2000) - IOP 2002 to 2012 ERTP	- Lake Okeechobee Regulation Schedule (LORS 2008) - SFWMD LEC Regional Water Supply Plan - ERTP October 2012 until replaced by COP; temporary planned deviations included Increment 1 and Increment 1.1 and 1.2 and 2 Operational Strategies - Herbert Hoover Dike Dam Safety Modification Study (HHD DSMS) risk reduction measures (2011 through 2022)	- LORS 2008 to be replaced by revised Lake Okeechobee System Operating Manual by 2022 - SFWMD periodically revises the LEC Regional Water Supply Plan
CERP Projects		Congressional Authorization Received: - Broward County Water Preserve Areas Project - Caloosahatchee River (C-43) West Basin Storage Reservoir	Future CERP Projects: - Lake Okeechobee Watershed Restoration Project - Western Everglades Restoration Project - Biscayne Bay Coastal Wetlands Phase 2

		- Central Everglades Planning Project (CEPP) - CEPP Post-Authorization Change Report for EAA Southern Reservoir Project (conditional authorization pending completion and ASA review of the 1308b report specified in the WRRDA 2018) Congressional Authorization Received and Construction in Progress: - Central Everglades Planning Projects (DOI removal of portions of Old Tamiami Trail roadway and SFWMD increased capacity of S-333N - Indian River Lagoon-South Project - Picayune Strand Restoration Project - Site 1 Impoundment Project - Biscayne Bay Coastal Wetlands Project Phase 1 - C-111 Spreader Canal Western Project (operated by SFWMD)	- C-111 Spreader Canal Project Phase 2

Beneficial effects to ENP have occurred through implementation of the incremental field tests conducted under the authority of the MWD Project. USACE signed a FONSI on February 21, 2018 for the MWD Increment 2 Field Test to raise the L-29 Canal maximum operating limit up to 8.5 feet NGVD subject to downstream constraints. Raising of the L-29 Canal constraint above 7.8 feet NGVD (the maximum operating limit under Increment 1.2) was dependent upon completion of critical features necessary to operate the C-111 South Dade Project NDA. Following completion of the C-111 South Dade Project construction (both the NDA and SDA components) in August 2018 and following recovery of the 8.5 SMA flood mitigation system from an early September 2018 rainfall event, the L-29 Canal maximum operating limit was incrementally increased from 8.3 feet NGVD to 8.5 feet NGVD on September 19, 2018. In 2018, 343,400 acre feet of water (inflow volume of S-333 plus S-356 minus S-334 outflows) was delivered to NESRS (**Figure D.2-75**). Increased flows have continued through 2019 and as of October 31, 2019, (at the time of this Draft EIS) 442,100 acre feet has been delivered. This is an increase of more than 235,725 acre feet of water into NESRS as compared to an average of 525,075 acre feet delivered per year from 2012 through 2015 prior to implementation of the MWD incremental field tests.

WCA-3A WATER DELIVERIES (AC-FT) TO NORTHEAST SHARK RIVER SLOUGH (S-333 + S-356 - S-334)*													
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2012	16,400	7,700	1,400	300	15,000	14,000	700	3,400	-200	-300	400	8,200	67,000
2013	18,900	8,200	2,200	500	26,400	18,200	3,500	1,000	-1,500	-700	0	0	76,700
2014	800	29,300	30,700	400	100	9,800	44,000	15,800	16,300	0	31,800	12,400	191,400
2015	1,700	0	5,700	0	0	0	0	0	6,400	36,700	26,300	8,600	85,400
2016	8,100	28,700	74,400	65,700	25,900	11,100	30,600	10,800	500	100	0	7,700	263,600
2017	2,700	5,200	1,300	300	100	33,300	10,500	0	20,300	700	4,100	45,500	124,000
2018	9,700	21,600	3,100	900	14,600	31,600	60,400	72,000	52,400	74,800	1,400	900	343,400
2019	1,000	21,100	21,700	16,300	24,700	49,400	80,000	74,400	86,400	67,100	0	0	442,100
2020													

Note: All data is provisional.

LEGEND
Minimum Water Delivery
IOP
ERTP
Increment 1
2016 Emergency Deviation
Increment 1.1/1.2
2017 Temporary Deviations
Increment 2
COP

Figure D.2-695. WCA 3A water deliveries (thousand acre feet) to NESRS (S-333+S-356-S-334)

The COP is expected to contribute to a net beneficial cumulative impact on the regional ecosystem, providing benefits to ENP by increasing flows to NESRS and Taylor Slough. The COP modifies the Rainfall Plan that conveys water from WCA 3A to ENP as per ERTP 2012. This is the first time the Rainfall Plan will be updated since the 1980's. The COP takes advantage of all that has been learned through operating the system under the MWD Incremental field tests and integrating modeling tools with real time operations. The COP PDT identified "the signal" which will guide the conveyance of water across Tamiami Trail to meet ecological, flood protection, and water supply needs simultaneously in WCA 3A and ENP. Although the L-29 Canal has been operated up to 8.5 feet NGVD recently, it has been under a short-term deviation approved by USACE. The COP, if approved, would make this operation permanent, until such time that the water control plan is revised under future CERP efforts. Based on ALTQ model results, just these two changes will enable water flows across Tamiami Trail to increase from 571,000 to 733,000 acre feet average annual flows. This is a 28% increase in flows to ENP just from changing operations with the infrastructure that is currently on the ground today.

Furthermore, the COP addresses high water conditions during extreme wet events by moving water from WCA 3A to ENP as part of regular operations to avoid high water emergency operations. The last three years have required USACE to seek planned temporary deviations from the current water control plan and has required the State of Florida to issue emergency orders, both of which require a tremendous amount of analysis and coordination. The inclusion of the EHWL in the COP would streamline the process (and the need for additional NEPA) required to implement changes due to extreme high water levels to apply more attention to alleviating future high water condition.

The COP would also enable the S-356 pump station to operate as part of the water control plan for the first time since construction. Not only will it be operated, it would have priority over S-333 to manage L-31N canal stages for flood protection as flows to NESRS increase.

Regular operation of S-328, which delivers water to Taylor Slough, would be included in the COP water control plan for the first time. This is consistent with the SFWMD's Florida Bay Initiative which had the goal to improve flood control in southern Miami-Dade County while directing much-needed water to natural areas. COP would move more water towards Taylor Slough with seasonal and lower canal operations consistent with the SFWMD's South Dade Study. COP will send 92,000 acre feet average annually towards Florida Bay. Furthermore, COP would reduce damaging flows from S-197 to Manatee

Bay/Barnes Sound by modifying operation of the C&SF structures while maintaining flood protection. This would be the first time operations at the southern end of the canal system has been revisited since construction of the S-197 structure. COP would reduce the frequency and volume of damaging flows. S-197 flows > 800 cfs at S-197 would decline from 4 times to 2 times per year, which corresponds to a reduction of average annual flows from 60,000 to 19,000 acre feet.

Table D.2-27 shows the net cumulative effects of the various resources which are directly or indirectly impacted. The COP will serve to further refine and optimize operations within WCA 3A, ENP and SDCS and make adjustments to the WCA 3 Rainfall Plan through implementation of the TTFF. Implementation of the COP is anticipated to increase the availability of water deliveries from WCA 3A to ENP through Northeast Shark River Slough and improve hydrologic conditions in Taylor Slough, the Rocky Glades, and the eastern panhandle of ENP. Development of the COP will also address the mandated RPA of the 2016 July BO.

Table D.2-27. Summary of cumulative effects.

Resource	Cumulative Effects
Hydrology	-
Past Actions	Flood and water control projects have greatly altered the natural hydrology.
Present Actions	Federal and state agencies are coordinating on and implementing projects to improve hydrology.
Proposed Action	The combined flows to ENP are anticipated to be greater than discharges to ENP relative to the 2012 Water Control Plan. Hydroperiods within NESRS and Taylor Slough are expected to increase with the Proposed Action.
Future Actions	Additional CERP projects propose to restore hydrology to more natural conditions.
Cumulative Effect	Although it is unlikely that natural hydrologic conditions would be fully restored to pre-drainage conditions, improved hydrology would occur with implementation of the Proposed Action. CERP is expected to improve the quantity, quality, timing and distribution of freshwater flow.
Endangered Species	-
Past Actions	Water management practices and urbanization have resulted in the degradation of existing habitat function and direct habitat loss leading to negative population trends of threatened and endangered species.
Present Actions	ERTP implementation represented a paradigm shift from single species to multi-species management. ERTP includes performance measures specifically directed at managing water levels and releases for the protection of multiple species and their habitats within the project area.
Proposed Action	Effects determinations for Federally threatened and endangered species within the project area are listed in **Table D.2-4**. USACE acknowledges the potential usage and occurrence of the previously discussed threatened and endangered species and/or critical habitat within the COP action area. The Proposed Action is being implemented in accordance with the mandated RPA of the 2016 ERTP BO and RPA for the benefit of the CSSS.
Future Actions	Ongoing projects would be implemented to maintain threatened and endangered species within the study area. It is anticipated that suitable CSSS habitat will be maintained under future restoration initiatives, but it may not occur with the current or historic footprints in some areas.

Resource	Cumulative Effects
Cumulative Effect	Habitat improvement, monitoring, and management of threatened and endangered species are anticipated to allow populations to be maintained. Improvement of degraded populations is expected to be facilitated by the restoration and enhancement of suitable habitat through efforts to restore more natural hydrologic conditions within the project area.
Fish and Wildlife Resources	-
Past Actions	Water management practices have resulted in aquatic vegetation community changes and a resultant disruption of aquatic productivity and function that has had repercussions through the food web, including effects on wading birds, large predatory fishes, reptiles and mammals.
Present Actions	Ongoing efforts have been made by Federal and state agencies to implement projects to improve hydrology within the project area to restore habitat conditions for fish and wildlife resources.
Proposed Action	Increases in forage prey availability (i.e. crayfish and other invertebrates, fish) resulting from improved hydroperiods would in turn provide beneficial effects for amphibian, reptile, small mammal, and wading bird species in ENP. Significant adverse impacts are not anticipated in WCA 3.
Future Actions	Some level of improvement to fish and wildlife resources is expected to occur as a result of implementation of projects with the capability of improving the timing, quantity, quality and distribution of freshwater flow to the study area. Hydrologic restoration planned as part of CERP would further improve fish and wildlife habitat.
Cumulative Effect	Habitat improvement efforts are anticipated to benefit fish and wildlife resources.
Vegetation and Wetlands	-
Past Actions	Drainage of Florida's interior wetlands, conversion of wetlands to agriculture, and urban development has reduced the spatial extent and quality of wetland resources.
Present Actions	Efforts are being taken by state and Federal regulatory agencies to reduce wetland losses.
Proposed Action	Increased hydroperiods within the eastern marl prairies may act to alleviate some of the problems associated with drier conditions. The Proposed Action may have beneficial effects on vegetative communities within NESRS and Taylor Slough. Additional operational flexibility has been included within the Proposed Action to further allow for a rapid response to extreme high water levels in WCA 3A, directly benefitting tree islands within WCA 3A.
Future Actions	Some level of improvement to vegetative communities is expected to occur as a result of implementation of projects with the capability of improving the timing, quantity, quality and distribution of freshwater flow to the study area. More natural hydrology as part of the CERP would assist in restoring natural plant communities.
Cumulative Effect	While the spatial extent of natural plant communities would not be restored to historic proportions, the quality of vegetative communities would be improved.
Water Quality	-
Past Actions	Water quality (nutrients, suspended solids, turbidity) has been degraded from urban, suburban, commercial, industrial, recreational and agricultural development.
Present Actions	Efforts to improve water quality (nutrients) from agricultural areas are ongoing. Construction of Federal and state projects can temporarily elevate localized levels of suspended solids and turbidity.

Resource	Cumulative Effects
Proposed Action	Water quality conditions in the vicinity of the L-29 Canal and L-31N Canal may be affected by implementation of the Proposed Action.
Future Actions	Actions by the State of Florida's Restoration Strategies is expected to decrease nutrient concentrations and loadings to the project area. In general there is a slowly improving trend in water quality entering and exiting the WCA's.
Cumulative Effect	While anthropogenic effects on water quality are unlikely to be eliminated, water quality is expected to slowly improve. This is based on trends indicated by data analysis and the fact that Best Management Practices (BMP's) are continuing to reduce nutrient loading to the system.

D.2.8 Conservation Recommendations

USACE acknowledges the potential usage and occurrence of the previously discussed threatened and endangered species and/or critical habitat within the action area. Species and habitat monitoring will continue to identify population trends for the CSSS, snail kite, wood stork and the vegetation characteristic of their habitats currently being conducted in compliance with the 2016 ERTP BO (USFWS 2016a). PSC will allow USACE and its Tribal and governmental partners to discuss ecological, hydrological, and meteorological conditions to achieve the objective of managing water levels and releases for the protection of multiple species and their habitats. Regularly scheduled interagency calls allow USACE to gather input on desired long-term (annual and/or seasonal) conditions within WCA 3 and ENP. In addition, the PSC occur on an as needed basis with the frequency of the calls determined based upon ongoing or anticipated conditions within the WCAs, SDCS, and ENP. The PSC focus on the status of a suite of species to allow for adaptive management of the system based upon the needs of multiple species and their habitats. Under COP, USACE will continue to implement PSC to provide real-time assessment of conditions within the action area to ensure wildlife recommendations are considered during the water management decision process.

Furthermore, a monitoring plan has been developed for COP. The COP Adaptive Management and Monitoring Plan (AMMP) includes the following: (1) Part 1 Adaptive Management and Ecological Monitoring Plan; (2) Part 2 Water Quality Monitoring Plan; (3) Part 3 Hydrometerological Monitoring Plan, and (4) Part 4 Cultural Resources Monitoring Plan. The COP AMMP identifies the monitoring information needed to inform COP implementation and to document progress towards meeting the projects goals and objectives. The COP AMMP identifies annual or biannual (twice per year) interagency workshops to describe the performance of operations relative to the achievement of COP goals and objectives. The overall objective of the COP AMMP is to focus resources on refinement of COP to fine tune performance due to inevitable uncertainties, based on existing knowledge and knowledge that will be gained through monitoring and assessment.

USACE will continue to evaluate how water management operations within the flexibility available to USACE under the water control plan, may be conducted to maximize beneficial effects for the CSSS. USACE will continue to utilize best available methods to monitor and estimate the spatial and temporal extent of hydrologic conditions (water above or below ground surface) relative to the CSSS habitat targets (i.e. dry nesting days and annual discontinuous hydroperiod). USACE will continue to implement provisions of the 2016 ERTP BO which require USACE to provide a report to the USFWS on the results of this monitoring at least twice annually to evaluate progress toward meeting the performance targets (USFWS 2016). Bi-annual reports will evaluate nesting season conditions and include information such as the operations that occurred and their effectiveness, and the spatial and temporal extent of hydrologic conditions within each CSSS subpopulation (USFWS 2016).

D.2.9 Conclusions

USACE acknowledges the potential usage and occurrence of the previously discussed threatened and endangered species and/or critical habitat within the COP action area. Based on available information, it is evident that the Florida panther, the Florida manatee, Florida bonneted bat, CSSS, snail kite, wood stork, American alligator, American crocodile, and Eastern indigo snake reside, travel, and or forage within the action area and could be affected by implementation of COP.

Other federally threatened or endangered species that are known to exist or potentially exist within the COP action area that are not affected by the proposed action include the piping plover, red-cockaded woodpecker, roseate tern, Bartram's hairstreak butterfly, Florida leafwing butterfly, Miami blue butterfly, Schaus swallowtail butterfly, Stock Island tree snail, crenulate lead-plant, Okeechobee gourd, Big Pine partridge pea, Blodgett's silverbush, Cape Sable thoroughwort, Carters small-flowered flax, Everglades bully, Florida brickell-bush, Florida bristle fern, Florida pineland crabgrass, Florida prairie-clover, Florida semaphore cactus, pineland sandmat, sand flax, deltoid spurge, Garber's spurge, Small's milkpea and tiny polygala. USACE has determined that implementation of COP will have no effect on these species.

USACE will continue discussions with USFWS in the event of operational modifications of the COP if such modifications are proposed to occur in the future. USACE will track implementation of the COP and communicate the status of all actions to USFWS as appropriate through regular interagency discussions (i.e. ERTP PSCs, COP AMMP Meetings). ESA consultation will be revisited as needed. If any effects to listed species associated with the COP are revealed that were not previously considered in this BA, USACE will reinitiate ESA consultation as appropriate. The COP is being pursued to address the mandated RPA of the July 22, 2016 ERTP BO which requires USACE to proceed as scheduled, and as allowable by law, for completing NEPA analysis for the COP by August of 2020. This document is being submitted for formal consultation with the USFWS pursuant to Section 7 of the ESA.

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APPENDIX A

WATER CONTROL PLAN

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7 WATER CONTROL PLAN

7.1 General Project Purposes, Goals, Objectives, and Benefits

The Central and Southern Florida (C&SF) Project was designed and constructed by the U.S. Army Corps of Engineers (USACE). The local sponsor for this project is the South Florida Water Management District (SFWMD). The USACE operates and maintains project works on the St. Lucie Canal, Caloosahatchee River, Herbert Hoover Dike, Lake Okeechobee major spillways, and the main outlets for Water Conservation Areas (WCAs) 1, 2, and 3. The SFWMD operates the remainder of the project in accordance with regulations prescribed by USACE. The congressionally authorized project purposes include flood control, water supply for municipal, industrial, and agricultural uses, prevention of saltwater intrusion, water supply for Everglades National Park, protection of fish and wildlife resources, groundwater recharge, recreation, and navigation. Another objective is the maintenance of marsh vegetation in the WCAs, which will provide a dampening effect on hurricane-induced wind tides. Levees 40 (L-40), L-36, L-35(A), L-35, L-37, L-33, L-30, L-31(N), and L 31(W) form the east coast protection levee. The east coast protection levee prevents floodwaters, which historically flowed from north to south across the broad flat peninsula, from flowing into the areas that are now developed along the southeast coast of Florida.

This Water Control Plan (WCP) combines the 2012 WCP water management operations for WCA 1 and WCA 2 with the new water management operations developed for WCA 3, ENP, and the South Dade Conveyance System (SDCS) in the Combined Operational Plan (COP). COP is an integrated operational plan for two modifications of the C&SF Project – known as Modified Water Deliveries (MWD) to ENP and the Canal 111 (C-111) South Dade (SD) projects. The purpose of the COP is to define the water management operations for the WCA 3A and WCA 3B outlets, structures in the L-31N and the C-111 basins constructed as part of the C&SF Project and the recently constructed components of the MWD and C-111 SD projects.

Concurrent with the MWD and C-111 SD projects' authorization, the C&SF Project Comprehensive Review Study was authorized in 1992. The purpose of this study was to reexamine the C&SF Project to determine the feasibility of modifying the project to restore the south Florida ecosystem and to provide for other water-related needs of the region. Specifically, the goals of the Review Study expanded on the purpose of the C&SF Project to include enhancing ecologic values by increasing the total spatial extent of natural areas, improving habitat and functional quality, improving native plant and animal species abundance and diversity. The goal to enhance economic values and social well-being was expanded to now include increasing availability of fresh water for agricultural/municipal and industrial uses, reducing flood damages to agricultural and urban uses, and protecting cultural and archeological resources and values. The COP goals, derived from the MWD and C-111 SD projects purposes include:

- Improve water deliveries (timing, location, volume) into ENP and take steps to restore natural hydrologic conditions in ENP given current C&SF infrastructure and features expected to be completed by the time of implementation, to the extent practicable by:
    - Changing schedule of water deliveries so that it fluctuates in accordance with local meteorological conditions, including providing for long term and annual variation in ecosystem conditions in the Everglades (Timing) (P.L. 101-229, Section 101b).

  - Restoring North East Shark River Slough (NESRS) as a functioning component of the Everglades hydrologic system (Location) (P.L. 101-229, Section 101b).
  - Adjusting the magnitude of water discharged to ENP to minimize effects of too much or too little water (Volume) (1992 MWD GDM, Section 44).
- Maximize progress toward restoring historic hydrologic conditions in the Taylor Slough, Rocky Glades, & Eastern Panhandle of ENP.
- Protect the intrinsic ecological values associated with WCA 3A and ENP.
- Minimize the damaging freshwater flows to Manatee Bay/Barnes Sound through the S-197 structure and increase flows through Taylor Slough and coastal creeks (1994 C-111 GRR, Section 5.2).
- Include consideration of cultural values and tribal interests & concerns within WCA 3A and ENP.

Water management operations at the main outlets for WCA 1, 2, and 3 are determined through a decision-making process that considers all the congressionally authorized project purposes for the WCAs. The decision-making process to determine quantity, timing, and duration of the potential releases from the WCAs include consideration of various information related to water management. This information includes but is not necessarily limited to: C&SF Project conditions, estuary conditions and projected needs (e.g., Biscayne Bay, Florida Bay), WCAs conditions and projected needs, WCA water levels, ENP conditions and projected needs, East Coast Canals (ECC) available capacity, ENP-SDCS available capacity, current climate conditions, climate forecasts, hydrologic outlooks, projected WCAs level rise and recession rates, and water supply conditions and projected needs.

All elevations in this document are in feet in relation to the National Geodetic Vertical Datum of 1929 (NGVD) unless otherwise stated. This document will be updated to the North American Vertical Datum of 1988 (NAVD) upon completion of datum updates throughout the control system and monitoring program.

7.2 Project Relationships and Interactions

This updated version of the WCAs–ENP–ENP-SDCS WCP depicts the current approved operating criteria for the region. The projects within this document are hydraulically linked to projects within adjacent water control plans, including Lake Okeechobee and Everglades Agricultural Area (Volume 3), and the East Coast Canals (Volume 5). The WCAs, ENP-SDCS and adjacent regions interact together to provide for C&SF Project purposes.

7.3 Major Constraints

7.3.1 Protection of the Cape Sable Seaside Sparrow and Other Listed Species

The Everglades Restoration Transition Plan (ERTP) was implemented in October 2012 through the 2012 WCP and included operational guidance for the constructed features of the MWD and C-111 South Dade Projects. USACE reinitiated Endangered Species Act (ESA) consultation on ERTP on November 17, 2014, as a result of an exceedance of an Incidental Take Reinitiation Trigger from the November 17, 2010, ERTP Biological Opinion (BO) for the Cape Sable Seaside Sparrow (CSSS). A BO states the opinion of the U.S. Fish and Wildlife Service (USFWS) as to whether a federal action is likely

to jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat. USFWS issued a new BO for ERTP on July 22, 2016, developed in formal ESA consultation with the USACE. As a result of this consultation, USFWS determined that current conditions within CSSS habitat threatened the survival of the sparrow, and as a result, USFWS issued a "jeopardy" BO which explained that unless alternatives to current water operational practices (which then included the 2012 WCP) were explored and implemented, continued implementation of ERTP was likely to jeopardize the continued existence of the CSSS. The revised BO, issued July 22, 2016 presented a Reasonable and Prudent Alternative (RPA) that would avoid jeopardizing the CSSS. The RPA identified operational modifications and proposed expediting restoration initiatives for some of the structures in the southern portion of the Everglades ecosystem to provide suitable nesting habitat for the endangered CSSS. Main elements of the RPA included: habitat performance targets; actions to move water east; surveys and studies; and adaptive management. These RPA actions included additional seasonal closures to outlet structures within WCA 3A (S-12A, S-12B, S-343A, S-343B, S-344), with the flexibility to open under high water conditions between October and November, and adjustments in operations in the SDCS that would enable additional flows to Biscayne Bay during the dry season as well as increased flows toward eastern ENP to extend hydroperiods during the early dry season. In response to the BO, USACE committed to taking specific actions to comply with the BO terms and conditions and implementing the RPA.

The 2016 ERTP BO stated that the S-12A/S-12B and associated structures currently direct water flows to the north of CSSS A, resulting in increased hydroperiods within this area. A delay in opening and implementing early closure of the S-12A, S-12B, S-343A, S-343B, and S-344 structures beyond their restrictions under ERTP was needed to limit flow into western SRS and provide drier conditions for this region. Structural closings for S-12A, S 12B, S-343A, S-343B, and S-344 under ERTP were retained under Increment 1 of the MWD Project; however the Increment 1 Operational Strategy was modified to address the mandated RPA of the July 22, 2016 ERTP BO, to include expanded closure periods for the S-12A, S-12B, S-343A, S-343B, and S-344 structures under Increment1.1 and 1.2. Increment 2 maintained the required closure periods for these structures and analyzed a set of alternatives to address the mandated RPA of the 2016 ERTP BO to raise the maximum operating limit in the L-29 Canal up to a maximum of 8.5 feet NGVD.

The BO issued July 22, 2016, may be accessed at the following website:

http://www.saj.usace.army.mil/Missions/Environmental/Ecosystem-Restoration/G-3273-and-S-356-Pump-Station-Field-Test/

The 2016 ERTP BO acknowledges the above planning efforts by USACE to increase flows into NESRS under the MWD Project and requires USACE to proceed as scheduled, and as allowable by law, for completing National Environmental Policy Act of 1970 (NEPA) analysis on Increment 2 prior to March 1, 2018, and COP in 2019.

The RPA further specified that the USACE shall implement the COP in 2019, while including a provision for an adaptive management mechanism through which the USFWS and USACE may pursue amendments to the current BO, The USFWS and USACE have agreed to amend the BO to reflect the revised anticipated date for COP, currently August 2020. Formal consultation for COP will occur with submittal of a Biological Assessment to the USFWS in December of 2019. A BO for COP is anticipated from USFWS in May 2020.

Successful recovery of CSSS requires continued collaborative efforts among federal, tribal and state partnering agencies. The USACE, within its authorities, will continue to work with the USFWS to find other helpful initiatives which could be enacted by partners and stakeholders to aid in this important effort.

7.3.2 U. S. Highway 41/Tamiami Trail South of L-29 Borrow Canal

The 2008 MWD Tamiami Trail Limited Re-evaluation Report (LRR) included recommendations to build a one mile long bridge in the project area's eastern segment and raise the headwater stage constraints in the L-29 Borrow Canal by one foot from 7.5 feet NGVD to 8.5 feet NGVD, which required road mitigation on parts of Tamiami Trail (U.S. Highway 41) in the action area, located between S-333 on the west and S-334 on the east. To ensure the safety and stability of the roadway subbase infrastructure along this segment of Tamiami Trail , operational constraints [referenced within Section 6 (Recommended Plan) of the 2008 Tamiami Trail LRR] were set forth within the "Contract Between the United States of America and Florida Department of Transportation (FDOT) for Relocation, Rearrangement, or Alteration of Facilities Modified Water Deliveries to Everglades National Park Project (Relocation Agreement)" dated September 25, 2008. FDOT allowed the USACE to use a new standard for the Tamiami Trail roadway (adopted in the March 2008 FDOT Flexible Pavement Design Manual) thereby reducing the required separation (Design Base Highwater Clearance) between the Design High Water (DHW) and the bottom of the road base. DHW (also referred to as Base Clearance Water Elevation) is defined as the average October wet season elevation plus the rainfall from a specific design storm event (10-year frequency, with duration [1-hour, 8-hour, or 24-hour] producing the highest stage and drawing down within a specific period). The previous FDOT standard required either a higher base or a lower DHW. At the time of writing this document (October 2019), funds have been appropriated by the State of Florida and the U.S. Congress for elevation of the Tamiami Trail road base to support a DHW of up to 9.7 feet NGVD. Actual construction may begin as early as 2023. Once the road is elevated existing constraints at Tamiami Trail will be removed, and other constraints on operations will need to be resolved.

Operational constraints as outlined within the Relocation Agreement dated September 25, 2008 are minimum protective standards that were included in the MWD Increment 2 Operational Strategy and retained for the COP WCP. In coordination with FDOT, USACE has implemented additional constraints that are not explicitly spelled out in the Relocation Agreement. Out of concern that the these additional constraints reduce the ability to meet field test goals and objectives of maximizing flows to NESRS, the USACE is currently working with technical staff from the FDOT to further refine the restrictions as described within the WCP and, in coordination with ENP, has implemented expanded hydrologic monitoring of water levels along this section of Tamiami Trail. Data collected in accordance with the Increment 2 monitoring plan developed in consultation with the FDOT will help to inform L-29 Canal operations in COP.

The requirements of the Relocation Agreement, including any subsequent amendments to this agreement between the USACE and FDOT, shall remain unchanged until full completion of Tamiami Trail Next Steps roadway construction, currently anticipated by 2022.

7.3.3 8.5 Square Mile Area

The 8.5 SMA (Las Palmas Community) Project features are designed to mitigate for increased flood risk as a result of increased water levels in NESRS and other areas of ENP resulting from the MWD to

ENP Project. This is consistent with the 2000 General Reevaluation Report and Final Supplemental Environmental Impact Statement (GRR/EIS) Recommended Plan (Alternative 6D). The 8.5 SMA Project features are to be operated to maintain the water levels within the project area between the L-357(W) levee and L-31(N) levee at pre-MWD levels and to preserve or enhance the hydropatterns of land located west of the L-357(W) levee (ENP and the publicly owned natural areas), consistent with the evaluation methodology previously applied for the 2000 GRR/EIS. The hydrologic modeling and flood risk evaluations conducted to support development of the COP included application of an evaluation methodology which is consistent with evaluation metrics used for the 2000 GRR authorization. As required by the 2000 GRR/EIS Record of Decision, periodic flooding east of the proposed levee, before and after project implementation, will remain unchanged from conditions in existence prior to implementation of the MWD Project.

The constructed features of the 8.5 SMA Project available for water management operations include: the canals C-357 and C-358, the 8.5 SMA flow way and the Northern Detention Area (NDA), pump stations S-357 and S-331, and structure S-357N. S-357 and S-357N provide primary flood mitigation to the residents of the 8.5 SMA and S-331 provides secondary flood mitigation benefits only during high water conditions in NESRS. The combination of local conditions, including, but not limited to, proximity to ENP NESRS, comparatively low ground surface elevations, and the high transmissivity of the surficial aquifer system, make the areas along the 8.5 SMA western boundaries challenging to maintain water levels below ground surface elevations and require real-time monitoring and modifications to water management alternatives to ensure flood mitigation success. An expanded hydrologic monitoring plan for the 8.5 SMA was developed during COP. This monitoring plan is located in the Adaptive Management and Monitoring Plan (AMMP) (Appendix C of the COP EIS).

7.3.4 Water Supply Releases from WCAs during Low Water Conditions

During low water conditions, it is difficult to draw water from the interior of the WCAs. The regulation schedules for WCAs 1, 2A, and 3A include a “floor” or minimum water levels below which water supply releases from the WCAs must be preceded by an equivalent volume of inflow. The water levels may continue to recede due to evaporation and seepage; however, as long as there is an inflow volume equal to the outflow volume, water can be released for water supply from the WCAs. There is no requirement to maintain the minimum elevations.

7.3.5 Maintenance of Marsh Vegetation in WCAs to Prevent Wind Tides

A major factor in water management for WCA 3A is the maintenance of marsh vegetation. Prolonged high and low water levels are detrimental to the establishment and maintenance of marsh vegetation. If large areas of open water develop as a result of a loss of vegetation, risk of potential hurricane-induced wind tides increases. In Part I, Supplement 33 GDM for WCA 3 (1960), it was noted one of the factors for establishing the regulation schedule and levee heights was the retention of marsh vegetation that would prevent large wind tides and waves from developing during hurricanes. It was determined that a marsh vegetation that could prevent wind tides could be retained with a seasonal regulation schedule varying between 9.0 to 11.0 feet NGVD. After consideration of other factors such as water supply and fish and wildlife resources, a seasonal regulation schedule varying from 9.5 to 10.5 feet NGVD was selected. The regulation schedule varies from high stages in the winter (dry season) to low stages in the beginning of the summer (wet season). Based on the assumption of marsh vegetation preventing wind tides, the levee design criteria in the GDM was to provide two and a half

feet of freeboard above the Standard Project Flood (SPF) profile, and about four feet above the period of record stage at that time.

7.3.6 WCA 2B and WCA 3B

Regulation schedules are not used for WCA 2B and WCA 3B due to high rates of seepage from these areas. However, releases from WCA 2A and WCA 3A to WCA 2B and WCA 3B, respectively, can be made. The southeast corner of WCA 3B has a very high transmissive rate that results in significant accumulation of water in the L-30 Borrow Canal. S-338 may not always be capable of routing WCA 3A releases and seepage from WCA 3B to tide due to structure capacity limitations.

7.3.7 WCA 3B Release Capability

The outlet for WCA 3B was originally S-12E. However, S-12E never functioned as intended due to tailwater conditions which were higher than designed. Subsequent construction of the ENP-SDCS has made S-12E a non-functional structure; the gates have been removed and a steel plate has been welded to it to prevent flow through the structure. The currently available release routes from WCA 3B are: 1) to tide through S-31 and S-26 via the Miami Canal (C-6), 2) to ENP through S-355A and S-355B into the L-29 Borrow Canal subject to the L-29 stage constraint, and 3) to the L 31(N) through S-337 and S-335. The G-69 structure was removed in 2007 as the function of that structure was tied to the L-67 pilot test. The original design discharge capability from WCA 3B (through the S-355A, S-355B, S-31, and S-337) is approximately 3,305 cfs. Water levels in the L-29 Borrow Canal influence the S-355A and S-355B tailwaters and have the potential to prevent or limit discharge capacity from the S-355s.

7.3.8 WCA 3A Release Capability

The S-12s are not capable of achieving the original design discharge of 32,000 cfs. Outlet capacity of the S-12s has either reduced over time OR was never as large as assumed for the original design routings. The topography adjacent to the S-12s results in very little head differential across the structures under normal water levels. There has been a change in the discharge rating curves for the S-12s over time. The U.S. Geological Survey (USGS) periodically updates the discharge rating curve for each of the S-12s. Experience has shown that actual S-12 releases have been about forty percent less than the design rating curves. The most recent discharge rating curve available should be used for determination of S-12s discharge capability.

The original design headwater of the S-12s was 12.4 feet and the peak average elevation for WCA 3A under the SPF event was 13.90 feet (C&SF Part I, Supplement 33). This stage level is reached only one time in the 41-year period of record of simulated COP operations, and the median value of the nearest gage (WCA3A-28) is approximately 9.0 feet NGVD. The result is that the S-12 structures are very rarely operating near their design criteria, and generally the system will be operated in a manner where the S12s will very rarely demonstrate flows near their design capacity. The as-built crest elevation of the L-29 Borrow Canal and crown elevation of U.S. Highway 41/Tamiami Trail in the S-12A to S-12D reach has been established to protect against the risk of overtopping from an adjacent flood of elevation 11.5 feet (corresponds to WCA 3A three gauge average stage of 12.45 feet, based on historical regression). See **subsection 7.3.9** for further information.

7.3.9 S-12 Stability and Risk of Overtopping

The stability analysis conducted during design of the S-12s is predicated on a maximum design headwater elevation of 12.4 feet with the differential head across the structure limited to 5.5 feet. The as-built crest elevation of L-29 and crown elevation of U.S. Highway 41/Tamiami Trail in the S-12A to S-12D reach has been established to protect against the risk of overtopping from an adjacent flood stage of 12.4 feet NGVD. The exceedance of these design conditions should be considered an immediate increase in risk to levee stability and would require decisive and prescribed measures to reduce the WCA 3A stage. In addition, application of the FDOT road base impact criteria to this reach of U.S. Highway 41/Tamiami Trail (estimated crown elevation of 14.95 feet) would result in a not to exceed regulated water stage of approximately elevation of 11.5 feet, adjacent to the roadbed (corresponds to WCA 3A three gauge average stage of 12.45 feet, based on historical regression).

The top of the gates at the S-12s (A/B/C/D) is 11.0 feet NGVD. When the S-12s headwater approaches this level, the S-12s may be opened an amount only to prevent water from overtopping the structure gates. USACE will assess the feasibility of leaving the gates closed and allow overtopping.

7.3.10 L-31(N)/C-111

The L-31(N) and C-111 canal system has several structures where water management operations are limited. Tailwater elevations of 6.0 feet and 5.3 feet NGVD at S-331 and G-211, respectively, create undesirable conditions relative to adjacent agricultural and residential areas.

7.3.11 Pump Station Mechanical Longevity

The mechanical longevity of an individual pump unit can be affected by numerous conditions, some of which are addressed in the pump manufacturer's Operation and Maintenance Manual(s). Other factors affecting pump station longevity have been realized through the experience of site-specific conditions at the pump station location and these factors are addressed through specific procedures at the pump station. Individual pump units at pump stations will be operated to avoid conditions that could lead to mechanical breakdowns of the pump units. This includes, but is not limited to, avoiding repeated cycling of pumps units between "On" and "Off", rotating the use of pump units from different pump stations that service the same body of water, and engaging the use of individual pump units of a pump station or pump stations that service the same body of water in a staggered manner including when it is prior to "On" criteria occurring. The pump station operator will establish specific procedures to maximize pump unit availability.

7.4 Operational Strategy to Meet Project Objectives

The complexity of water management operations is a clear consequence of the multiple, varied, and sometimes conflicting goals for the regional system (i.e. flood risk management, water supply, environment, navigation, etc). Day-to-day water management operations for the structures within the WCAs and ENP-SDCS will necessitate the use of operating criteria and other related information contained within this WCP and System Operating Manual (SOM). The WCP and the SOM Structure Descriptions and Rating Curves (Appendix A of this SOM) contain a compilation of water control criteria, guidelines, diagrams, and specifications that govern the release functions of the pertinent structure(s) for the congressionally authorized project purposes. In general, they indicate controlling or limiting rates of discharge, levels, and storage space required for the project purposes.

7.4.1 Achieving Natural System Goals, Objectives, and Benefits

Normal operations are expected to achieve the goals and objectives for the system which are detailed above in **subsection 7.1**, and as recorded in the EIS for the COP (2020, until superseded by any future EIS or EA). This section first discusses the individual operational considerations and project objectives and then concludes with the system operational criteria. The operational criteria and overall strategy for the water management operations are expected to accomplish the goals of the C&SF system and COP. As future projects are developed and installed, these changes should interact with the existing system in order to accomplish the restoration goals of the larger C&SF Project.

7.4.2 Flood Risk Management

During high water events, water is passed southward from WCA 1 into WCA 2A; from WCA 2A into WCA 3A; and from WCA 3A into ENP and/or the ENP-SDCS. The water control structures typically pass the water from north to south to allow for a smooth articulation of water through the WCAs and into ENP and/or ENP-SDCS. Releases from the WCAs to tide via east coast canals can also be made. When the east coast canals are full, discharging water eastward from the WCAs could cause or aggravate local flooding. This is also possible if the east coast canals are being utilized for discharge to tide from the WCAs and a significant rainfall event over the east coast canals occurs. Therefore, water from the WCAs can only be discharged to tide via the east coast canals when rainfall over adjacent areas has not produced large amounts of runoff and canal capacity exists. The discharge capacity to tide through the structures that connect the WCAs to the coastal canal system is often relatively small compared to the primary structures (e.g., S-10s, S-11s, and S-12s). For example in WCA 1, S-39 has a design discharge of approximately five percent of that of a single S-10 structure. In addition, favorable conditions for an extended period are required to make meaningful releases through the coastal structures.

7.4.2.1 Water Conservation Areas

The S-10, S-11, and S-12 spillways were sized to pass the SPF. The basic purpose of these spillways is to provide a means of controlling flow and providing conveyance for all flood releases up to the Spillway Design Flood (SDF). Rapid removal of flood storage in the WCAs is limited due to the slow movement of water in the densely vegetated WCAs, relative to the potentially high rates of inflows that come from upstream structures combined with rainfall. The relatively flat terrain and dense vegetation often lead to sloping pool conditions in the WCAs and backwater effects. When conditions in the coastal canals permit, some additional releases to tide can be made by SFWMD from the WCAs. The peak SPF stage in WCA 1 is approximately 18.3 feet NGVD with a concurrent total storage of approximately 494,000 acre-feet. The peak SPF stage in WCA- 2A is approximately 16.6 feet NGVD with a concurrent total storage of approximately 596,000 acre feet. WCA 3A storage is approximately 2.7 million acre-feet when the headwater at the S-12s is 12.4 feet NGVD. Analysis conducted in 2011 indicated that the current configuration of WCA 3A inflow and outflow structures would result in a peak SPF elevation within WCA 3A (3-gauge average) of 15.20 feet NGVD, which corresponds to a headwater of the S-12s of 13.76 feet NGVD. The levees around the WCAs were generally based on minimum freeboard requirements above the SPF water surface profile (3.0 feet in WCA 1 and 2.5 feet in WCA 2A and 3A).

The USACE is currently nearing completion of an updated WCA flood routing analysis study, the Baseline and Modification Model (BAMM). The intent of the BAMM study is to identify and quantify

the cumulative changes to design stage and flow conditions within the WCA system (WCA 1, WCA 2, and WCA 3) due to infrastructure and operational changes that have occurred since the originally authorized C&SF design. The BAMM effort includes development of a new regional flood routing model and model simulations of SPF hydraulic routings for each of the WCAs. The BAMM flood routing results will be used by the USACE to conduct comprehensive risk analysis of levees and structures within the WCAs, including hydraulic, hydrological, geotechnical, and structural engineering, if results warrant. The USACE will evaluate any substantial WCA design deficiencies and determine the resulting path forward based on human health and safety and other C&SF Project requirements.

7.4.2.2 ENP-South Dade Conveyance System

The C&SF Project features in South Miami-Dade County maintain optimum stages for the purposes of flood control, water supply, groundwater recharge, and prevention of saltwater intrusion. The C-111 Basin spillways (S-196, S-194, S-176, S-177, S-18C, and S-197) were designed to pass 40 percent of the SPF without exceeding design stages, and to control releases during floods in excess of design to prevent damaging velocities at the structures and in the canal.

7.4.2.3 Lake Okeechobee and the Everglades Agricultural Area

Releases can be made from Lake Okeechobee and the EAA to the WCAs. To maintain EAA canal levels, EAA canal water is typically pumped into STAs or, if necessary during storm events, to the WCAs. For more detailed discussion, refer to SOM Volume 3, Lake Okeechobee and Everglades Agricultural Area.

7.4.3 Water Quality

The State of Florida is responsible for regulating water quality and is responsible for achieving state water quality standards. USACE is responsible for developing water control plans for operation of the C&SF system. SFWMD, acting on behalf of the state, may petition the USACE for operational changes within the C&SF system where it sees that water quality benefits may be achieved in the project area. USACE considers such requests and whether they interfere with achievement of the project's authorized purposes.

The consent decree in United States v. South Florida Water Management District, Case No. 88-1886-Civ-Moreno ("Consent Decree"), a 1988 lawsuit the United States filed against the State of Florida, commits the State to taking such action as is necessary so that waters delivered to the ENP and Loxahatchee National Wildlife Refuge (Refuge, or WCA 1) achieve state water quality standards. The Federal (USACE, ENP, and the Refuge) and State parties (SFWMD and FDEP) agreed that the actions set forth in the Consent Decree were necessary to halt or prevent imbalances in natural populations of aquatic flora and fauna and other water quality violations in ENP and the Refuge. The Consent Decree is still being implemented and its requirements, among other things, include State construction and operation of Stormwater Treatment Areas (STA). The State has constructed and is operating the STAs.

The consent decree provides for a Technical Oversight Committee (TOC), with a representative from each settling party, to make technically based recommendations concerning research, monitoring and Consent Decree compliance. The TOC regularly discusses the status of compliance and potential causes when there are exceedances of consent decree limitations.

Appendix A of the Consent Decree sets flow dependent limits on total phosphorus for water discharged into ENP Shark River Slough (SRS). Generally, increased water flows across Tamiami Trail results in a lower allowable phosphorus concentration limit. The Long-Term Limit for ENP Shark River Slough has a fixed lower total phosphorus concentrations limit (7.6 ppb annual flow-weighted mean - FWM) and does not prevent or limit flows that exceed base period flows as observed in Appendix A.

Since the Parties entered into the Consent Decree, there have been water quality concerns associated with flows to the Everglades Protection Area (EPA) which includes ENP, the Refuge and the Water Conservation Areas. The SFWMD, FDEP, and USEPA engaged in technical discussions starting in 2010. In 2012, the State committed to a suite of additional water quality projects, known as Restoration Strategies, to address then existing flows to the EPA and work in conjunction with the STAs constructed under the Consent Decree to meet the Water Quality Based Effluent Limit (WQBEL) established for the STAs. The WQBEL and Restoration Strategies were incorporated into the Clean Water Act National Pollutant Discharge Elimination System (NPDES) permit and associated State Consent Order, which were endorsed by USEPA. Work on Restoration Strategies began immediately and that work is scheduled, pursuant to the NPDES permit and Consent Order, to be completed and fully operational by the end of 2025. Based upon current and best available technical information, he State, USACE and its federal partners believe at this time that the State Restoration Strategies, implemented in accordance with the NPDES permit and Consent Order along with the STAs constructed under the Consent Decree, will be sufficient and are anticipated to achieve water quality requirements for existing flows to the EPA. In the interim, the upstream pollution control remedies being implemented under State law, the Consent Decree STAs, and constructed components of Restoration Strategies are making significant progress in reducing phosphorus levels entering the EPA. Based on the State of Florida's current implementation schedule for Restoration Strategies, confirmation of attainment of the WQBEL for inflows to the EPA will require up to five years of monitoring after the features are fully functional in 2025.

COP represents a significant step in changing C&SF operations to redistribute flows and increase water volume to ENP above existing flows. COP has been formulated and evaluated based on the existing inflows to the EPA, consistent with the assumptions used for the development of Restoration Strategies.

The USACE and its Federal and State partners recognize that achieving long-term hydrologic improvement may temporarily impact water quality, particularly as measured by the current Consent Decree Appendix A compliance methodology. Because COP will significantly alter the timing and distribution of flows into ENP, while also increasing the volume of water delivered to SRS, the Federal parties conducted a water quality evaluation to assess the effect of COP on compliance with Appendix A. That analysis shows that COP has the potential in the near term to result in more frequent exceedances of the Appendix A limits due to the following: 1) the redistribution of flows from west to east across Tamiami Trail; 2) higher flow volumes across Tamiami Trail into ENP, an increase from 571k to 733k acre-feet average annual flows (a 28% increase), that will result in lower Appendix A limits; and/or 3) increased volume and duration of flows during low-stage water deliveries through the S-333 and S-12D to SRS, when localized higher phosphorus concentration water predominates. The potential water quality impacts associated with COP are directly influenced by the quality of water delivered to the upstream areas (WCA 3A) and low water conditions in WCA 3A. Restoration Strategies are expected to address the upstream water quality concerns associated with the nutrient levels in the water delivered to WCA 3A. Components of the CERP Central Everglades Planning Project (CEPP) project (including plugs along the Miami canal, the Blue Shanty flowway, and distributed inflow

points at the northern boundary of WCA 3A from the EAA basin) are expected to improve sheetflow and reduce dryout conditions in WCA 3A. Once Restoration Strategies are fully implemented, the WQBEL is achieved and the CEPP features are completed, the increased flows expected to be delivered to the NESRS should not result in any increased potential for violations of Appendix A.

To address the potential near-term water quality concerns associated with the increased COP flows to the NESRS before the WQBEL is achieved and the CEPP features are completed, the multi-agency water quality sub-team evaluated potential water quality mitigation strategies by leveraging sensitivity modeling simulations with the RSM-GL. Based on review of the modeling results, the analysis conducted by this team found that through the application of water quality adaptive management strategies, water quality could be improved relative to the COP No Action baseline (ECB19RR) and Alternative Q by the year 2023. Alternative Q showed a potential for an increased average FWM as compared to the baseline if Alternative Q was implemented in 2018. Alternative Q also indicated an increased phosphorous loading delivered at concentrations above 8 ppb under 2018 conditions. Implementation of the water quality adaptive management measures indicated water quality improvement for the water delivered to NESRS under 2023 conditions. This improvement was measured by the reduction of nutrient loading delivered by flow concentrations above 8 ppb as compared to the baseline and Alternative Q. Using adaptive management water quality strategies, the NESRS annual FWM was able to match ECB19RR (baseline) under 2023 conditions.

Consistent on the authorizing legislation for the MWD and C-111 South Dade Projects, the COP formulation goals and objectives prioritized restoration of natural hydrologic conditions in ENP over other identified planning considerations, including water quality. As part of the development of COP, several operational strategies were modeled and incorporated into the COP AMMP (Appendix C of the COP EIS) and the COP Water Control Plan to address potential impacts on hydrology and water quality performance. These actions include 1) limited delays/flow reductions in releases to the ENP during the dry season to wet season transition 2) shifting S12D flows to S12C temporarily and 3) reducing dry season recession rates in WCA 3A by reducing releases from WCA3A when the three gage average is at or below 10 ft. starting Dec 1st. The AMMP further details the specific criteria and triggers for these actions which are expected to reduce high nutrient pulses to ENP during the dry season to wet season transition. The intent is to implement these minor operational adjustments to improve water quality via the operational flexibility allowed under adaptive management. The venue to discuss the implementation of these measures would be the periodic scientist meetings. Weather projections, current stage conditions, wildlife conditions, etc. would need to be considered and discussed in the periodic scientist meeting before implementing any of the measures to improve water quality deliveries.

Many of the water quality concepts outlined in CEPP may also be considered during the implementation and operation of COP. In an effort to address these potential impacts and determine updates to Appendix A to reflect increased inflows into ENP since the Consent Decree was entered, the parties to the Consent Decree have established a process and scope for evaluating and identifying necessary revisions to the Appendix A compliance methodology utilizing the scientific expertise of the TOC. The TOC may consider all relevant data, including the 20 years of data collected since Appendix A was implemented. Ultimately, such evaluations and changes to the Appendix A compliance methodology would be recommended by the Consent Decree's TOC for potential agreement by all parties.

7.4.4 Water Supply Operations

SFWMD allocates water to various existing legal users. Some of the beneficial uses that have been identified specifically in legislation or later approved plans are water supply for municipal and industrial use, agricultural irrigation, the ENP, and for salinity control and dilution of pollutants in project canals.

Low coastal elevations over highly porous formations, combined with extensive groundwater use, require critical management of surface and groundwater levels to control saltwater intrusion. Water supply releases can be made from the WCAs, or transferred from Lake Okeechobee, to the coastal areas to prevent saltwater intrusion and recharge the surficial aquifer system. Inland movement of saltwater in tidal canals and streams is basically a function of the relative densities of freshwater and saltwater, the rates of freshwater discharge, and tidal action. The coastal spillways prevent a saltwater wedge from moving up the canals and supporting maintenance of a sufficient freshwater head to prevent saltwater intrusion in the aquifer.

The surficial aquifer system, including the water table and Biscayne aquifers, underlies approximately 3,000 square miles of Miami-Dade, Broward, and southern Palm Beach counties. It is a surficial, highly permeable, wedge-shaped aquifer that is approximately 200 feet thick at the coast but thins to a few feet thick near its western boundary 35 to 40 miles inland. The surficial aquifer system provides water for six water use categories established by the DEP (public water supply, domestic self-supply, industrial and power generation water supply, agricultural and landscape irrigation) along the southeast coast. Seepage and water supply releases from the WCAs prevent saltwater intrusion along the coast and recharge the surficial aquifer system.

At times, water supply releases are also made from the WCAs to the EAA. The WCAs can function to store water from rainfall events which may later be released when additional water is needed in the developed areas and ENP.

One of the objectives of the C&SF Project is to increase the water supply to ENP by reducing flow to the east coast during wet periods and to retain enough water in storage to meet water supply needs of the project area. When there is insufficient water available in the WCAs, water is transferred from Lake Okeechobee through the WCAs to meet water supply needs. SFWMD can make water supply releases to the east coast from the WCAs through S-5A(S), S-39, S-38, S-143, S 141, S-142, S-34E, S-31, S-337, S-151, and S-333.

In order to prevent salt-water intrusion and meet water supply demands in the ENP-SDCS south of S-331, deliveries typically begin when the water levels fall below the stages listed in **Table 7-1**. These stages are not meant to be maintained at these levels because even with water supply deliveries, the water levels in the canals usually decline considerably below these stages. For additional operating criteria, refer to section 7.4.9. Under COP, it is anticipated that water supply deliveries to the SDCS will not be needed when S-356 is pumping. If S-356 is pumping and S-334 and/or S-335 are to be utilized to deliver water supply to SDCS, then S-356 will stop pumping.

Table 7-1. Water Supply Deliveries Allowed when Approaching Identified Canal Stages in ENP-South Dade Conveyance System.

Canal	Reach	Elevation (feet NGVD)
Levee 31N Borrow Canal	S-331/S-173 to S-176	4.0
Canal 111	S-176 to S-177	3.0
Canal 111	S-177 to S-18C	2.0
Canal 111	S-18C to S-197	1.0

7.4.5 Recreation

Recreation is an authorized project purpose for the C&SF Project including the WCAs. WCA 1 is designated as the Arthur R. Marshall Loxahatchee National Wildlife Refuge (LNWR). WCAs 2 and 3 together compose the Everglades and Francis S. Taylor Wildlife Management Area (EWMA), which are managed by Florida Fish and Wildlife Conservation Commission (FWC). There are abundant recreational facilities within the project area, both private and public. The Greater Everglades, which includes ENP, the EWMA, and LNWR provide opportunities for sightseeing, wildlife viewing, photography, hiking, bicycling, boat touring, boating, kayaking, canoeing, camping, fishing, and hunting. ENP receives over a million visitors per year, as does the EWMA, while LNWR receives about 400,000 visitors annually. Recreation in these areas increases tourist activity and provides economic benefits to the communities within and surrounding the area. Recreation is considered in the decision-making process and may influence water management operations on rare occasions.

7.4.6 Fish and Wildlife

Preservation of fish and wildlife is an authorized project purpose. WCAs 1, 2, and 3 are public hunting and fishing areas and provide exceptional opportunities for high quality wildlife-dependent recreation. Florida Bay and the Gulf Coast region of ENP also provide excellent fishing opportunities. The effects of the regulation schedules on fish, wildlife, and vegetation in the WCAs were and are important considerations in determining seasonal water levels along with recession and ascension rates. The regulation schedules for WCAs 1, 2A, and 3A include a "floor" elevation; these are minimum levels (14.0 feet, 10.5 feet, and 7.5 feet NGVD respectively) that were established to help reduce adverse impacts on fish and wildlife resources. The WCAs also preserve an Everglades wetland environment interspersed with tree islands that provide important habitat for a diversity of plant and wildlife species. These tree islands habitats can be adversely affected by prolonged high water conditions.

7.4.6.1 Protected Species and Their Habitat

Twenty-four federally-listed threatened and endangered species are either known to exist or potentially exist within the Everglades (WCAs, ENP, coastal areas) including the Florida panther, Florida manatee, smalltoothed sawfish, Cape Sable Seaside Sparrow, Everglade snail kite, wood stork, American alligator, American crocodile, and Eastern indigo snake. In addition, designated critical habitat also occurs in the area including: marl prairie areas in ENP and the East Everglades for the CSSS; all of WCA 3A, all of WCA 1, and portions of SRS for the Everglade snail kite; coastal areas along Florida Bay for the American crocodile; and coastal areas around ENP for the Florida manatee.

State-listed species in the Everglades include the Big Cypress fox squirrel, Everglades mink, Florida sandhill crane, little blue heron, reddish egret, roseate spoonbill, Southeastern American kestrel, and tricolored heron. The Everglades contain some of the largest and most important wading bird colonies in North America. The EWMA provides numerous and abundant nesting opportunities for Florida's wading birds, and the Alley North colony in WCA 3A is often the largest colony in the greater Everglades.

7.4.6.2 Terrestrial Wildlife

Terrestrial wildlife, such as deer, marsh rabbits, bobcats, and raccoons, are native and common within the WCAs. During periods of high-water levels, resident deer and other terrestrial mammals in WCA 3A can be negatively impacted to the point of population reduction. As water levels rise, terrestrial wildlife respond by moving to elevated locations such as tree islands, spoil islands, and surrounding levees. As water levels continue to rise, the areas of high ground become more limited, making large and small mammals much more vulnerable to stress, disease, starvation, and predation. When restricted to higher ground, preferred food sources are limited, and wildlife must resort to less nutritious foods. Over time, fat reserves become exhausted and malnutrition and death will occur. The FWC and USFWS monitor conditions and provide important information when there is concern that high-water levels could negatively affect wildlife populations and their habitats

In the EWMA, the deer herd management goal is to maintain the density at or slightly below the predicted high-water carrying capacity. To assist with this goal, management strategies such as antler restrictions, conservative harvest rates, careful monitoring of the deer herd, public access restrictions during periods of high water, and ecological recommendations provided to water managers are used. A large proportion of an Everglades deer diet is aquatic herbs (Labisky 2003, Loveless 1959). Everglades deer are generally healthy and free of parasites and disease, but when deer are crowded on elevated sites and suffering from stress and malnutrition, there is increased susceptibility to parasitism and disease associated with malnutrition (Loveless 1959).

Water levels in WCA 3A exceed the FWC high water criterion when the combined average of the Site 62 and Site 63 gauges is greater than 11.60 feet NGVD. Under these conditions, essential wildlife behaviors are disrupted, recreation is impacted, and public access may be limited by FWC Executive Order. Prolonged high-water levels pose an increasing threat to state and federally listed species, and high water conditions that last longer than 60 days are detrimental to wildlife health and habitats, and can have long-lasting impacts. The FWC position paper entitled Hydrologic Requirements for the Everglades and Francis S. Taylor Wildlife Management Area dated November 20, 2013 (https://myfwc.com/media/6679/4bevergladespositionpaper.pdf) provides biologically based guidance for managing water levels to ensure the conservation, protection, and restoration of fish and wildlife populations, habitats, species diversity, and cultural resources. FWC biologists use deer as an indicator of increased wildlife use of levees and under normal conditions, less than 10 deer will be observed during a spotlight survey on the L-5 levee. The observation of more than 10 deer on the L-5 levee is an indicator that high water conditions are having a detrimental effect on wildlife health and habitats. FWC biologists report wildlife monitoring results through the existing WCA 3 Periodic Scientists Call.

When water levels exceed the FWC high water criterion and impacts are imminent, FWC Commissioners or the Office of the Executive Director may call an Emergency High Water Meeting. USACE, USFWS, DOI, SFWMD, FDEP, FDACS, and Tribes may be invited to attend in order to share information, assess the status of the regional water management system, and develop management

strategies and options for relief from high water conditions that create deleterious ecological conditions.

7.4.7 Navigation

There are no authorized project features for navigation however, recreational boating in ENP and the WCAs and associated project canals is very popular. The minimum stages for the conservation pools in the WCAs help reduce adverse impacts on recreational boating during drought periods.

7.4.7.1 Access to Cultural Areas Downstream of S-12A

To provide the Miccosukee Tribe of Indians of Florida (Miccosukee Tribe) access to cultural areas S-12A may release up to 100 cfs upon request from the Tribe during periods of time when the structure would have otherwise remained closed. From 1 October through 14 July, the USACE must request consultation with USFWS to avoid impacts on CSSS subpopulation A. During the 1 October through 14 July time period, the duration of this release would not exceed five consecutive days. The initial release would be managed as a field test to determine any potential effects associated with the release on CSSS subpopulation A. If no adverse impacts occur, subsequent releases would be coordinated and monitored appropriately.

During the decision making process to determine whether to implement a request from the Miccosukee Tribe to release up to 100 cfs through S-12A, hydro-meteorological data such as, but not limited to, NP-205 water elevation, rainfall, and rainfall forecasts will be utilized. Other pertinent details related to this decision making process are in the USFWS BO for ERTP:

http://www.saj.usace.army.mil/Missions/Environmental/Ecosystem-Restoration/G-3273-and-S-356-Pump-Station-Field-Test/

During implementation of the S-12A up to 100 cfs release for access to Miccosukee Tribe cultural areas, relevant environmental data will be monitored. If NP-205 stage is observed to increase or anticipated to increase above 5.7 feet NGVD, S-12A will be closed. A water level gauge (SPARO) located between S-12A and NP-205 also provides additional insight into the effectiveness of S-12A releases for providing access to cultural areas and S-12A but still avoiding impacts on CSSS subpopulation A.

7.4.8 Overall Plan for Water Management

7.4.8.1 Water Conservation Areas

The WCAs, located south and east of the EAA and west of the urbanized East Coast, comprise an area of about 1,350 square miles (approximately 864,000 acres)(See Figure 7-1). The WCAs make up a large segment of the original Everglades. Water typically enters these areas following treatment from one of the STAs. Flow across the WCAs is generally slow due to flat slopes and relatively dense vegetative cover, and significant backwater effects can develop. The flat ground slopes and dense vegetation often lead to sloping pool conditions observed by different stages in the interior and outer portions of the WCAs. An interior levee across the southern portion of WCA 2 subdivides it into WCA 2A and 2B. This levee reduces water losses due to seepage into the extremely porous aquifer that underlies WCA 2B, and obviates the need to raise existing levees to the grade needed to provide protection against wind tides and wave run-up. Two interior levees, L-67A and L-67C run diagonally from pump

station S-9 in a southwest direction to S-333 subdividing WCA 3 into WCA 3A and 3B. These levees reduce water losses due to seepage into the porous aquifer that underlies WCA 3B.

Regulation schedules contain instructions and guidance on how project water management structures are to be operated to maintain water levels in the WCAs. The regulation schedule essentially represents the seasonal and monthly limits of storage which guides project regulation for the planned purposes. The regulation schedules vary from high stages in the late fall and winter to low stages at the beginning of the wet season. This seasonal range permits the storage of rainfall and runoff during the wet season for use during the dry season. In addition, it serves to maintain and preserve the vegetative regime including tree islands in the WCAs, which are essential to fish and wildlife and the prevention of wind tides. Regulation schedules must take into account the various and sometimes conflicting project purposes.

Conceptually, reservoir storage is commonly divided into the inactive zone, the water supply (conservation) zone, and the flood control zone. The distribution of water between the flood control and water supply zones varies seasonally in the WCA's. The regulation schedules for WCAs 1, 2A, and 3A include a “floor” elevation or minimum levels (14.0 feet, 10.5 feet, and 7.5 feet NGVD respectively) below which water releases from the WCAs must be preceded by an equivalent volume of inflow. Note that this does not mean that a minimum stage is maintained in the WCAs. When water levels fall below the minimum levels, transfers from Lake Okeechobee or the WCAs are made to meet water supply demands. For example in WCA 3A, if the water level measured at the Site 3-69W gauge fell below 7.5 feet NGVD, water could be transferred from Lake Okeechobee and/or WCA 2A through WCA 3A to meet water supply demands.

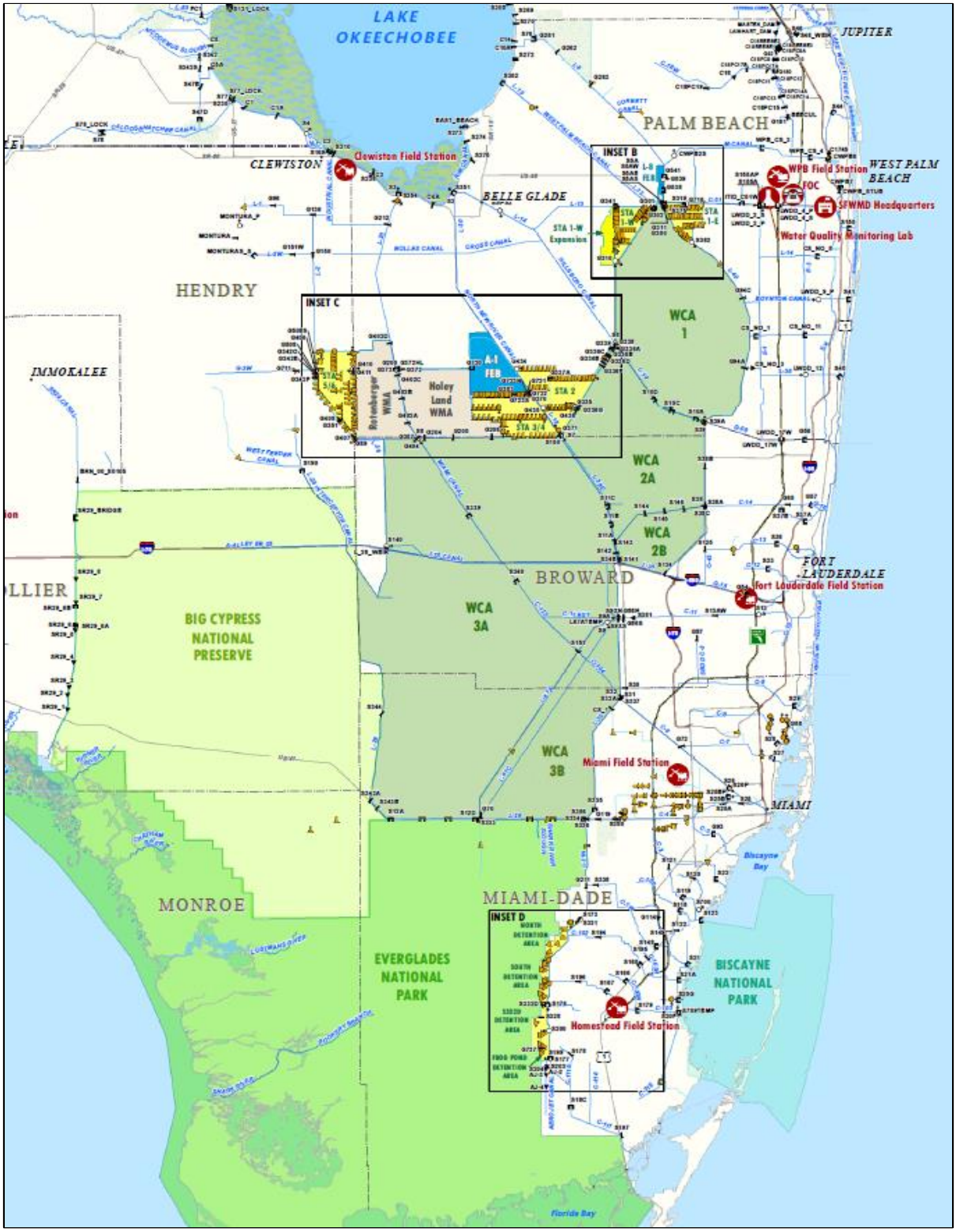


Figure 7-1. Infrastructure Map.

7.4.8.1.1 Water Conservation Area 1

WCA 1 resides within the Arthur R. Marshall Loxahatchee National Wildlife Refuge (LNWR) (see **Figure 7-2**) boundary which has an area of 221 square miles and is completely contained by Levees 7, 40 and 39. Inflows to the area were previously controlled by pump stations S-5A and S-6 (until 2000 when S-6 pump station flows were routed south for treatment in STA-2 and discharge to WCA 2A). These pump stations are designed to remove 3/4 of an inch of agricultural area runoff from their tributary drainage area per day. S-5A pumps water from the West Palm Beach Canal and has a design capacity of 4,800 cfs. S-319 also pumps water from the West Palm Beach Canal with a design capacity of 3,980 cfs to provide flood protection to the C-51W Basin. WCA 1 inflows (S-5A and S-319) are directed through STA-1E and STA-1W whose releases are now the primary inflows to WCA 1. Releases for STA-1E are through S-362 and releases from STA-1W are through G-310 and G-251 into WCA 1. In the event of extreme high water, inflows to WCA 1 may be diverted untreated through G-300, G-301 and G-338 which are SFWMD structures. S-6 may also operate in conjunction with G-338 to send untreated water to WCA 1 in the event of extreme high water upstream of WCA 1.

WCA 1 is regulated primarily by the S-10s, which consists of three spillways; S-10A, S-10C, and S-10D. The design capacity of the S-10s is 14,800 cfs under SPF stages. Water can also be discharged to the east into the Hillsboro Canal via S-39. This is a single bay gated spillway with a design capacity of 800 cfs. S-5A(S) can be used to discharge water from WCA 1 to the L-8 Borrow Canal and the West Palm Beach Canal.

The WCA 1 regulation schedule is shown in **Figure 7-3**. From 1 January through 30 June the indicator water level gauge for regulation is 1-8 Canal (1-8C). During 1 July through 31 December the 1-8C gauge is used as the indicator gauge, except during rising stages when the 1-8C stage exceeds the average of the interior gauges, 1-7, 1-8T, and 1-9. In that case, the average interior stage (gauges 1-7, 1-8T, 1-9) is used as the indicator stage. S-10s have no required minimum low flow discharge. The regulation schedule is intended to produce favorable conditions for wetland fish and wildlife resources, including species listed under provisions of the ESA. This schedule was put into effect to achieve the benefits of allowing higher water levels during wet years in the northern portion of the LNWR; increase the hydroperiod of interior marshes of the LNWR such that dry-out does not occur on an annual basis; increase the proportion of the interior marsh of the LNWR that serves as nursery areas for aquatic organisms; improve the timing of winter stage drawdown in the LNWR to benefit wading birds; restore conditions in the LNWR similar to those found when the areas were used by snail kites for nesting; and allow for the storage of a greater quantity of water within the C&SF system during wet and normal rainfall years.

The fourth and current WCA 1 regulation schedule was implemented in May 1995. In this scheduleZone A1 (15.75-17.5 feet NGVD) is the flood control zone from January through June. In Zone A1, releases are made up to maximum capacity at the S-10s and maximum capacity at S-39 when agreed between USACE and SFWMD. From July through December, attempts are to be made to maintain water levels within Zone A2 of the regulation schedule. In Zone A2, S-10 releases are based on USACE forecasts and water supply releases are made as needed. If Lake Okeechobee stage is above WCA 1 stage or no more than one foot below WCA 1 stage, water supply releases must be preceded by an equivalent volume of inflow. In Zone B (14.0-17.0 feet NGVD), the water supply zone, water supply releases are made from WCA 1 as needed. If Lake Okeechobee stage is above WCA 1 stage or no more than one foot below WCA 1 stage, water supply releases must be preceded by an equivalent volume of inflow. In Zone C (below 14.0 feet NGVD), the drought zone, there would be no net release

of water from WCA 1. Below this elevation no further releases will be permitted from the area unless a supply of water from another storage area is transferred to WCA 1. Experience has shown that it is difficult to draw water out of the interior of WCA 1 when the stage is below 15.5 feet NGVD.

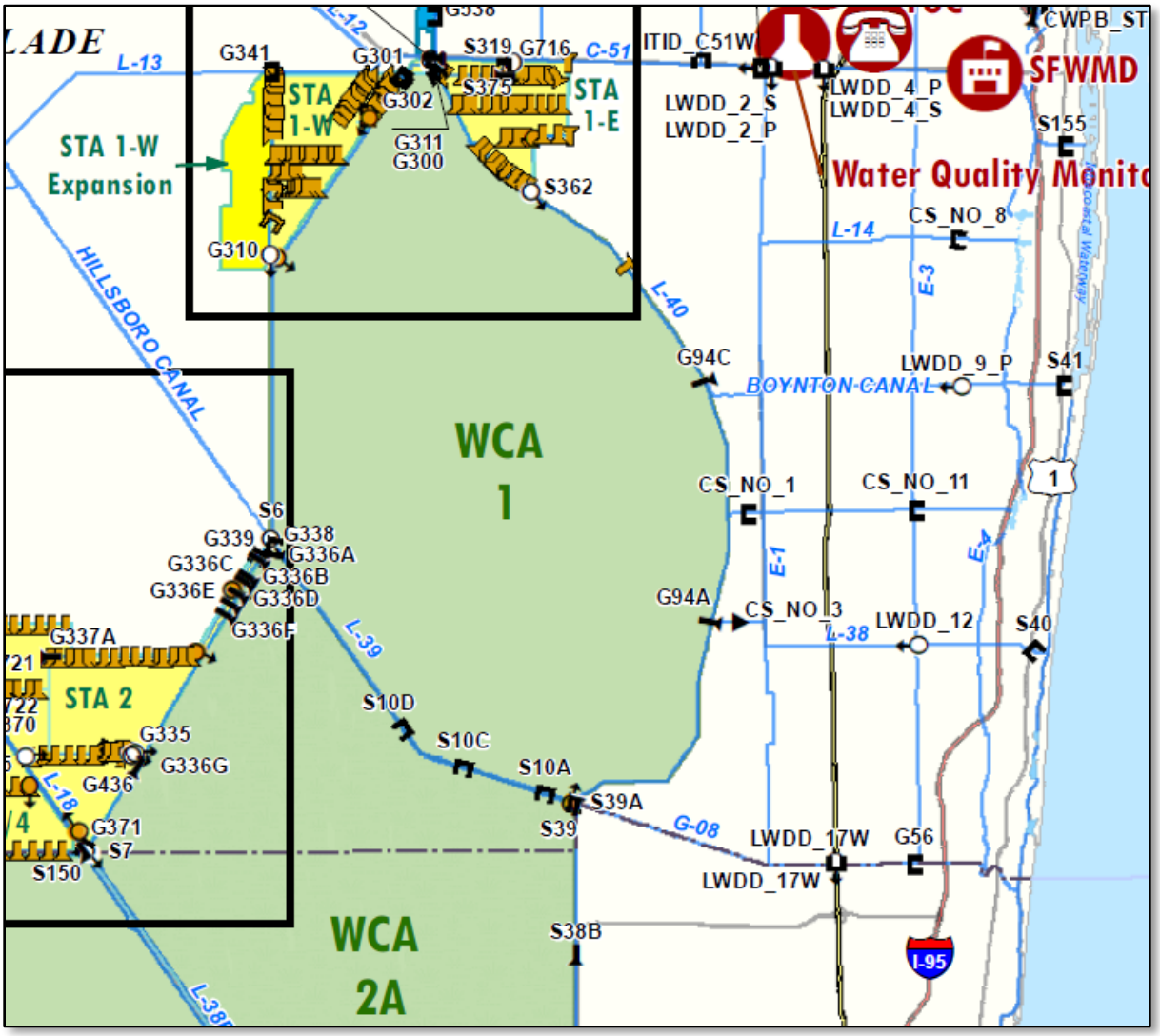
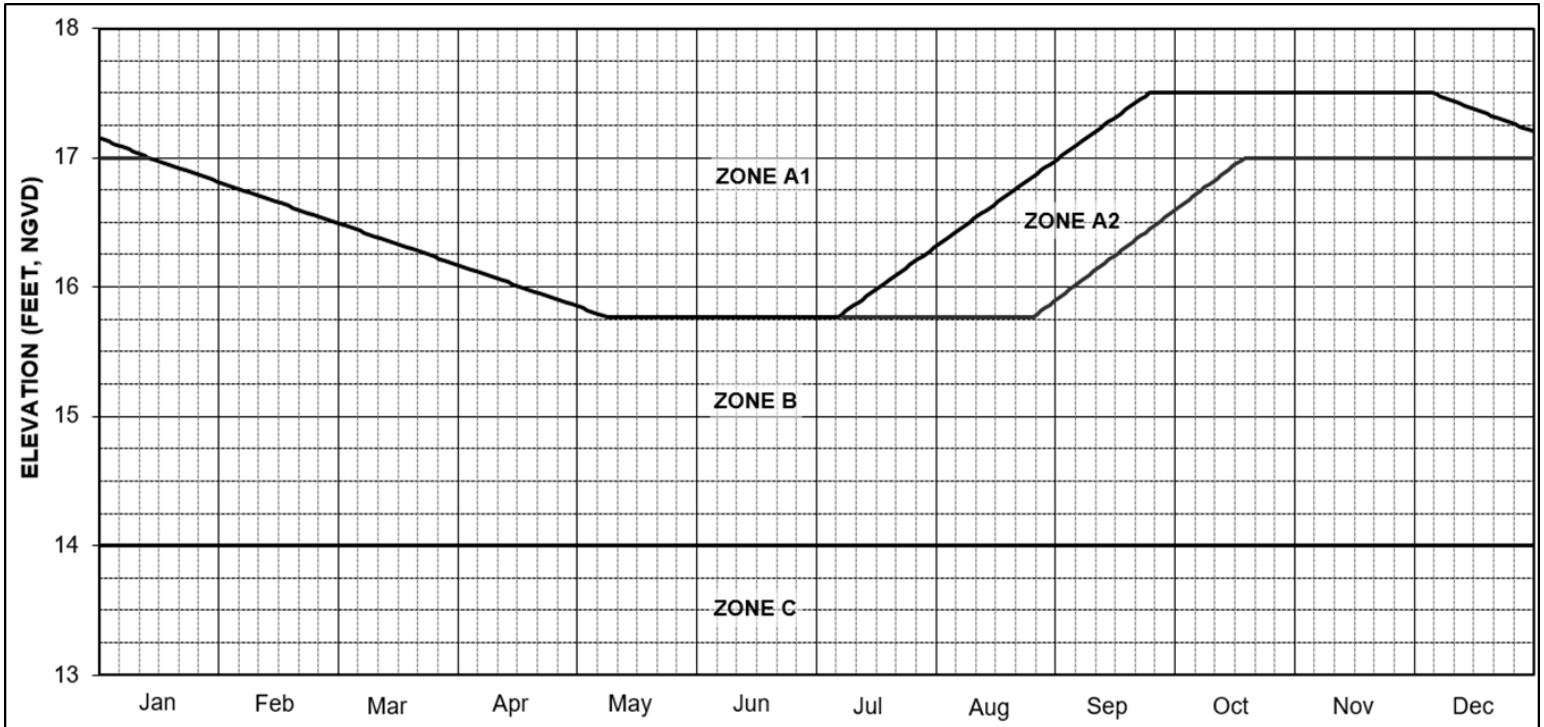


Figure 7-2. WCA 1 Map.



Zone	Releases
A1	Up to maximum at S-10 (and S-39 when agreed between Corps and SFWMD). Water Supply Released as needed.
A2	S-10 releases based on Corps forecasts. Water Supply releases as needed. If Lake Okeechobee Stage is above WCA 1 stage or no more than one foot below WCA 1 stage, then water supply releases from WCA 1 must be preceded by an equivalent volume of inflow.
B	Water supply as needed. If Lake Okeechobee Stage is above WCA 1 stage or no more than one foot below WCA 1 stage, then water supply releases from WCA 1 must be preceded by an equivalent volume of inflow.
C	No net releases from WCA 1. Any water supply releases must be preceded by an equivalent volume of inflow.

Dates	Use gauge	Conditions
1 Jan - 30 Jun	1-8 Canal	All
1 Jul - 31 Dec	1-8 Canal	Except as noted below
	Avg 1-7, 1-8T, 1-9	During rising stages when canal stage exceeds average

CENTRAL AND SOUTHERN FLORIDA PROJECT
REGULATION SCHEDULE
Water Conservation Area 1

US ARMY ENGINEER DISTRICT
JACKSONVILLE, FLORIDA
03 May 1995

Figure 7-3. WCA 1 Regulation Schedule.

7.4.8.1.2 Water Conservation Area 2A

WCA 2A lies between the WCA 1 and WCA 3 (see **Figure 7-4**). The Hillsboro Canal runs between WCA 1 and WCA 2A and the North New River Canal runs between WCA 2A and WCA 3A. In addition to the S-10s, WCA 2A receives inflow from pump station S-7 (following treatment in STA-3/4 and pump stations G-335 and G-436 (following treatment in STA-2). STA-2 releases via pump stations G-335 through culvert structures G-336A-F and G-336G into WCA 2A. The S-7 station pumps water from the North New River Canal (following treatment in STA-3/4), and has a design capacity of 2,490 cfs. Pumping begins when the canal level exceeds 11.5 to 12.0 feet NGVD, unless the water level in WCA 2A is low enough to allow gravity flow from the canal through the spillway at S-7; or the water level in WCA 3A is low enough to permit gravity flow through S-150 into WCA 3A. S-6 pumps water from the Hillsboro Canal into STA-2 and has a design capacity of 2,925 cfs. Pumping should begin when canal stages exceed 11.5 to 12.0 feet NGVD.

The main outlets from WCA 2A are the S-11s, which consists of three spillways: S-11A, S-11B, and S-11C. The design capacity of the three structures is 16,600 cfs under SPF stages. Water can also be transferred into WCA 2B through S-144, S-145, and S-146. These structures have design capacity of 210 cfs each. S-143, with a design capacity of 500 cfs, releases water to the east into the North New River Canal through S-34E. S-38, with a design capacity of 500 cfs, releases water into the C-14 canal.

The WCA 2A regulation schedule is shown on **Figure 7-5**. When the WCA 2A stage is in Zone A, releases are made up to maximum capacity at the S-11s; maximum capacity at S-144, S-145 and S-146; and maximum practicable at S-143 and S-38 when agreed between USACE and SFWMD. The L-35(B) and L-38 Borrow Canals should not be drawn down below 10.5 feet NGVD. Releases to WCA 2B from S-144, S-145, and S-146 are to be terminated if the WCA 2B stage (measured at gauge 99) exceeds 11.0 feet NGVD. In Zone B, only releases for water supply are made. From 1 January through 31 January, the Site 2-17 gauge is the indicator gauge for regulation; however, if the Site 2-17 stage recedes to 11.5 feet NGVD, the indicator gauge becomes the S-11B HW gauge. From 1 February through 30 June the S-11B HW gauge is the indicator gauge for regulation. Then from 1 July through 31 December the Site 2-17 gauge is the indicator gauge for regulation. The S-11s have no required minimum low flow discharge. During droughts a minimum elevation in the borrow canals of 10.5 feet NGVD, will be observed. Below this elevation no further releases will be permitted from the area unless preceded by an equivalent volume of inflow.

7.4.8.1.3 Water Conservation Area 2B

Regulatory releases from WCA 2B are made via S-141. S-141 is a three-bay spillway structure that controls the water level in WCA 2B, and permits releases from the area to the North New River Canal through S-34E. Whenever the pool elevation in WCA 2B exceeds 11.0 ft. NGVD, as measured at Site 99, S-141 will be operated for flood releases through S-34E if canal capacity is available and inflows from S-144, S-145, and S-146 will be suspended. Water levels in WCA 2B are mainly dependent on seepage and rainfall. A regulation schedule is not utilized for WCA 2B due to high rates of seepage from the area.

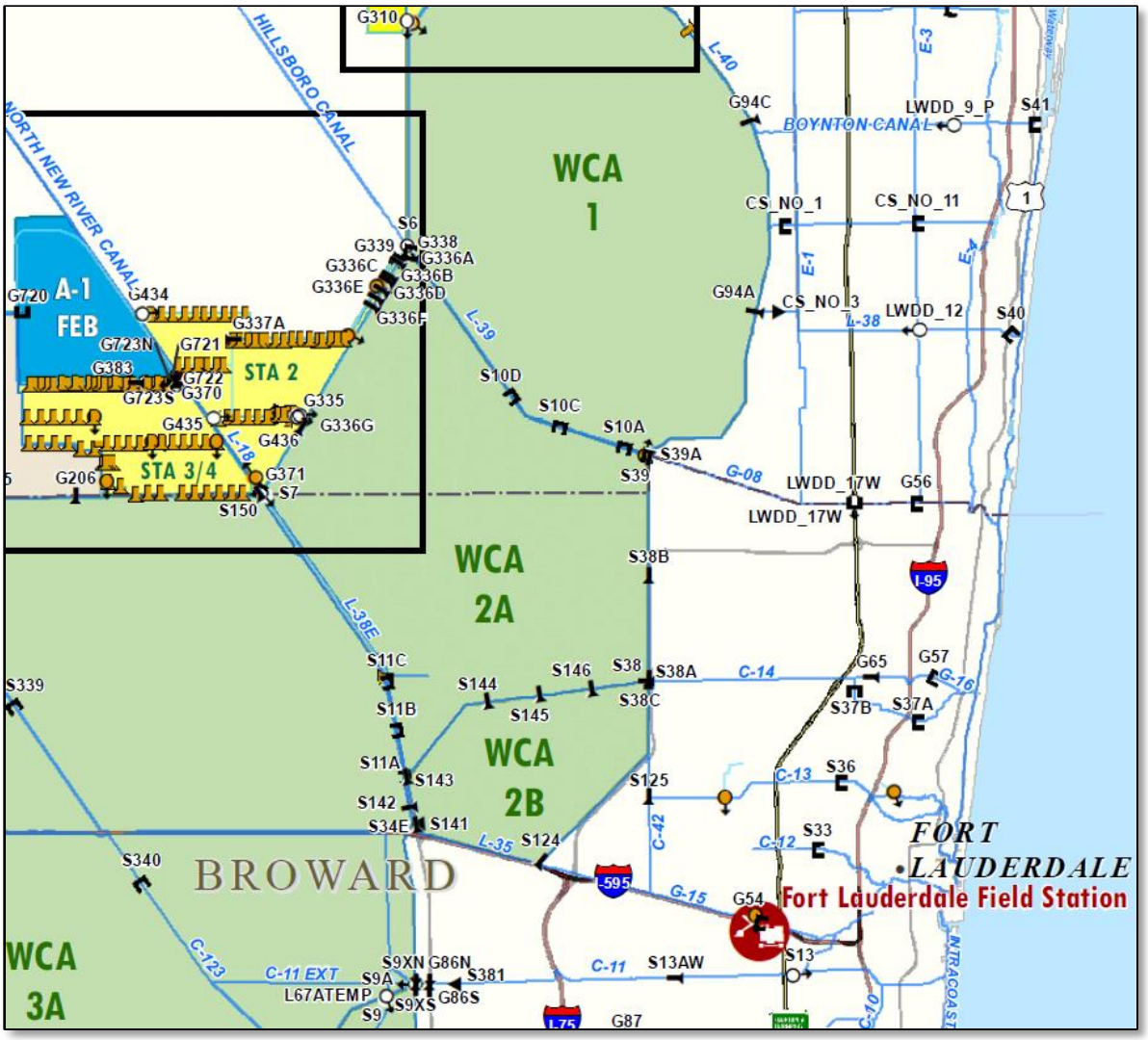
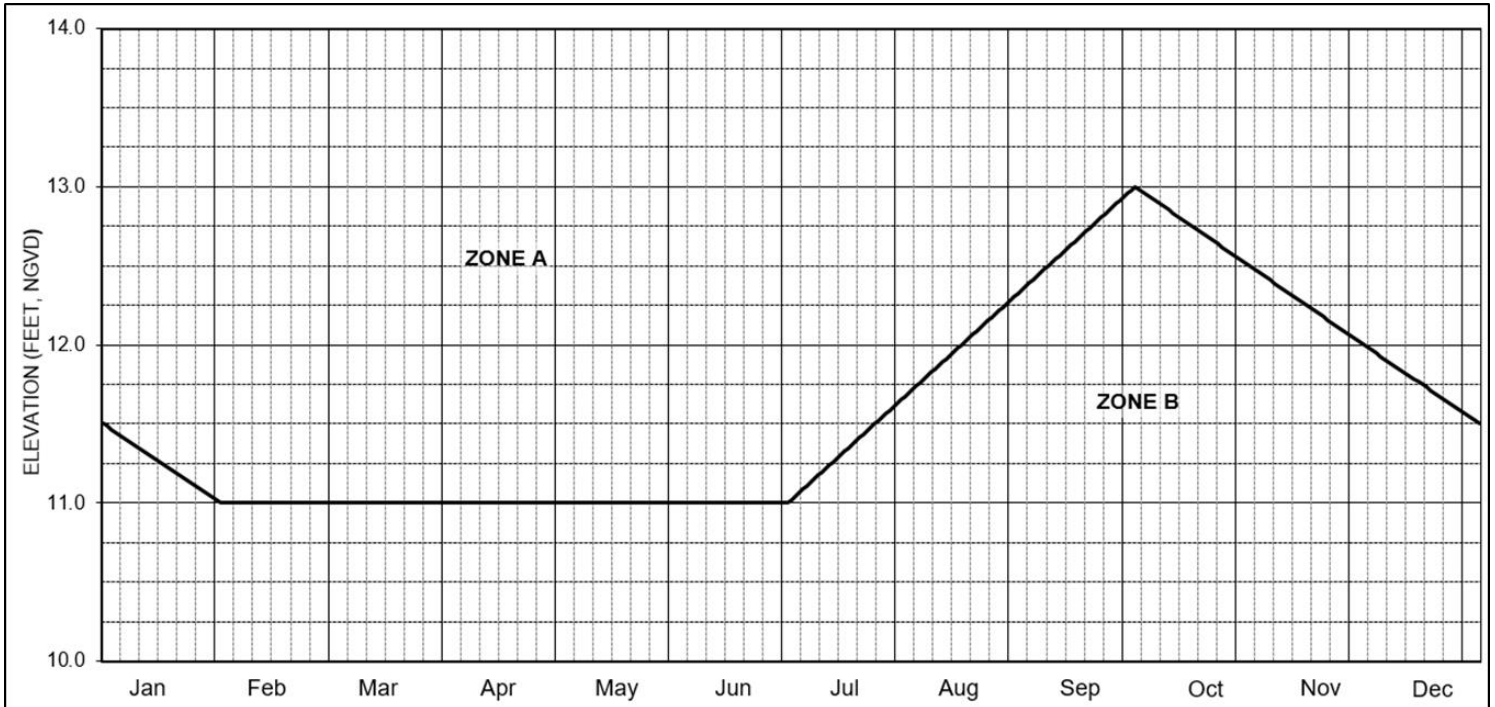


Figure 7-4. WCA 2A Map.



Zone	Releases
A	Up to maximum at S-11; Maximum capacity at S-144, 145, & 146; Maximum practicable at S-143 & S-38 when requested by the Corps of Engineers but not to exceed 11.0 ft, NGVD, in WCA 2B. L-35B & L-38 borrow canals should not be drawn down below 10.5 ft, NGVD.
B	Water supply. L-35B & L-38 borrow canals should not be drawn down below 10.5 ft, NGVD, unless water is supplied from another source.

Dates	Use gauge	Conditions
1 Jan - 31 Jan	2-17	If 2-17 stage recedes to 11.5 ft, NGVD, swithch to S-11B HW gauge.
1 Feb - 30 Jun	S-11B HW	All
1 Jul - 31 Dec	2-17	All

CENTRAL AND SOUTHERN FLORIDA PROJECT
REGULATION SCHEDULE
Water Conservation Area 2A

US ARMY ENGINEER DISTRICT
JACKSONVILLE, FLORIDA
28 March 1998

Figure 7-5. WCA 2A Regulation Schedule.

7.4.8.1.4 Water Conservation Area 3A

WCA 3A lies below STA 5/6, Rottenberger and Holey Land tracts, STA 3/4, STA 2 and WCA 2 (see **Figure 7-4**). The updated 2020 WCA 3A regulation schedule is shown in **Figure 7-7**. The WCA 3A stage is the 3 station average of gauges A-3 (Site 63), A-4 (Site 64) and A3-28 (Site 65).

In addition to receiving releases from the S-11s, WCA 3A receives inflow from S-150 and S-190 by gravity and from pumping at S-8, S-9, S-9A and S-140. Inflows from S-8 and S-150 consist of STA-3/4 and STA-5/6 treated water. S-9 and S-9A remove runoff in the east coast area from the South New River Canal (C-11W Basin) up to the design capacity of 2,880 cfs and 500 cfs, respectively. Pumping occurs at S-9/S-9A with S-381 open (deflated), to maintain the stage in the South New River Canal below 3.6 feet NGVD. When S-381 is closed, S-9A is used to return seepage from WCA 3A. S-140 removes water from the L-28 Borrow Canal up to the design capacity of 1,305 cfs. S-140 is used to maintain canal levels below 10.5 feet NGVD, unless gravity flow into WCA 3A is possible at an adequate rate. . S-190 is a gravity structure on the L-28 Interceptor Canal that releases runoff from the Western Basin into WCA 3A.

The S-12s (S-12A, S-12B, S 12C, and S-12D) and S-333 are the main sources of outflow from WCA 3A and it is through these structures that the ENP water deliveries are made. However, both S-12A and S-12B have a closure period (1 October through 14 July, with limited conditional openings during October for S-12A/B and November for S-12B) for the protection of CSSS subpopulation A (further defined in **subsection Table 7-3**). The S-12s consist of four, six-gate spillways with a combined capacity designed to be 32,000 cfs under the SPF stages. However, as noted in the Project Constraints section above, the S-12s are not capable of achieving the original design discharge. S-333 is a single-bay gated spillway with a design discharge of 1,350 cfs. S-333 also releases from WCA 3A to the ENP-SDCS for water supply and when conditions result in the transfer of S-333 releases to S-334. S-333N is being constructed adjacent to S-333 to move water from WCA 3A to L-29 Canal. The structure has a design discharge capacity of 1,150 cfs. The structure is scheduled to be constructed and operational by June 2020. This structure will be operated in accordance with FDEP permit 0362076-001 or any subsequent modifications issued to SFWMD.

S-343A, S-343B, may discharge, up to the design discharge capacity of 195 cfs each, from WCA 3A into the Big Cypress National Preserve when the WCA 3A water level is in Zone A. However, these structures also have a closure period (1 October through 14 July) for the protection of the CSSS subpopulation A. S-344 may discharge, up to the design capacity of 135 cfs, from WCA 3A to the Big Cypress National Preserve when WCA 3A is in Zone A.

S-14 was built to provide gravity drainage from the lower reaches of the Levee 28 borrow pit, via the Levee 29, Section 2, borrow pit, through the U.S. Highway 41/Tamiami Trail into ENP. However, S-14 never functioned as intended due to tailwater conditions which were higher than design assumptions and currently is not operational. The former S-12F culvert structure, equipped with stoplogs, located in the Tamiami Canal between S-12C and S-12D, has been removed and replaced with an earthen plug.

S-142, with a design capacity of 430 cfs, releases from WCA 3A into the North New River Canal through S-34E. S-151 releases from WCA 3A to the C-304 in WCA 3B for flood diversion and for the purpose of providing water supply to Miami area canals and the ENP-SDCS. S-151 may discharge up to the design discharge of 1,105 cfs subject to the headwater at S-31 not exceeding 9.0 feet NGVD.

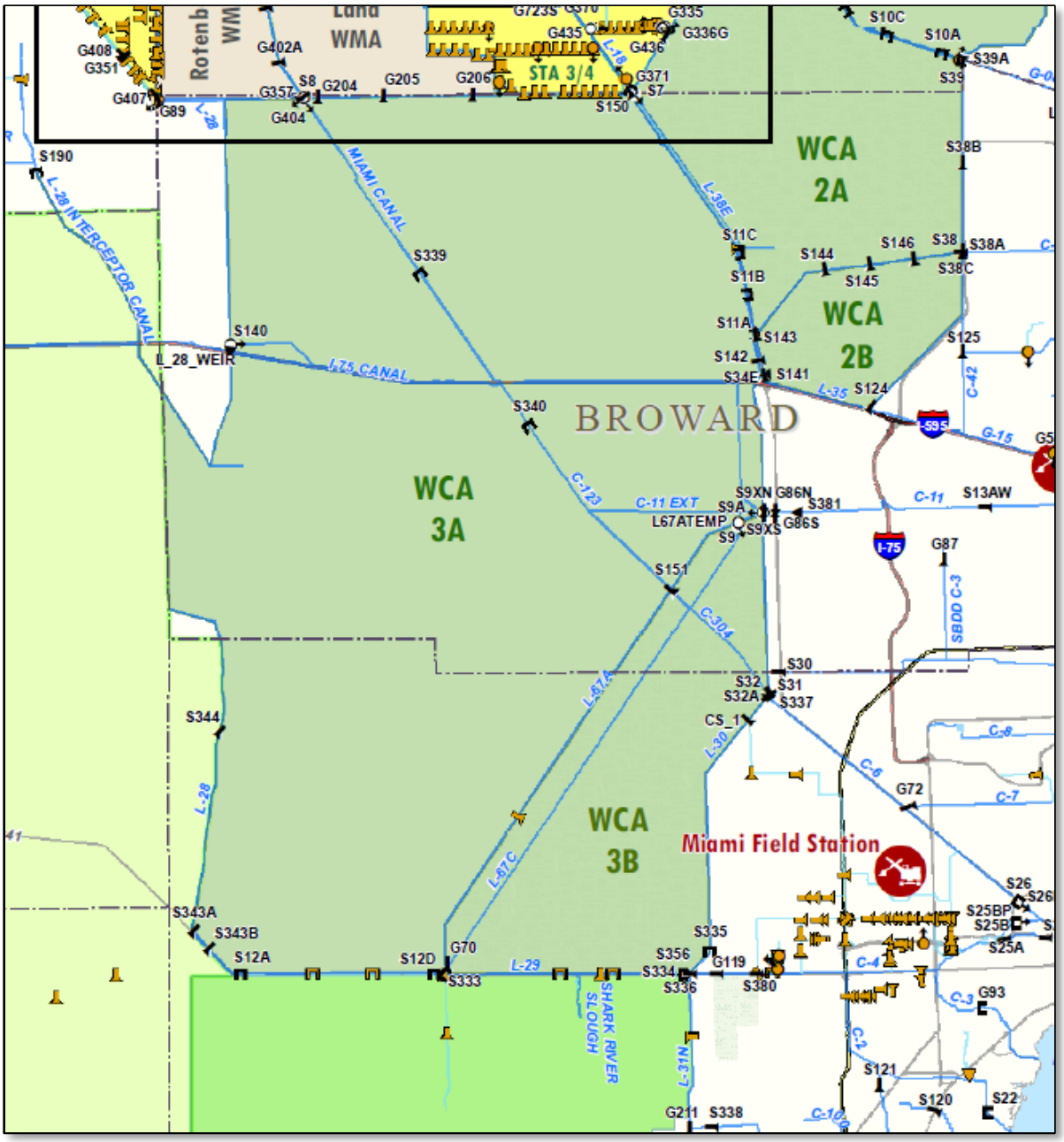
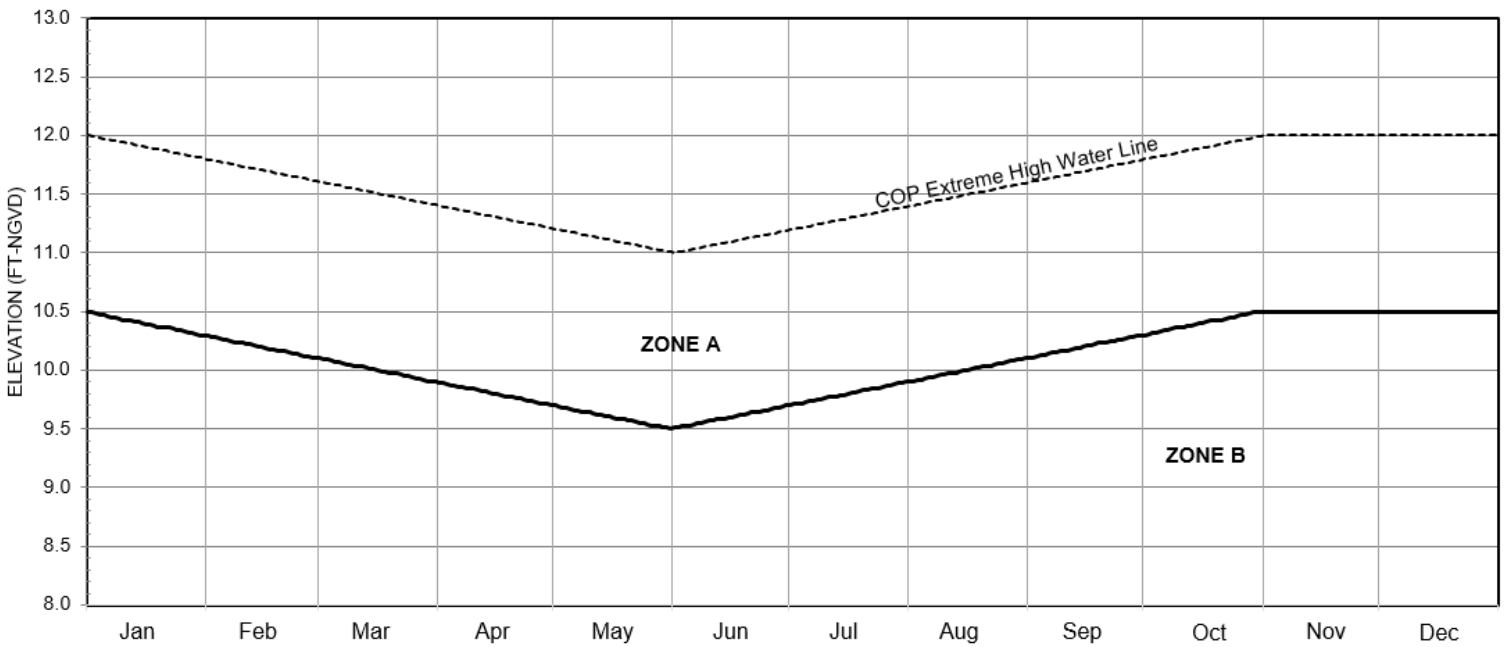


Figure 7-6. WCA 3A and WCA 3B Map.



Zone	Releases
A	Maximum releases at S-333, S-12D, S-12C, S-12B, S-12A, S-343B, S-343A, S-344, and S-151 subject to downstream constraints.
B	Up to the TTFF weekly target flows at S-333, S-12D, S-12C, S-12B, and S-12A (listed in priority order) to prioritize water deliveries to NESRS first and WSRS second, subject to downstream constraints.
Notes	S-343A and S-343B are closed from 1 October through 14 July. S-12A and S-12B are closed from 1 October through 14 July with high water exit strategy.

Condition	EHWL Releases
1	When WCA-3A stage is above the EHWL and is not projected to rise above Elevation 12.7 feet, NGVD, S-333 has the priority over S-356. S-334 may also be used up to its maximum capacity of 1,200 cfs to send water to L-31N Canal while adhering to the conveyance flow constraints identified below within the South Dade Conveyance System. Under this condition, first priority will be water deliveries to the eastern boundary structures of ENP if capacity is available.
2	When WCA-3A stage is above the EHWL and in the position analysis with the appropriate (analog) years are used (1) is projected to rise above Elevation 12.7 feet, NGVD (2) within the next 60 days, S-333 has the priority over S-356. S-334 may be utilized up to its maximum capacity of 1,200 cfs subject to SDCS flow constraints and through use of all remaining available coastal discharge structures including S-197. Extreme High Water Condition 1 priorities remain and will be maximized before sending additional water south to S-197.
3	Extreme High Water Condition 3. When WCA-3A's three gage average stage is above 12.3 feet NGVD then S-197 may be increased up to 2,400 cfs until WCA 3A water levels recede to below 12.0 feet NGVD. S-333 has the priority over S-356. S-334 may be utilized up to its maximum capacity of 1,200 cfs subject to SDCS flow constraints and through use of all remaining available coastal discharge structures including S-197. Extreme High Water Condition 1 priorities remain and will be maximized before sending additional water south to S-197.

CENTRAL AND SOUTHERN FLORIDA PROJECT
REGULATION SCHEDULE
Water Conservation Area 3A
US ARMY ENGINEER DISTRICT
JACKSONVILLE, FLORIDA
August 2020

Figure 7-7. WCA 3A Regulation Schedule.

S-152 releases from WCA 3A to WCA 3B and is part of the Decompartmentalization and Sheetflow Enhancement Physical Model (DPM) project. S-152 is a temporary structure for the DPM, which is a field-scale test that is being conducted to determine the best plan for future decompartmentalization of WCA 3, as envisioned in the Comprehensive Everglades Restoration Plan (CERP). The DPM operational window is anticipated to be from November 2017 through 2021. S-152 releases up to the design discharge of 750 cfs under the following restrictions:

- L-67A must be above 7.5 feet NGVD;
- Site 71 gauge in WCA 3B must be below 8.5 feet NGVD;
- Water quality constraint criteria per FDEP Permit Number 0304879 must be met;
- May be closed when S-355A and S-355B are closed due to L-29 canal stage constraints

S-339 and S-340 are structures on the C-123 (Miami Canal) that prevent over drainage of the northern end of WCA 3A, and force water through the marsh. These structures also provide the ability to transfer water to ENP and to Miami-Dade County canals including ENP-SDCS. These structures are normally closed, and operated according to the Operations Schedule for Canal 123, Structures 339 and 340 (**Figure 7-8**). The Site 62 (Gauge 3-2/"Deer Gauge") is the indicator gauge for operation of these structures.

When the average of the Site 62 and Site 63 gauges is 9.30 feet NGVD, water levels are on average 1.0 ft below the surface over approximately 25% of WCA 3A North. At or below this water level, the risk of muck fires is increased and FWC will close the area to public access. Muck fires burn the soil and can cause extensive damage, in particular the loss of tree islands that provide critical upland habitat for wildlife species. If the water levels reach the criteria for FWC to close the area to public access, then the same water levels (9.30 feet NGVD average of Site 62/63 gauges) will be utilized to recommend re-opening the area. However, since the Site 62 and Site 63 gauges are up to 5 miles away from the northern end of the WMA and may not reflect actual conditions near the L5 levee, where most ORV activity occurs, FWC will assess field conditions prior to re-opening the area. When the average of the Site 62 and Site 63 gauges is ≥11.60 feet NGVD, essential wildlife behaviors are disrupted, recreation is impacted, and public access may be limited by FWC Executive Order.

The 2020 WCA 3A Regulation Schedule has two zones; Zone A and Zone B along with an Extreme High Water Line (EHWL). Zone A is above Zone B and delineated by a seasonally varying line that ranges from a maximum of 10.5 feet NGVD (01 November) to a minimum of 9.5 feet NGVD. In Zone A, maximum releases at S-333, S-333N, S-12D, S-12C, S-12B, S-12A, S-343A, S-343B, S-344, and S-151 subject to the closure periods and downstream constraints and the FDEP permit in the case of S-333N. In Zone B, the WCA 3A release targets are computed by the Tamiami Trail Flow Formula (TTFF) for S-333, S-12D, S-12C, S-12B, S-12A (listed in priority order) to prioritize releases to Northeast Shark River Slough (NESRS) first and Western Shark River Slough (WSRS) second. The TTFF is further described in Section 7.4.8.1.4.1. The EHWL ranges from a minimum of 11.0 feet NGVD (01 June) to a maximum of 12.0 feet NGVD (01 November-01 Jan) and is further described in **subsection 7.4.8.1.4.2**.

The “floor” or minimum elevation for WCA 3A is 7.5 feet NGVD, at Site 3-69W. Below this elevation no further releases for water supply will be permitted from the area unless preceded by an equivalent volume of inflow.

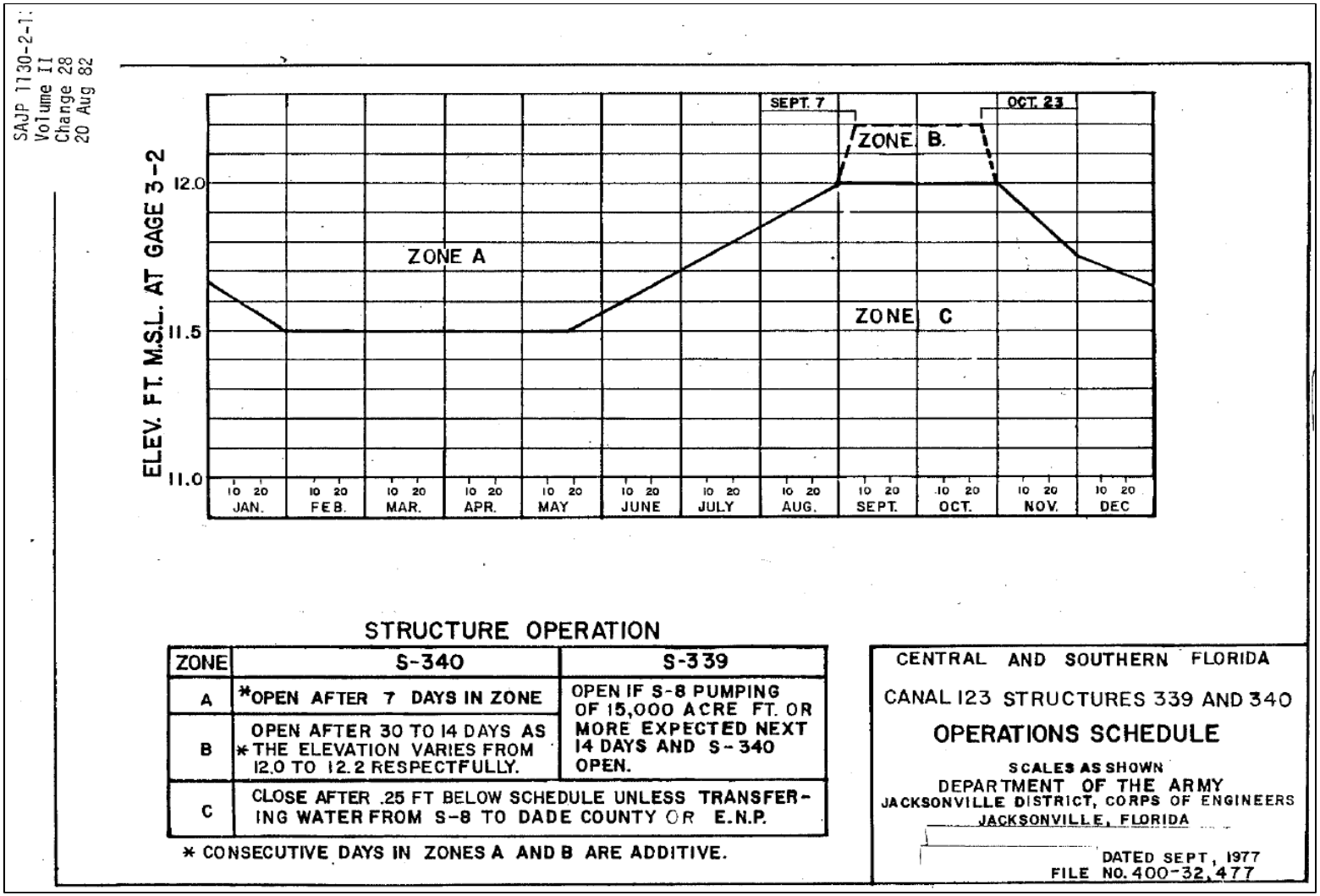


Figure 7-8. S-339 and S-340 Regulation Schedule.

7.4.8.1.4.1 Tamiami Trail Flow Formula

COP developed a set of water management operating protocols for WCA 3A and WCA 3B key outlet structures to ENP that leveraged decades of infrastructure improvements. The operational protocols shift the system towards enhanced ecosystem and landscape performance while recognizing constraints imposed by flood protection, water supply and other key systems requirements. Additionally, the operational protocols also include updating the "Rainfall Plan" (RFP) into a new "Tamiami Trail Flow Formula" (TTFF).

The TTFF replaces the Rainfall Plan and determines releases from WCA 3A (when in Zone B of the regulation schedule) to ENP and is further described in Appendix H of the COP EIS. The TTFF improves upon the RFP, achieves hydrologic targets including:

- Surface water flow deliveries that resemble more natural processes
- Gradual rate changes to deliver surface water flows
- Surface water flow distributed across the entire slough

The TTFF uses a network of stage, potential ET (PET), and rainfall gauges in WCA 3A and ENP to guide real-time operations to convey water from WCA 3A across Tamiami Trail to ENP to meet ecological, flood protection, and water supply needs in WCA 3A and ENP. The TTFF uses multiple stage stations for the start of the current week and the previous week's flow in a linear approximation formula to compute a flow target for the coming week. The flow formula and its variables are listed below.

$$\mathrm{Q}_{\mathrm{t}}^{\mathrm{sum}} = \beta^1 * \mathrm{S}_{\mathrm{t}}^{\mathrm{avg1}} + \beta^2 * \mathrm{S}_{\mathrm{t}}^{\mathrm{nesrs2}} + \beta^3 * \mathrm{Q}_{\mathrm{t-1}}^{\mathrm{sum}} + \beta^4 * \mathrm{R}_{\mathrm{t}}^{\mathrm{Avg}} + \beta^5 * \mathrm{PET}_{\mathrm{t}} + \beta^6 * \mathrm{ZA}_{\mathrm{t}}$$

where

$\boldsymbol{Q_t^{sum}}$ is the target daily releases (sum of S-12A, S-12B, S-12C, S-12D and S-333) for the current (upcoming) week, t (cfs),

$\boldsymbol{S_t^{avg1}}$ is the spatial average of observed stages (feet NGVD) at WCA 3A stages A-3 (Site 63), A-4 (Site64) and A3-28 (Site 65) for the start of the current week *t*,

$\boldsymbol{S_t^{nesrs2}}$ is the observed stage (feet NGVD) at ENP stage NESRS2 for the start of the current week t,

$\boldsymbol{Q_{t-1}^{sum}}$ is the daily average of **observed** releases (sum of S-12C, S-12D, S-333, S-333N, S-12A, and S-12B) for the previous week t-1 (cfs),

$\boldsymbol{R_t^{avg}}$ is the areal average for the total weekly rainfall (inches) for the entire WCA 3A and Mullet Slough. for current week t,

$\boldsymbol{PET_t^1}$ is the total weekly potential evapotranspiration (inches) at the 3AS3WX location, and

$\mathbf{ZA_t}$ is the Zone A regulation stage (ft, NGVD) value for time step t (beginning of current week).

βs are TTFF coefficients (see **Table 7-2** below)

Table 7-2. TTFF coefficients and associated standard error.

Parameter	S_t^{avg1}	S_t^{nesrs2}	Q_{t-1}^{sum}	R_t^{avg}	PET_t^1	ZA_t
Coefficient	318.42	-44.62	0.644	24.32	-96.31	-221.79
Standard Error	18.22	18.50	0.016	7.23	28.83	13.67

The TTFF is applied at the beginning of the current week t, time at which rainfall and PET for that week are not known, so the application of the formula requires to use expected or forecasted values. There are several options that can be used to derive the forecast values. For rainfall:

- Use the median and 10% exceedance of the historical rainfall data as was done in the modeling (10% exceedance value is used when tropical activity or unusual high rainfall are expected; otherwise median is used).
- Use observed rainfall for the preceding 7-day period.
- Use 7-day Quantitative Precipitation Forecast (QPF) issued by the National Weather Service or by SFWMD's meteorologists.

For potential evapotranspiration, the simplest option is to use the observed value for the preceding 7-day period.

Since in most of the cases observed rainfall and PET will not agree with the corresponding forecast, a correction term is applied to the computed target release for the current week t which is obtained as the difference between the recomputed target releases for the previous week t-1, using observed rainfall and PET for the preceding 7-day period and using the target release computed at that point in time (i.e. 7 days ago). The application of the weekly correction to the release target makes the approaches to obtain forecast rainfall and PET less critical. The coefficients for rainfall and PET in the TTFF indicate that if 1-inch error in any direction (over or underestimate) is made on the selected forecast for rainfall and PET, the impact for that week will be approximately at most ± 120 cfs.

While refinement of the TTFF to improve upon some of the inherent limitations acknowledged in linear generalization of the optimal signal is possible, these efforts can be pursued in subsequent CEPP operational plan development activities anticipated in upcoming years. Additionally, the COP AMMP (Appendix C of the COP EIS) developed strategies to help improve the performance of the TTFF during dry conditions. These strategies may be implemented to modify the TTFF target flows to ENP during specific drought conditions.

7.4.8.1.4.2 Extreme High Water Line

The 2020 WCA 3A regulation schedule includes the EHWL to provide operational flexibility for water management operations when extreme high water levels in WCA 3A exist. The purpose of the EHWL is to provide a capacity for regional water managers to effectively respond to extreme high water levels in WCA 3A. The operations described here are not expected to be triggered frequently and are intended to be available as the last resort if needed to help reduce risks to the WCA 3A perimeter levee system, the population of people who would be put at risk if the levee system failed, hurricane evacuation routes, and wildlife and tree islands from extreme high water conditions.

The EHWL is shown in **Figure 7-7** and ranges from 11.0 to 12.0 feet NGVD. When WCA 3A water levels are above the EHWL, this will trigger a thorough evaluation of the C&SF system conditions from Lake Okeechobee and its watershed to the WCAs, EAA, ECC, ENP, and SDCS, including consideration of other related actions which may be undertaken by the State of Florida. The information from this evaluation along with input provided from ENP will be used by USACE and SFWMD to decide on whether or not to implement any or all actions authorized by the EHWL. The conditions detailed below outline the additional operational flexibility for water management operations authorized by the EHWL.

Condition 1. When WCA 3A stage is above the EHWL but below 12.3 feet and the SFWMD position analysis (P90) does not project it to rise above Elevation 12.7 feet NGVD within the next 60 days, S-333 may have priority over S-356. S-334 may also be used up to its maximum capacity of 1,200 cfs to send water to tide and the eastern ENP boundary subject to SDCS system constraints. Under this condition, first priority will be water deliveries to the eastern boundary structures of ENP if capacity is available. S-332B, S-332C, and S-332D will be used to send water to North Detention Area (NDA), South Detention Area (SDA), and S-332D Detention Area. S-336, S-338, S-194, and S-196 will continue to be used to make maximum practicable WCA 3A releases to tide (coastal discharge structures).

Condition 2. When WCA 3A stage is above the EHWL but below 12.3 feet NGVD and the SFWMD position analysis (P90) projects it to rise above Elevation 12.7 feet NGVD within the next 60 days, S-333 may have priority over S-356. S-334 may also be used up to its maximum capacity of 1,200 cfs to send water to tide through the use of all remaining coastal discharge structures including S-197 subject to SDCS system constraints. Extreme High Water Condition 1 priorities remain and will be maximized before sending additional water south to S-197. When in Extreme High Water Condition 2 and S-18C HW is above 2.3 ft. NGVD, S-197 releases may be increased to a daily average maximum of 1,200 cfs to accommodate additional flows through S-334. The expectation is that routing excess water from WCA 3A to S-197 would occur when S-334 is releasing at least 100 cfs. The total available capacity at S-197 will be decreased to 600 cfs when S-18C HW falls below 2.3 feet NGVD.

Condition 3. When WCA 3A stage is above 12.3 feet NGVD then S-197 may be increased up to 2,400 cfs until WCA 3A stage falls below 12.0 feet NGVD. S-333 may have priority over S-356. S-334 may be utilized up to its maximum capacity of 1,200 cfs subject to SDCS system constraints and through use of all remaining available coastal discharge structures including S-197. Extreme High Water Condition 1 priorities remain and will be maximized before sending additional water south to S-197.

In addition, the WCA 3A releases to the L-29 Canal and through the SDCS have the following constraints under extreme high water conditions:

The L-29 canal's maximum operating stage is 8.5 feet NGVD subject to the FDOT constraints. S-333 and S-356 releases will be reduced or terminated when L-29 exceeds 8.5 ft. NGVD as required to lower the L-29 below 8.5 feet NGVD quickly.

S-333N operates in accordance with the criteria specified in the Florida Department of Environmental Protection CERPRA permit (#0362076-001) issued to SFWMD

When the average stage in L-31N at the HW of S-332B, S-332C, and S-332D cannot be maintained below 4.4 feet NGVD then;

When daily combined pumping at S-332B, S-332C, and S-332D is less than 1,125 cfs, S-334 may be used to deliver up to a maximum flow rate of 250 cfs to S-332B, S-332C, S-332D, S-200, and S-199. S334 releases above 250 cfs shall be passes through S-176 and S-177

When daily combined pumping at S-332B, S-332C, and S-332D is less than 1,000 cfs S-334 may be used to deliver up to a maximum of 400 cfs to S-332B, S-332C, S-332D, S-200, and S-199. S-334 releases above 400 cfs shall be passed through S-176 and S-177.

When the daily average stage in L-31N using the HW of S-332B, S-332C, and S-332D can be maintained below 4.2 feet NGVD then there is no limit on the S-334 discharge (up to 1,200 cfs) as long as the other L-31N canal reaches are maintained within or below their respective ranges

If potential storm or an actual flooding condition in the L-31N Canal basin requires the use of S-356 as a flood risk management reduction measure, then S-334 operation will cease until S-356 headwater can be maintained between 5.5 and 5.8 feet NGVD.

8.5 SMA flood mitigation must be maintained and S-333/S-333N releases to NESRS may be stopped if the adherence with the 8.5 SMA flood mitigation criteria is not achieved as further defined in Section 7-4.8.3.2.. The intent of a reduction and a temporary suspension of WCA 3A releases to NESRS is to allow 8.5 SMA to recover from a prolonged hydroperiod that exceeded the flood mitigation criteria. An after action report will be required anytime WCA 3A releases to NESRS are stopped because 8.5 SMA flood mitigation criteria are not being met.

Operations as per the EHWL Conditions 1, 2 or 3 will end with a transition period of less than 14 days and the when the WCA 3A stage is at least 0.2 feet below the EHWL.

7.4.8.1.5 Water Conservation Area 3B

A regulation schedule has not been historically used for WCA 3B due to the limited inflow and high rates of seepage from the area. The regulatory outlet for WCA 3B was originally S-12E. However, S-12E never functioned as intended due to tailwater conditions which were higher than design assumptions. Subsequent construction of the ENP-SDCS has made S-12E a non-functional structure. Currently, releases from WCA 3B can be made through S-31, S-337, S-355A, and S-355B. See **Table 7-3** for additional S-31 operating criteria to avoid fish kills.

WCA-3B inflow and outflow structures including the S-355A and S-355B water control structures shall be operated consistent with FWC guidance for achieving inundation and recession/ascension targets in WCA-3B to the extent that achieving or trying to achieve the identified goals does not conflict with 1) flood damage reduction, 2) water supply, or 3) the other operational constraints listed above.

7.4.8.1.6 FWC Hydrologic Management Strategy for WCA 3B (Measured at Site 71)

Dry Season Low Range Surface Water Depth: 0.06 to 0.96 feet.

Wet Season High Surface Water Depth: Approximately 2.0 feet (~8.3 feet NGVD).

January 1 Target Surface Water Depth Range: 1.16 to 2.06 feet.

Recession Rate Guidelines (January 1 - June l): Approximately 0.05 to 0.07 feet per week to benefit snail kites, wood storks, and wading birds.

Ascension Rate Guidelines (June 1 - October 1): Maximum of 0.25 feet per week and approximately 0.05 feet per week minimum.

Tree Island Threshold: Surface Water Depths >2.0 feet for no more than 60 days per year (8.5 feet NGVD at Site 71).

7.4.8.2 Everglades National Park

Public Law 91-282, passed in June 1970, assured the Everglades National Park a minimum supply of water from the C&SF Project. The Supplemental Appropriations Act of 1984, Public Law 98-118, authorized an experimental program for the delivery of water to the Everglades National Park for the purpose of determining an improved schedule for such delivery. This "Experimental Program" was to last for two years, but was subsequently extended until 1989. The Energy and Water Development Appropriations Act, 1992, Public Law 102-104, extended the Experimental Program until modifications of the Central and Southern Florida project authorized under section 104 of Public Law 101-229, the MWD project, are completed and implemented.

The Experimental Program ends with the implementation of COP. The COP is an integrated operational plan for MWD to ENP and the C-111 SD projects. The COP operations do not call for continuation of minimum deliveries as identified in Public Law 91-282 but will convey more natural deliveries to ENP based on environmental conditions tied to rainfall and stages in ENP and WCA 3A. The COP operations improve water deliveries (timing, location, volume) into ENP and take steps to restore natural hydrologic conditions in NESRS, Taylor Slough, Rocky Glades, and the eastern Panhandle of ENP.

The physical roadway of Tamiami Trail is undergoing a series of construction phases to enable increased flow to pass under the eastern 10 miles of road adjacent to the L-29 canal between S-333 and S-334. Over three miles of bridges have been installed, with a 1-mile stretch on the eastern side and a 2.3-mile stretch on the western side. Federal and state funding has also been allocated to further modify the road base in this area to support L-29 canal stages up to 9.7 feet NGVD.

7.4.8.2.1 Northeast Shark River Slough

The L-29 Canal conveys water released through S-333 or S-356 to ENP/NESRS. The L-29 canal will be maintained up to 8.5 feet NGVD for up to 90 cumulative days per water year (01 May through 30 April), with the opportunity to increase the duration based on written FDOT approval. The number of either cumulative or consecutive days will be measured when L-29 stages exceed 8.3 feet NGVD. L-29 stages at 8.5 feet NGVD for longer than 90 days will need FDOT written approval.

In order to avoid exceeding 8.5 feet NGVD in the L-29 canal, the 5-day QPF will be monitored and stages in the L-29 may be reduced. This criteria is further defined in **Table 7-3**. Once the L-29 canal reaches a stage of 8.5 feet NGVD all inflows to the L-29 canal (S-333, S-333N, S-355A, S-355B, S-356) will be stopped. S-334 may be used to ensure the L-29 stage remains at or below 8.5 feet NGVD provided that the inflows are secured.

7.4.8.2.2 Water Deliveries towards Taylor Slough (Florida Bay)

SDCS operations utilize the C-111 NDA, C-111 SDA, and the S-332D Flow-way to maintain canal stage targets in the lower L-31N canal. Prolonged use of the C-111 South Dade detention areas, particularly following significant rain events, has the tendency to set up a large stage difference between the marsh to the west and the canal stage in the lower L-31N and C-111 Canals. This is expected and is how the system is designed to work, as it is the water level in the detention areas that provides the hydraulic ridge that supports this stage difference. However, the hydraulic ridge can dissipate quickly following an abrupt cessation of pumping. This abrupt cessation can lead to a rapid reduction in the water level of the marsh near the detention areas. While drying down of the marsh occurs naturally during the dry seasons, the rate of marsh recession that can occur when pumping is halted after a significant rain event is much faster than naturally induced recession rates, and rapid recession can be particularly harmful to fish communities. It is important to manage the operations in such a way that marsh recession resembles the natural recession rates that have beneficial effects for wildlife communities. The seasonal operations for S-332s, S-200, and S-199 support maintenance of the hydraulic ridge and its gradual recession.

To mitigate for this potential reduction in the water level of the marsh and to provide environmental benefits to Taylor Slough, COP analyses indicate that supplemental water deliveries up to 400 cfs may be made from WCA 3B and L-30 Canal (upstream of S-335) from 01 August thru 14 February. The following S-335 operating criteria provide these flows:

1. Release up to 200 cfs when S-335 HW stages are 5.3 to 6.0 feet NGVD.
2. Release up to 400 cfs when S-335 HW stages are 6.0 to 6.5 feet NGVD.
3. Supplemental releases suspended when the S-335 TW stage equals or exceeds 6.1 feet NGVD or when S-176 HW stage equals or exceeds 4.7 feet NGVD.

Similar releases up to 200 cfs may also be made between 14 February and 01 May when the S-335 HW is above 6.0 feet NGVD.

Additionally, a separate source of water from WCA 3A to maintain the hydraulic ridge along the C-111 detention areas and/or provide deliveries to Taylor Slough can be used under limited circumstances. This operation will be limited to 200 cfs and when stages are 0.5 feet above the muck fire closure criteria for northern WCA3A (9.80 feet NGVD average at Site 62 and Site 63 gauges). These deliveries, if provided, will be coordinated by USACE with SFWMD and ENP. This flow limit will be measured at S-334 or S-337. This operation is intended to support gradual recession rates in the marsh by providing additional water to the S-332B, S332C, S332D, S-200, and S-199 pump stations.

When S-332C headwater elevation falls below 3.8 feet NGVD during the dry season, all pump operations for Taylor Slough deliveries and the maintenance of the hydraulic ridge will cease. S-332BN may be utilized for supplemental water deliveries when S-332D, S-332BW, or S-332C is not available because of a routine maintenance or repair.

Because the timing of the COP field test was accelerated by 4 years, we are still conducting analyses supporting our understanding of the specific operational goals for Taylor Slough. This effort is ongoing and will be conducted in the context of adaptive management process. Specific suggestions for modification of the System Operational Manual will be made based on the outcome of those analyses and will be reviewed under the NEPA process when necessary.

7.4.8.2.3 Water Control in the Florida Bay Flamingo Area

S-341 was constructed in the Buttonwood Canal in ENP. The purpose of S-341 is to prevent the influx of hyper-saline water from Florida Bay into Coot Bay, and reduce the loss of freshwater from the interior during drought conditions. Operation and maintenance of S-341 is the responsibility of the NPS. Based on the 1981 Buttonwood Canal Plug, Gated Culvert and Boat Hoist Agreement and Permit, the Buttonwood Canal plug, gated culvert, (S-341) and boat hoist should be operated pursuant to the Operation and Maintenance Manual for these project features and other provisions.

7.4.8.2.4 Water Deliveries to the Eastern Panhandle of ENP via C-111

The purposes of S-18C are to maintain a desirable freshwater head to prevent saltwater intrusion through C-111, pass flood flows up to 40 percent SPF without exceeding design stages upstream, and act as a control point for water deliveries to the eastern panhandle of ENP. Material on the southern side of the C-111 between S-18C and -S-197 was removed to improve sheetflow of freshwater from S-18C to ENP and Florida Bay as well as to moderate the frequency of S-197 gate openings. Water flows over the spoil bank along C-111 into the Eastern Panhandle of ENP. Gate operations are remotely controlled to maintain S-18C HW stages between 2.3 and 2.65 feet NGVD.

S-197 maintains water control stages in C-111 and prevents saltwater intrusion during high tides. Typically, S-197 is closed to divert discharge from S-18C over land to the eastern panhandle of ENP. S-197 releases water only for flood control according to S-197 Operating Criteria (**Table 7-3**). The COP operations are designed to minimize the damaging freshwater flows to Manatee Bay/Barnes Sound through the S-197 structure and preserve the design discharge capacity of 2,400 cfs for rare use only during extreme flooding events.

7.4.8.3 Everglades National Park-South Dade Conveyance System (L-31N & C-111)

The ENP-SDCS water levels are optimized in COP to provide environmental benefits, flood protection, and water supply. Canal stages and structure operations prompting water supply are listed in **Table 7-1**. Normal system operational guidance is provided in **Table 7-3**. **Subsection 7.5** also contains reference to Pre-Storm / Storm / and Storm Recovery Operations for SDCS.

7.4.8.3.1 South Dade County

The purposes of the C&SF Project works in South Miami-Dade County were to remove the 40 percent of SPF runoff from the entire 206 square mile effective drainage area, reduce depth and duration of larger floods, provide water control to prevent over drainage in the area, prevent saltwater intrusion, and provide facilities to convey up to 500 cfs to ENP when normal runoff is available. The construction of the ENP-SDCS modified the existing project works in South Miami-Dade County. More detailed discussions of the South Miami-Dade County Project works are contained in Volume 5, East Coast Canals Master Water Control Manual.

7.4.8.3.2 8.5 Square Mile Area

The 8.5 Square Mile Area (SMA), aka Las Palmas Community project features are designed to mitigate for increased flood risk as a result of increased water levels in NESRS and other areas of ENP resulting from the MWD to ENP Project. The constructed features of the 8.5 SMA Project and C-111 South Dade Project available for water management operations include: the canals C-357 and C-358, the 8.5 SMA flow way

and the Northern Detention Area (NDA), pump stations S-357 and S-331, and structure S-357N. S-357 and S-357N provide primary flood mitigation to the residents of the 8.5 SMA and S-331 provides secondary flood mitigation benefits only during high water conditions. Detailed structure operations are listed in **Table 7-3**.

COP modeling demonstrated all interior areas of 8.5 SMA met the flood mitigation requirements, consistent with the 2000 GRR/EIS, however modeling also indicated that there are portions of 8.5 SMA along the western ENP boundary that remain very challenging and require real-time monitoring to ensure compliance. Based on the COP modeling results and information gained during the incremental field test an expanded hydrologic monitoring plan for the 8.5 SMA has been revised and is provided in the AMMP (Appendix C of the COP EIS).

The USACE will monitor rainfall at S-331 and recession rates at indicator gauges located within and around the 8.5 SMA (LPG-1, LPG-2, LPG-16, and LPG-17) to ensure flood mitigation targets are met. The flood mitigation criteria must be maintained. If the flood mitigation criteria is projected to be exceeded, flows to NESRS may be temporarily suspended to help reduce water levels in the 8.5 SMA.

7.4.8.4 Standing Instructions to Project Operators Summary Table

The Operating Criteria table (**Table 7-3**) lists structures and operating criteria for the WCAs, ENP, and ENP-SDCS according to their respective hydrologic basins or canals from north to south. If there is a perceived conflict between the criteria in **Table 7-3** compared to the criteria described in complementary text of this Chapter or if the table lacks clarity, then the criteria as described in the body of the text shall be consulted and shall control.

The Flood Risk Management (FRM) and Environmental Restoration (ER) operational ranges prescribed in **Table 7-3** were developed from a combination of operational experience, modeling results, analysis of historical data, and the expected performance of existing and proposed features. These ranges are not simple ON and OFF ranges used for pumps or simple OPEN and CLOSE used for gates in some earlier C&SF hydrologic modeling analyses.

When stages are above the FRM&ER HIGH stage criteria, timely action (e.g., gate adjustment or pumping changes) will be made to lower the stage at a rate consistent with the current conditions (e.g., height above the HIGH stage, rate of rise, recent basin rainfall, and expected inflows) and forecasted conditions, seasonal variability, and antecedent conditions. Within the range between the FRM&ER HIGH and FRM&ER LOW stage criteria, the operators have full discretion to adjust pumps or gates or a combination of both to achieve the stage deemed most appropriate for the current and forecasted conditions as long as they remain consistent with prescribed objectives and constraints. Changes in pumps or pumping rate (number or RPM of pumps) can be implemented to rotate pumps or compensate for unavailable pumps. For basins with high rates of surface and groundwater interactions, compliance with the operation range should be based upon the daily average stage. For canal stages being maintained by pump stations, compliance with the operation range should allow the use of daily averages (0000 to 2400 hours) with the lowest operating stage maintained above the lower limit for each pump.

When the canal stage falls below the FRM&ER LOW stage criteria, timely operational changes will be made to either raise the canal stage back to the operational range or transition into appropriate operational stages below the FRM&ER LOW stage (e.g. water conservation).

Table 7-3. Operating Criteria.

Basin / Canal	Operational Component	Description and Operating Criteria
WCA 1	S-10A, S-10C, S-10D	WCA 1 is regulated by three main outlet structures, S-10A, S-10C, and S-10D with a combined design capacity of 14,800 cfs under SPF stages. The S-10s discharge water from WCA 1 to WCA 2A based on water levels in WCA 1 and its regulation schedule (**Figure 7-3**).
WCA 1	S-39	S-39 releases water from WCA 1 to the Hillsboro Canal. Its primary purpose is to provide for water supply needs along the Hillsboro Canal during the dry season. It also can be used to discharge excess water from WCA 1 when downstream capacity is available. S-39 has a design discharge capacity of 800 cfs.
WCA 2A	S-11A, S-11B, and S-11C	WCA 2A is regulated by three main outlet structures, S-11A, S-11B, and S-11C with a combined design capacity of 16,600 cfs under SPF stages. The S-11s discharge water from WCA 2A to WCA 3A based on water levels in WCA 2A and its regulation schedule (**Figure 7-5**).
WCA 2A	S-144, S-145, and S-146	Water can be transferred into WCA 2B via S-144, S-145, and S-146, located in L-35B. These structures each have design capacity of 210 cfs. When WCA 2A is in Zone A, regulatory releases can be made into WCA 2B until the Site 99 gauge reaches 11.0 feet NGVD.
WCA 2A	S-143	S-143 releases water from WCA 2A to supply water needs along the North New River Canal during the dry season and can be used to discharge excess of water from WCA 2A when capacity is available in the North New River Canal and when the water is not needed in WCA 3A and stage downstream of S-34 is not above 6.0 feet NGVD. S-143 has a design discharge capacity of 500 cfs.
WCA 2A	S-38	S-38 releases water from WCA 2A to supply water needs in the area served by Canals 13 and 14 (C-13 and C-14) during the dry season. It also can be used to discharge excess water from WCA 2A when capacity is available in C-13 and C-14 and when the water is not needed in WCA 3A. S-38 has a design discharge capacity of 500 cfs.
WCA 2B	S-141	S-141 releases water from WCA 2B to the North New River Canal. When Site 99 gauge elevation > 11.0 feet NGVD, S-141 is open for flood releases through S-34E if canal capacity is available. A regulation schedule is not utilized for WCA 2B due to high rates of seepage from the area. S-141 has a design discharge capacity of 435 cfs.
WCA 2A/2B	S-34E	S-34E releases water from WCA 2A or WCA 3A to supply water needs along the North New River Canal during the dry season. It also can be used to discharge excess water from WCA 2A, WCA 3A and/or WCA 2B when capacity is available in the North New River Canal and when the water is not needed in WCA 3. S-34E has a design discharge of 450 cfs.
WCA 3A	WCA 3A Regulation Schedule and Tamiami Trail Flow Formula (TTFF)	WCA 3A is regulated the S-12A, S-12B, S-12C, S-12D, S-333, S-333N, S-344, S-343A, S-343B, S-151, and S-152 structures. The primary structures for WCA 3A water deliveries to ENP are the S-12s and S-333. Releases are based on the 2020 WCA 3A Regulation Schedule (**Figure 7-7**) and TTFF (**subsection 7.4.8.1.4.1**). WCA 3A stage is the three (3)-station average of gauges A-3 (Site 63), A-4 (Site 64) and A3-28 (Site 65). There are two zones in the WCA 3A Regulation Schedule: Zone A and Zone B. Zone A is higher than Zone B. The zones are delineated by a seasonally

Basin / Canal	Operational Component	Description and Operating Criteria
		varying line that ranges from a high of 10.5 feet NGVD (01 November) to a minimum of 9.5 feet NGVD (01 June). In Zone A, maximum releases at S-333, S-333N (per FDEP permit), S-12D, S-12C, S-12B, S-12A, S-343B, S-343A, S-344, and S-151 subject to downstream constraints. In Zone B, weekly WCA 3A release targets will be computed with the TTFF for S-333, S-12D, S-12C, S-12B, S-12A, (listed in priority order) to prioritize water deliveries to Northeast Shark River Slough (NESRS) first and Western Shark River Slough (WSRS) second, subject to downstream constraints.
WCA 3A	WCA 3A Tamiami Trail Flow Formula	TTFF will provide weekly release targets across Tamiami Trail. (See **subsection 7.4.8.1.4.1** and Appendix H of the COP EIS) *Note: Replaces WCA 3A Rainfall-based Management Plan.*
WCA 3A	COP Extreme High Water Line (EHWL)	COP EHWL ranges between 11.0 to 12.0 feet NGVD (see **Figure 7-7** and **subsection 7.4.8.1.4.2**)
WCA 3A	Water Supply Releases from WCAs	During low water conditions, it is difficult to draw water from the interior of the WCAs. The regulation schedules for Water Conservation Areas 1, 2A, and 3A include a "floor" or minimum water levels below which water supply releases from the WCAs must be preceded by an equivalent volume of inflow. The water levels may continue to recede due to evaporation and seepage; however, as long as there is an inflow volume equal to the outflow volume, water can be released from the WCAs. There is not a requirement to maintain the minimum elevation. Monitoring gauges for the WCAs floors are: WCA 1 - Gauge 1-8C at 14.0 feet NGVD WCA 2A - S-11B HW stage at 10.5 feet NGVD WCA 3A - Gauge 3-69W at 7.5 feet NGVD Water supply releases from WCA 3A are delivered for water supply to east and south Miami-Dade County to maintain minimum canal levels and prevent salt water intrusion.
WCA 3A	S-142	S-142 releases water from WCA 3A to supply water needs along the North New River Canal during the dry season. It can also discharge excess water from WCA 3A when capacity is available in the North New River Canal. S-142 has a design discharge capacity of 500 cfs.
WCA 3A	S-339	S-339 structure is a sheet pile barrier dam on C-123 (the Miami Canal) about 6 miles north of I-75. It was designed to prevent over drainage of the northern portion of WCA 3A by forcing flows from C-123 Canal out into the marsh, and to transfer water to the ENP, the Metropolitan Miami, and the South Dade County areas. The structure is closed most of the time, but it is opened fully in accordance with the operations schedule (**Figure 7-8**). The optimum headwater elevation is 11.0 feet NGVD. S-339 has a design discharge capacity of 1,100 cfs.
WCA 3A	S-340	S-340 structure is a sheet pile barrier dam on C-123 (the Miami Canal) about 2.7 miles south of I-75. It was designed to prevent over drainage of the northern portion of WCA 3A by forcing flows from C-123 Canal out into

Basin / Canal	Operational Component	Description and Operating Criteria
		the marsh, and to transfer water to the ENP, the Metropolitan Miami, and the South Dade County areas. The structure is closed most of the time, but it is opened fully in accordance with the operations schedule (**Figure 7-8**). The optimum headwater elevation is 9.3 feet NGVD. S-340 has a design discharge capacity of 1,100 cfs.
WCA 3A	S-344	S-344 releases water from WCA 3A to Big Cypress National Preserve. The structure is open when WCA 3A is in Zone A and closed when WCA 3A is in Zone B, subject to the below CSSS closure period and downstream constraint. CSSS closure period is 01 Oct through 14 Jul in accordance with the USFWS Everglades Transition Plan (ERTP 2016) Biological Opinion RPAs (changes to the closure period are subject to future ESA consultation for COP). Downstream constraint: Loop Rd 1 Gauge should be kept below 8.5 feet NGVD to avoid flooding Loop Road. S-344 has a design discharge capacity of 135 cfs.
WCA 3A	S-343A and S-343B	S-343A and S-343B release water from WCA 3A to Big Cypress National Preserve. The structures are open 15 July through 30 September when WCA 3A is in Zone A and closed 01 October through 14 July. The structures are also closed at all times when WCA 3A is in Zone B and are subject to the below downstream constraint. Downstream constraint: Loop Rd 1 Gauge should be maintained below 8.5 feet NGVD to avoid flooding Loop Road. S-343A and S-343B each has a design discharge capacity of 195 cfs.
WCA 3A	S-12A/B/C/D	S-12A/B/C/D, all are operated in accordance with WCA 3A regulation schedule and TTFF, except for S-12A and S-12B which have the following seasonal closure criteria for the marl prairie and Cape Sable Seaside Sparrow (CSSS) subpopulation A. Seasonal Closure Criteria: S-12A and S12-B closed from 01 October through 14 July with the following limited conditional opening: S-12A and/or S-12B will be conditionally opened during October under the following conditions. 1. WCA 3A stage based on 3 gauge average of Site 63, Site 64, and Site 65 on 30 September is greater than 10.5 feet NGVD; or 2. WCA 3A stage is projected to rise above 10.75 feet NGVD during October, based on consideration of projected inflows and direct rainfall. 3. S-12A and/or S-12B will be closed when the WCA 3A stage falls below 10.25 feet NGVD, OR on 01 November, whichever comes first. S-12B will be conditionally opened during November under the following conditions: 1. WCA 3A stage on 31 Oct is greater than 11.0 feet NGVD; or 2. WCA 3A stage is projected to rise above 11.25 feet NGVD during November, based on consideration of projected inflows and direct rainfall.

Basin / Canal	Operational Component	Description and Operating Criteria
		3. S-12B will be closed when the WCA 3A stage falls below 10.75 feet NGVD, OR on 01 December, whichever comes first. S-12C no closure period. S-12D no closure period. Year-Round Operational Criteria: S-12A Year-round: To provide access to cultural areas, when Tamiami Trail Flow Formula (TTFF) results in S-12 target flows, S-12A up to 100 cfs release is available when requested by the Tribe. (See **subsection 7.4.7.1**.) S-12A Cultural Access Release: S-12A up to 100 cfs release is available when TTFF results in S-12 target flows and is requested by the Tribe. From 01 October through 14 July, the Tribe and USACE must request informal consultation with USFWS to avoid impacts on CSSS-A. During this time, the duration of this release will not exceed five consecutive days. S-12A up to 100 cfs release may only occur when 3-gauge average (Sites 63, 64, 65 in WCA 3A) is greater than 8.4 feet NGVD. During S-12A up to 100 cfs release, data such as but not limited to NP-205 and area rainfall will be monitored with NP-205 increase or anticipated increase above 5.7 feet NGVD resulting in closing of S-12A. S-12C/D Year-round: S-12C and/or S-12D release up to WCA 3A Regulation Schedule (Zone A maximum) or TTFF (target flow). S-12s Flow Distribution: S-12 openings sequence to meet Target Flows is prioritized from east to west (S-12D, S-12C, S-12B then S-12A) as each structure reaches their maximum flow capacity; S-12A/B/C/D may be opened if their headwater is greater than 11.0 feet NGVD to pass an amount only enough to prevent overtopping of gates. For S-12A and S-12B, the USACE will assess upstream conditions and will close S-12A/B gates when headwater levels drop below 10.75 feet NGVD.
WCA 3A	S-151	S-151 releases water from WCA 3A to the C-304 canal in WCA 3B for both flood diversion and water supply. S-151 may make maximum releases when WCA 3A is in Zone A and when the Site 71 gauge is less than 8.5 feet NGVD. S-151 may also be used to provide water for environmental deliveries to Taylor Slough or to maintain the hydraulic ridge, subject to criteria further defined in **subsection 7.4.8.2.2**. S-151 has a design discharge capacity of 1,105 cfs.
WCA 3A	S-152	S-152 releases water from WCA 3A to WCA 3B Per Decompartmentalization and Sheetflow Enhancement Physical Model (DPM) phase 2, S-152 operating criteria listed below: 1. May be operated when L-67A Canal stage at S-152 HW exceeds 7.5 feet NGVD. 2. Closed when WCA 3B site 71 stage equals or exceeds 8.5 feet NGVD. 3. S-152 releases may be reduced or discontinued when S-355A and S-355B are closed due to L-29 canal stage constraints. 4. Releases may be reduced or discontinued when water quality constraint criteria per the FDEP Permit are exceeded.

Basin / Canal	Operational Component	Description and Operating Criteria
		Note: This is a temporary structure for the Decompartmentalization and Sheetflow Enhancement Physical Model (DPM), which is a field-scale test that is being conducted to determine how best to design and formulate plans for future decompartmentalization of WCA 3A, as envisioned in CERP. The phase 2 of the DPM operational window is anticipated to be from November 2017 through 2021. S-152 has a design discharge capacity of 800 cfs, however a maximum discharge of 640 cfs was observed on 14 Jul 2017 during an emergency deviation.
WCA 3B	S-355A/B	S-355A and S-355B release water from WCA 3B to the L-29 canal. The structures are open whenever hydraulic gradient allows flow from WCA 3B to L-29 with low risk of backflow from L-29 to WCA 3B. Constraints on the Operation of S-355A and S-355B. 1. The S-355A and S-355B water control structures will be operated to comply with the following constraints: a. The S-355A or S-355B or both shall be opened only when there is sufficient stage difference between the water levels in WCA 3B at S-355A/B and the L-29 Borrow Canal and whenever the gradient allows for southerly flow from WCA 3B at S-355A/B to L-29 Borrow Canal. b. Releases from S-355A or S-355B or a combination of both shall be limited as required to prevent the L-29 Canal stage from exceeding the 8.5 feet NGVD L-29 Canal stage constraint. c. Releases from S-355A or S-355B or a combination of both shall be limited as required to prevent impacts to the existing project purposes of the C&SF Project including but not limited to flood damage reduction and water supply. 2. The S-355A and S-355B water control structures shall be closed if any of the three conditions above are not met, and when there is a potential for reverse flow (from L-29 Canal to WCA 3B) through the structures. The actual open and close levels of the structures will depend on the water conditions, forecasts, and other system constraints. 3. S-355A and S-355B operations for the DPM structure S-152 will be in accordance with FDEP Permit. WCA 3B will be managed by conveying S-152 releases through WCA 3B to the L-29 borrow canal via S-355A and B. S-152 releases will be determined based upon several conditions including but not limited to: Rainfall Plan, DPM test objectives, WCA 3B water level, L-29 canal water level, and SDCS status (Source: 2017 DPM Operational Strategy).
WCA 3B / C 304 / Miami Canal	S-31	S-31 releases water from WCA 3B/3A (C-304 canal) to the Miami Canal (C-6). The structure is open only when S-151 is also opened equal or greater amount to prevent fish kills that can occur between S-151 and S-31. S-31 can also be used to discharge from WCA 3A under EHWL operations subject to channel capacity in the Miami Canal. S-31 has a design discharge of 700 cfs.

Basin / Canal	Operational Component	Description and Operating Criteria
L-30	S-337	S-337 operates together with S-31 and S-151 to permit releases from WCA 3B/3A and to supply water for Miami-Dade County. The structure is open only when S-151 is also opened equal or greater amount to prevent fish kills that can occur between S-151 and S-337 and downstream capacity is available. S-337 may also be used to provide water for environmental deliveries to Taylor Slough or to maintain the hydraulic ridge, subject to criteria further defined in **subsection 7.4.8.2.2**. S-337 has a design discharge of 605 cfs.
L-30	S-335	S-335 releases water from the L-30 canal to the L-31N canal. The structure has an operating range for Flood Control of 6.5 to 7.5 feet NGVD. The structure has an operating range for Flood Control of 6.5 to 7.5 feet NGVD. S-335 is closed when the TW stage equals or exceeds 6.1 feet NGVD. S-335 may: 1. Release up to 200 cfs when S-335 HW stages are 5.3 to 6.0 feet NGVD from 01 Aug through 14 Feb 2. Release up to 400 cfs when S-335 HW stages are 6.0 to 6.5 feet NGVD from 01 Aug through 14 Feb 3. These additional S-335 operations are suspended when TW stage equals or exceeds 6.1 feet NGVD or when S176 HW stage equals or exceeds 4.7 feet NGVD. 4. Releases made for this purpose should be considered coincident to any releases being made for water supply to South Dade County. S-335 releases up to 200 cfs may continue between 14 Feb and 01 May when S-335 HW is above 6.0 feet NGVD. S-335 has a design discharge capacity of 525 cfs.
WCA 3A	Environmental Water Deliveries to Maintain Hydraulic Ridge and provide water to Taylor Slough	To prevent rapid reduction in the water level of ENP west of the L-31N Canal, COP includes the operations for water managers to convey water from WCA 3A to maintain the hydraulic ridge along the C-111 detention areas and/or provide deliveries to Taylor Slough. Water deliveries from WCA 3A will be limited to 200 cfs when average stage at Site 62 and Site 63 gauges is greater than 9.80 feet NGVD, which is 0.5 feet above the FWC muck fire closure criteria for northern WCA 3A. These deliveries, if provided, will be coordinated by USACE with SFWMD and ENP. This flow limit will be measured at S-334 or S-337. This operation is intended to support gradual recession rates in the marsh by providing additional water to the S-332B, S332C, S332D, S-200, and S-199 pump stations, or maintain a canal stage in a range conducive to gradual recession rates. When S-332C headwater elevation falls below 3.8 feet NGVD during the dry season, all pump operations for the maintenance of the hydraulic ridge will cease. S-332BN may be utilized for supplemental water deliveries when S-332D, S-332BW, or S-332C is not available because of a routine maintenance or repair. During the water delivery operations, S-176 HW stage will be maintained between 3.8 and 4.3 feet NGVD.
L-29		L-29 may operate up to 8.5 feet NGVD for up to 90 days per water year (starting on 1 May and ending on 30 Apr of the following year), with the

Basin / Canal	Operational Component	Description and Operating Criteria
		opportunity to increase the duration of stages beyond 90 days based on real-time monitoring of the US-41 Subbase (interim FDOT constraint until Tamiami Trail Next Step (TTNS) construction completed) and 8.5 SMA flood mitigation criteria. Outside the 90-day FDOT limit, L-29 canal level will be maintained below 8.3 feet NGVD subject to downstream constraints and L-29 event driven criteria below. L-29 canal elevation with regard to these criteria will be measured at the higher of the S-333 Tailwater (S-333 TW) or the S-334 Headwater (S-334 HW). The L-29 Canal will be operated to ensure the stability and safety of the Tamiami Trail (U.S. 41) Highway between S-333 and S-334, based upon coordination with the FDOT concerning implementation of the Relocation Agreement dated September 25, 2008. The below requirements shall remain unchanged until full completion of TTNS construction (projected 2022). When the stage in the L-29 Canal reaches a stage of 8.5 feet NGVD, input from all structures that discharge into the canal (S-333, S-355A/B, and S-356) shall be stopped until the level in the L-29 Canal recedes below 8.5 feet NGVD. If unexpected high rainfall beyond what was forecasted causes the L-29 Canal to exceed 8.5 feet NGVD, inflow structures will be operated with the intention of limiting event durations with L-29 Canal stages above 8.5 feet NGVD to a target maximum duration of 72 hours. For each water year (May through April), the L-29 Canal inflow structures will be managed to limit the duration of L-29 Canal stages near 8.5 feet NGVD to 90 cumulative days* or a maximum of 90 consecutive days*, and the conditions of the Tamiami Trail roadway sub-base and roadway will be continuously monitored during implementation of COP using the monitoring plan in Appendix H of the COP EIS. Continued L-29 structure inflows which result in either cumulative or consecutive days with L-29 Canal stages at 8.5 feet NGVD for longer than 90 days will require written approval from the FDOT, given evaluation of the monitoring data by the USACE, SFWMD, and FDOT. L-29 canal elevation with regard to these criteria will be measured at the higher of the S-333 TW or the S-334 HW. L-29 Event Driven Criteria**: For example, the below Quantitative Precipitation Forecasts (QPF) ranges may be used to maintain L-29 below 8.5 feet NGVD. 8.4' If the 5-day QPF is for 2 to 3 inches L-29 structural inflows shall be reduced until the stage is below 8.4 feet NGVD 8.3' If the 5-day QPF is for 3 to 4 inches L-29 structural inflows shall be reduced until the stage is below 8.3 feet NGVD 8.2' If the 5-day QPF is for 4 to 5 inches L-29 structural inflows shall be reduced until the stage is below 8.2 feet NGVD 8.1' If the 5-day QPF is for 5 to 6 inches L-29 structural inflows shall be reduced until the stage is below 8.1 feet NGVD. * The number of either cumulative or consecutive days in each period will be measured when L-29 stages exceed 8.3 feet NGVD. This does not exclude short-term operations to address the L-29 Event Driven Criteria. There will be one period per water year (1 May through 30 Apr), subject to revision via FDOT approval.

Basin / Canal	Operational Component	Description and Operating Criteria
		** Stopping flows shall occur in the order prescribed by S-356 and S-333 criteria specified in Conditions 1, 2, 3, and 4 with the intent to achieve the required stage reduction within 72 hours. When 8.5 SMA flood mitigation constraints are violated, L-29 Canal stage may be lowered to elevation 7.8 feet NGVD.
L-29	S-333	S-333 releases water from WCA 3A to the L-29 canal. The S-333 releases are in accordance with WCA 3A regulation schedule, the TTFF, and L-29 maximum canal operating limits. S-333 is available to meet TTFF, water supply, environmental water deliveries, and the Extreme High Water Line operations. S-333 may be temporarily suspended from discharging to NESRS when 8.5 SMA flood mitigation requirements are exceeded. S-334 will not be open under these conditions. S-333 has a design discharge capacity of 1,350 cfs.
L-29	S-333N (owned and operated by SFWMD)	S-333N is a CEPP project structure and is currently under construction with completion estimated for June 2020. S-333N will release water from WCA 3A to the L-29 canal per FDEP permit (July 2018). S-333N may be operated by SFWMD under Emergency Limited Operations for WCA 3A High Water Relief under the following conditions: 1. When the average stages at gauges Site 62 and Site 63 exceed elevation 11.6 feet NGVD for 72 hours. Releases from the existing S-356 Pump Station shall have priority over the S-333N Gated Spillway releases. 2. S-333N is closed when the L-29 Canal stage limits the operations of the S-356 Pump Station, or when the average of the Site 62 and Site 63 gauges recedes below an elevation of 11.0 feet NGVD. 3. During operations of S-333N Gated Spillway, the following operations shall take place: a. There shall be no use of S-334 Gated Spillway to divert WCA 3A regulatory releases to the L-31N Canal. b. The S-356 Pump Station will have priority over the S-333N Gated Spillway and the S-356 Pump Station will be operated up to its full available capacity prior to opening G-211 Gated Culvert, and as the water levels recede in WCA 3, the G-211 Gated Culvert will be closed before the pumping at the S-356 Pump Station is reduced. S-333N headwater is in WCA 3A and its tailwater is in the L-29 Canal. S-333N has a design discharge capacity of 1,150 cfs.
L-29	S-334	S-334 releases water from the L-29 canal for water supply, environmental water deliveries, and flood control. Under the Extreme High Water Line operations as detailed in **subsection 7.4.8.1.4.2** of Chapter 7 of the WCP, S-334 may be operated up to its design capacity of 1,200 cfs subject to SDCS flow constraints and through the use of all remaining available coastal discharge structures. Primary Route: L-29, L-31N, and C-111 canals and through S-333, S-334, G-211, S-331, S-176, S-177, and S-18C structures

Basin / Canal	Operational Component	Description and Operating Criteria
		Priority order of outflow structures: S-332B/C/D, S-338, S-194, S-196, S-200, S-199, S-336, and S-197 S-334 may be used to maintain the L-29 Canal stage at or below the adjusted constraint of 8.5 feet NGVD to ensure the stability and safety of the Tamiami Trail (U.S. 41) Highway between S-333 and S-334, provided S-333 is closed based upon coordination with the FDOT concerning implementation of the Relocation Agreement dated September 25, 2008. If S-334 is operated in accordance with this condition, S-334 is closed as soon as 8.3 ft, NGVD in L-29 is reached following the post-event recession.
L-31N	S-356	S-356 pump station manages water stages in the L-31N and L-30 canals between S-334 and G-211 by pumping water to the L-29 canal. The pump station has an operating Range from 5.5 to 5.8 feet NGVD S-356 has priority over S-333. When WCA 3A is above the Extreme High Water Line, S-333 may have priority over S-356. S-356 has a design discharge capacity of 575 cfs.
L-31N	S-336	S-336 releases water from the L-30, L-31N, or L-29 canal to supply water to Miami-Dade County and ENP when the headwater stage at either S-25B or S-22 falls below the optimum stage of 2.0 feet NGVD during dry periods. S-336 may also be used to make flood releases when downstream conditions have conveyance capacity. S-336 has a design discharge of 145 cfs.
L-31N	S-338	S-338 releases water to the east, from the L-31N canal to the C-1W canal. The structure has an operating Range from 5.5 to 5.7 feet NGVD. S-338 has a design discharge of 170 cfs.
L-31N	G-211	G-211 is a divide structure for the L-31N canal between S-335 and S-331. The structure has an operating Range from 5.5 feet to 6.0 feet NGVD. G-211 is primarily used to convey water supply and environmental deliveries to south Miami-Dade. S-356 is the first priority for keeping the reach of the L-31N Canal upstream of the G-211 from exceeding its normal operating range. G-211 has a design discharge of approximately 1,100 cfs.
L-31N	S-331	S-331 pump station manages water stages in the L-31N canal. The pump station has an operating Range of 4.5 to 5.0 feet NGVD from 14 Feb through 31 Jul and 4.3 to 4.6 feet NGVD from 01 Aug through 1 Jan. A transition between the two operating ranges is to be accomplished between 1 Jan and 14 Feb. S-331 pumping will be secured when tailwater stage is above 6.0 feet NGVD. S-331 operations are available to assist S-357 in meeting 8.5 SMA flood mitigation requirements. When G-3273 > 7.5 feet NGVD and LPG-2 stage trend is not expected to recover in accordance with the 8.5 SMA flood mitigation criteria, G-211 will be closed and the, S-331 HW will be lowered to 3.0 to 3.5 feet NGVD until stages at LPG-2 meet 8.5 SMA flood mitigation criteria. At elevated water levels above 7.5 feet NGVD at G-3273, both S-357 and S-331 pump stations will need to be operated in tandem in order to manage the increased seepage from NESRS and L-31N Canal into the 8.5 SMA while providing the required flood mitigation. The

Basin / Canal	Operational Component	Description and Operating Criteria
		operating intent is to gradually transition S-331 to normal operations prior to S-357 returning to normal operations. S-331 has a design discharge capacity of 1,160 cfs. The pump station has three diesel units with each rated for 387 cfs at 3.0-foot static head. When S-331 is operating to assist in providing drainage to 8.5 SMA then up to 200 cfs can be routed to S-197 as long as S-18C HW > 2.3 feet NGVD. Flow from S-331 resulting in operation of S-332B, S-332C, and S-332D within 0.2 feet of the top of the range should result in use of available capacity at S-199 and S-200 (in coordination with SFWMD), and then, if needed, releases of up to 200 cfs at S-197. Priority would be to utilize available capacity at S-332B/C/D, S-199, and S-200 prior to opening S-197.
L-31N	S-173	S-173 is a gated-culvert adjacent to S-331. S-173 may be used for water supply, water deliveries to Taylor Slough and maintenance of the hydraulic ridge, and environmental water deliveries to Biscayne Bay. S-173 has a design discharge capacity of 100 cfs.
L-31N	S-194	S-194 releases water from the L-31N canal east to the C-102 canal. The structure has an operating range from 4.1 to 4.7 feet NGVD. S-194 has a design discharge capacity of 190 cfs.
L-31N	S-196	S-196 releases water from the L-31N canal east to the C-103 canal. The structure has an operating range from 4.1 to 4. 7 feet NGVD. S-196 has a design discharge capacity of 200 cfs.
L-31N	L-31N Reach between S-331 and S-176	Structure discharge priorities and operating ranges: Priority 1. S-332D 3.8 to 4.8 ft, NGVD S-332BW 3.8 to 4.8 ft, NGVD S-332C 3.8 to 4.8 ft, NGVD S-332BN 3.8 to 4.8 ft, NGVD Priority 2. S-196 4.1 to 4.7 ft, NGVD S-194 4.1 to 4.7 ft, NGVD S-176 4.5 to 5.0 ft, NGVD (last in-line within Tier 2 unless S-200 and S-199 pumping capacities are available If S-331 is operating to assist in providing drainage to 8.5 SMA and/or facilitate the EHWL operations have occurred within the last 48 hours, the operating ranges are: Priority 1 S-332D 3.8 to 4.6 ft, NGVD S-332BW 3.8 to 4.6 ft, NGVD S-332C 3.8 to 4.6 ft, NGVD S-332BN 3.8 to 4.6 ft, NGVD Priority 2 S-196 4.1 to 4.6 ft, NGVD S-194 4.1 to 4.6 ft, NGVD S-176 4.3 to 4.6 ft, NGVD Seasonal ranges for the pump stations are detailed below.

Basin / Canal	Operational Component	Description and Operating Criteria
L-31N	S-332B	S-332BN releases water into the North Detention Area (NDA) with two 125 cfs-diesel units. S-332BW releases water into the SDA with one 75 cfs-electric unit and two 125 cfs-diesel units. After S-332B is replaced, it will have four 125 cfs diesel units and two 75 cfs electric pumps. When S-332B is replaced with a permanent pump station, up to 250 cfs can be diverted to NDA. S-332B operational criteria vary seasonally, as prescribed below: 1. Gradual Transition from condition (01 Jan to 14 Feb) operating range: 3.8 to 4.8 feet NGVD 2. CSSS nesting period (15 Feb through 31 July) operating range: 4.0 to 4.8 feet NGVD 3. South Dade Typical Planting Season (01 Aug to 31 Dec) operating range:3.8 to 4.4 feet NGVD
L-31N	S-332C	S-332C releases water into the Southern Detention Area (SDA) with one 75 cfs-electric unit and four 125 cfs-diesel units. After S-332C is replaced with permanent station, it will have four 125 cfs diesel units and two 75 cfs electric pumps. S-332C operational criteria vary seasonally, as prescribed below: 1. Gradual Transition (01 Jan to 14 Feb) operating range: 3.8 to 4.8 feet NGVD 2. CSSS nesting period (15 Feb through 31 July) operating range: 4.0 to 4.8 feet NGVD 3. South Dade Typical Planting Season (01 Aug to 31 Dec) operating range: 3.8 to 4.4 feet NGVD
L-31N	S-332D	S-332D releases water into the S-332D Flow-way with one 75 cfs-electric unit and four 125 cfs-diesel units. Calendar based CSSS restrictions apply for southerly flows within the S-332D Flow-way (S-332DX1 releases are not counted against the S-332D discharge limits): 1. 500 cfs (15 Jul to 31 Dec) 2. 325 cfs (01 Jan to 31 Jan) 3. 250 cfs without the use of S-332DX1 or 375 cfs with S-332DX1 discharge of 125 cfs (01 Feb to 14 Jul) S-332D operational criteria vary seasonally, as prescribed below: 1. Gradual Transition (01 Jan to 14 Feb) operating range from 3.8 to 4.8 feet NGVD. 2. CSSS nesting period (15 Feb through 31 July) operating range from 4.0 to 4.8 feet NGVD. 3. South Dade Typical Planting Season (01 Aug to 31 Dec) operating range from 3.8 to 4.4 feet NGVD.
S-332D High Head Cell	S-332DX1	S-332DX1 connects the S-332D Flow-way to the Southern Detention Area (SDA). S-332DX1 is typically closed from July 15 through Nov. 30 to prioritize releases to S-332D Flow-way toward Taylor Slough. S-332DX1 gates are closed when SDA water stage > 7.5 feet NGVD (SDA S-321C weir crest elevation is at 8.0 feet NGVD).

Basin / Canal	Operational Component	Description and Operating Criteria
		S-332DX1 is limited to 100cfs when SDA water stage < 7.5 feet NGVD and more than 250 cfs flows through S-332D. S-332DX1 may also be open to divert S-332D flows above the calendar based CSSS discharge limits.
L-31N	C-111 North Detention Area (NDA)	No stage constraint; emergency overflow weir crest elevation is 10.0 feet NGVD. S-357 and S-332BW discharge into the NDA.
L-31N	C-111 South Detention Area (SDA)	No stage constraint; emergency overflow weir crest elevation is 10.0 feet NGVD. S-332BW and S-332C discharge into the SDA.
L-31N	S-176	S-176 is the divide structure between the L-31N and C-111 between S-331 and S-177. The structure has an operating Range from 4.5 to 5.0 feet NGVD. S-176 may release up to 200 cfs when S-332B/C/D restricted by CSSS habitat or nesting conditions identified in the COP Biological Opinion (consistent with the ERTP 2016 Biological Opinion) provided that S-176 HW can be maintained within its operational range; Additional releases may be used anytime of the year, without causing S-18C HW to exceed 2.9 feet NGVD, to diminish likelihood of triggering a Level 2 or Level 3 opening at S-197. When S-331 is operating to assist in providing drainage to 8.5 SMA and/or to facilitate the EHWL operations, operating range is lowered to a range from 4.3 to 4.6 feet NGVD. For the duration of these S-331 operations up to 200 cfs can be routed to S-197 as long as S-18C HW > 2.3 feet NGVD. Flow from S-331 resulting in operation of S-332B, S-332C, and S-332D within 0.2 feet of the top of the S-332B/C/D range should result in use of available capacity at S-199 and S-200, and then, if needed, releases of up to 200 cfs at S-197. Priority would be to utilize available capacity at S-332B/C/D, S-199, and S-200 prior to opening S-197. S-176 has a design discharge of 630 cfs.
C-111	S-200 (owned and operated by SFWMD)	The construction and operation of S-200 is a local responsibility and S-200 is operated per the current FDEP Regulatory Permit. S-200 is intended to work in unison with the Frog Pond Detention Area and Aeroject canal features to create a 6-mile long hydraulic ridge in ENP. The operating criteria below are from the December 2016 FDEP permit, File Number 0293559-011. Based on the stage at S-177 HW, the operating range is: 1. Transition from 01 Jan to 14 Feb: 3.0 to 4.0 feet NGVD 2. 15 Feb to 31 July: 3.3 to 4.0 feet NGVD 3. 01 Aug to 31 Dec: 3.0 to 3.4 feet NGVD Pumping at S-200 will cease if stage at monitoring station R3110 > 4.95 feet NGVD (10 cm depth) during the critical portion of the CSSS nesting season from 15 Mar thru 30 Jun. S-200 has a design capacity of 300 cfs (four 75 cfs electric pumps).
C-111	S-199 (owned and operated by SFWMD)	The construction and operation of S-199 is a local responsibility and S-199 is operated per the current FDEP Regulatory Permit. S-199 is intended to work in unison with the Frog Pond Detention Area and Aeroject canal features to create a 6-mile long hydraulic ridge in ENP. The operating

Basin / Canal	Operational Component	Description and Operating Criteria
		criteria below are from the December 2016 FDEP permit, File Number 0293559-011. Based on the stage at S-177 HW, the operating range is: 1. Transition from 01 Jan to 14 Feb: 3.0 to 4.0 feet NGVD 2. 15 Feb to 31 July: 3.3 to 4.0 feet NGVD 3. 01 Aug to 31 Dec: 3.0 to 3.4 feet NGVD Pumping at S-199 will cease if stage at monitoring station EVER4 > 2.36 feet NGVD (3 cm depth) during the critical portion of the CSSS nesting season from 15 Mar thru 30 Jun. S-199 has a design capacity of 300 cfs (four 75 cfs electric pumps).
C-111	S-177	S-177 is in the C-111 south of S-176. The structure has an operating Range from 3.6 to 4.2 feet NGVD. If the rainfall over the past 14 days exceeds 5.5 inches or if significant rainfall is forecasted, then S-177 may be opened to lower S-177 HW to 3.3 feet NGVD. When flows at S-332B/C/D are restricted to achieve the CSSS habitat or nesting conditions, up to 200 cfs may be conveyed through S-177 when S-177 HW is below its operational range. S-177 has a design discharge of 1,400 cfs.
C-111	S-18C	S-18C is used to maintain a desirable freshwater head against northerly saltwater intrusion and to provide water to the panhandle of ENP. The structure has an operating Range from 2.3 to 2.65 feet NGVD S-18C has a design discharge of 2,100 cfs.
C-111	S-197	S-197 releases water from the C-111 to tide. The operation of S-197 is based on the S-18C HW and releases are based on the Levels below: 1. Level 1. When S-18C HW > 2.7 feet NGVD, open S-197 up to 200 cfs; close when S-18C HW < 2.5 ft NGVD. Flow may be adjusted from 0 to 200 cfs within the range. When transition from Level 2, wait 24 hours and reassess. 2. Level 2. When S-18C HW > 2.9 feet NGVD, operate S-197 up to 800 cfs; reduce to Level 1 when S-18C HW < 2.4 feet NGVD. 3. Level 3. When S-18C > 3.3 feet NGVD, operate S-197 up to 2400 cfs; reduce to Level 2 when S-18C HW < 2.4 feet NGVD. Operating intent is to transition down to lower flows while holding S-18C HW < 2.4 feet NGVD. When S-331 is operating to assist in providing drainage to 8.5 SMA then up to 200 cfs can be routed to S-197 as long as S-18C HW > 2.3 feet NGVD. Priority would be to utilize available capacity at S-332B/C/D, S-199, S-200 prior to opening S-197. When in Extreme High Water Condition 2 and S-18C HW is above 2.3 feet NGVD, S-197 releases may be increased to a daily average maximum of 1,200 cfs to accommodate additional flows through S-334 which exceed the South Dade Conveyance System Flow Constraints for S-332B, S332C, and S-332D. The total available capacity at S-197 will be decreased to 600 cfs when S-18C HW falls below 2.3 feet NGVD. S-197 has a design discharge capacity of 2,400 cfs.
C-357 (8.5 SMA)	S-357	S-357 pumps water from the C-357 and C-358 canals to the Northern Detention Area (NDA). The pump station has a normal operational range of 3.5 feet to 6.0 feet NGVD.

Basin / Canal	Operational Component	Description and Operating Criteria
		S-357 will be operated according to the below criteria. 1a. Angels < 6.0 feet NGVD, C-357 will be maintained between 5.5 and 6.0 feet NGVD. 1b. 6.0 ≤ Angels < 6.4 feet NGVD, C-357 will be maintained between 5.0 and 6.0 feet NGVD. 1c. Angels ≥ 6.4 feet NGVD, C-357 will be maintained between 4.5 and 5.5 feet NGVD. 1d. Angels ≥ 6.7 feet NGVD and LPG-2 ≥ 6.6 feet NGVD, C-357 will be maintained between 4.0 and 5.0 feet NGVD until LPG-2 < 6.4 feet NGVD. 1e. Angels ≥ 7.2 feet NGVD, and LPG-2 is projected to remain ≥ 6.6 feet NGVD for 7 days or more, C-357 will be maintained between 3.5 and 4.5 feet NGVD until LPG-2 < 6.4 feet NGVD. 2. LPG-2 ≥ 7.0 feet NGVD for more than 24 hours, C-357 will be maintained between 3.5 and 4.5 feet NGVD until LPG-2 < 6.4 feet NGVD. 3. When G-3273 > 7.5 feet NGVD and LPG-2 stage trend is not expected to recover in accordance with the 8.5 SMA flood mitigation criteria, S-357 HW will be lowered to 2.3 to 3.0 feet NGVD and S-331HW will be lowered to 2.8 to 3.5 feet NGVD until LPG2 can be maintained between 6.2 and 6.6 feet NGVD. At elevated water levels above 7.5 feet NGVD at G-3273, both S-357 and S-331 pump stations will need to be operated in tandem in order to manage the increased seepage from NESRS and L-31N Canal into 8.5 SMA while providing the required flood mitigation. Operating intent is to transition S-331 to normal operations prior to S-357 returning to normal operations. S-357 has a design discharge capacity of 575 cfs When both S-357 and S-331 operate at the lowest canal settings and the 8.5 SMA flood mitigation criteria are not met, WCA 3A flows to NESRS may be temporarily suspended until water levels in 8.5 SMA, specifically the area west of C-357 Canal recede below ground surface elevations. 8.5 SMA flood mitigation criteria shall be assessed against the following criteria: a. water levels in 8.5 SMA are projected to exceed 6 inches below the lowest first floor elevation of residential properties near to L-357W Levee within 48 hours. The lowest first floor elevation will be translated to LPG-2 or LPG-1 (or future in-kind replacement locations), OR b. the maximum target continuous hydroperiod for a rainfall event at LPG-2 or LPG-1 (or future in-kind replacement locations) is projected to be exceeded for more than 7 days, OR c. the maximum target discontinuous hydroperiod for a season at LPG-2 or LPG-1 (or future in-kind replacement locations) is projected to be exceeded for more than 7 days.
C-358 (8.5 SMA)	S-357N	S-357N releases water from the C-358 canal to the C-357 canal. S-375N assists to meet the authorized level of flood mitigation to the residents of the Las Palmas Community (8.5 SMA). The structure has an operating range of 3.0 to 5.0 feet NGVD during wet conditions and 4.0 to 6.0 feet NGVD during dry conditions.

Basin / Canal	Operational Component	Description and Operating Criteria
		S-357N will be limited to 100 cfs during normal operations with the ability to utilize up to 325 cfs design discharge capacity to assist 8.5 SMA flood mitigation.
C-111E	S-178	S-178 releases water from the C-111E to the C-111 upstream of S-18C. The structure is typically open year round but will close if stages fall below 2.0 feet NGVD. S-178 remains full open for tropical storms and hurricanes S-178 has a design discharge of 500 cfs.
S-332D Flow Way	S-328	S-328 releases water from the S-332D Flow-way to Taylor Slough. The structure is opened up to 250 cfs when S-332D flows are greater than 250 cfs. S-328 has a design discharge of 500 cfs.
C-200 Canal	G-737 (owned and operated by SFWMD)	G-737 is downstream of S-200 in the Frog Pond Detention Area. The structure is operated per FDEP regulatory permit (issued to SFWMD). G-737 may be opened when there is a positive (westward) head across the structure; upstream S-200 pump station operations adhere to the CSSS seasonal constraint at R3110. G-737 has a design discharge of 125 cfs.
L-31W Canal	S-205	The S-205 weir is located on the east side of the L-31W Canal at the south end of the S332D Flow-way. It is composed of an approximately 500-foot fixed-crest weir at 6 ft NGVD and an integrated weir with a 96-foot adjustable flashboard riser section (adjusts between 4.25 feet and 6 feet NGVD). The flashboards will remain in place year-round unless extreme conditions occur and require removing the flashboards to increase flows west toward L-31W canal.

7.5 Pre-Storm Operations

The hurricane season is from June through November. When there are tropical depressions, tropical storms, and/or hurricanes in the Atlantic/Caribbean Basin, the National Hurricane Center (NHC) issue tropical cyclone public advisories, forecast advisories, forecast discussions, and strike probability forecasts every 6 hours. It should be noted that the large bands of heavy rain associated with a tropical storms and hurricanes often extend considerable distance beyond the areas of tropical or hurricane force wind.

It is important to emphasize that the C&SF Project is multi-purpose in design, and that pre-storm operations may not prevent flooding, such as experienced after Hurricane Irene in October 1999 or the no name storm in October 2000. The condition of the groundwater system at the time of a storm event is significant and is highly dependent on the amount and extent of rainfall that has already occurred prior to subsequent events. Further, there are areas of Miami-Dade County and south Florida in general, which are at low elevations and for which no amount of drawdown can prevent flooding for large rainfall events. The water levels discussed in this document are target levels and may not be attainable with the antecedent conditions, available capacity and time available.

7.5.1 Hurricane and Tropical Storm Regulations

These regulations may be supplemented by, but not superseded by, SAJ All-Hazards Plan. The All-Hazards Plan should be consulted for related emergency preparation and actions and can be found here: https://intranet.usace.army.mil/sad/saj/EM/Pages/Home.aspx. The SFWMD has specific instructions and regulations contained in their Hurricane Procedure Plan, which is updated annually.

When a hurricane or tropical storm alert is initiated, USACE personnel from the South Florida Operations Office (SFOO) will inspect the S-10s, S-11s, and S-12s and make sure they are operating properly. The Water Management Section, Jacksonville District Office, USACE will provide the desired gate settings to the SFOO personnel to be used during the alert period.

7.5.2 Pre-Storm / Storm / and Storm Recovery Operations for SDCS

This section provides criteria (pre-storm operations) to be used in preparing the SDCS/Miami-Dade County for forecasted storm events. The SDCS is composed of L 31(N), L-31(W), and C-111 canal system and control structures. Currently, for the East Coast Canal System, the canal system and control structures to the east of L-31(N), the SFWMD implements canal drawdown operations based on impending rainfall events. The goal for the SDCS is to implement a similar set of canal drawdown operating criteria which seek to balance the needs of the natural system with the authorized purposes of the C&SF Project, which is multipurpose in scope and includes flood control and water supply.

The SFWMD employs meteorologists who evaluate each tropical event and prepare average forecast errors using NHC forecast tracking maps. The average forecast error means when the Hydrometeorological Prediction Center (HPC) or NHC has forecasted a specific track and the cyclone could end up anywhere in that swath within the next 72 hours with around a 60 percent confidence level. The average forecast error swath is based on the 10-year average of forecast errors.

The SFWMD Operations Office has defined operational procedures to be implemented depending on the timing or amount of advance warning prior to the onset of tropical storm force winds. USACE also has defined, in the Master Water Control Manual for each part of the C&SF Project, a water control plan with instructions for pre-storm operations for structures around Lake Okeechobee and the WCAs. The SFWMD operational procedures are delineated based on time prior to onset of Tropical Storm force winds; the specific operating procedures for these time frames will be described in further detail in this document. Time frames are briefly summarized as follows:

1. 72 to 48 hours prior to the impact of tropical storm force winds, is earliest level of preparation when the system is evaluated and initial adjustments made to operations depending on the forecast and nature of the storm. Coordinate with USACE and local drainage districts.
2. 48 to 24 hours prior to the impact of tropical storm force winds, continue pre-storm operations and coordination with USACE and local drainage districts.
3. 24 to 12 hours prior to the impact of tropical storm force winds, bring telemetry-controlled sites to final pre-storm configuration, establish alternate emergency control station if necessary.

The remaining levels of preparation are 12 to 0 hours prior to the impact of tropical storm force winds; during the event; and recovery after the event. It is important to note that some storms form close to land and make landfall with less than 48 hours of advance warning (e.g., Tropical Storm Emily, 2017).

7.5.2.1 Notification and Briefing Process

The Executive level will be briefed prior to initiation of pre-storm operations. This may occur prior to 72 hours or as soon as the average error forecast swath shows south Florida to be likely to be in the path of a storm.

7.5.2.2 Drawdown Implementation

Between 24 and 72 Hours prior to forecast arrival of tropical storm force winds:

The initiation of the pre-storm drawdown criteria will be triggered for the SDCS when Miami-Dade County is within the average error forecast swath as developed by the NHC. (**Table 7-4**)These pre-storm drawdown levels are not less than the level at which water supply deliveries are made during dry periods, that is 1.5 feet below optimum canal levels, except the reach north of G-211, which is 1.0 foot below current, normal operating levels. These levels are target levels and may not be attainable.

Table 7-4. Pre-Storm Drawdown Targets.

Canal	Reach	Target Level for Draw-down (feet NGVD)
L-31(N)	S-335 to G-211	5.0
L-31(N)	G-211 to S-331	4.0*
L-31(N)	S-331 to S-176	4.0
C-111	S-176 to S-177	3.0
C-111	S-177 to S-18C	2.0
C-111	S-18C to S-197	No change**
C-357	S-357 HW	3.5

*If the water surface elevation measured at 8.5 SMA LPG1 or LPG2 is 5.5 feet NGVD or below, then 4.0 would be the target; otherwise, 3.5 feet NGVD at the headwater of S-331 will be the target.
**Operation as specified in the SFWMD structure book for S-197

In an effort to achieve the specified drawdown targets, a sequence of operational actions is recommended as described in **Table 7-5**. The goal is achieve one target before preceding the next sequence, however, it may not be possible to achieve the target level and operations will proceed as based on the best available information at the time. If practical with the existing conditions and time available the L-31(N) reach from S 331/S 173 to S-176 will be lowered using only S-332B, S-332C, and S 332D.

Table 7-5. Pre-Storm Drawdown Sequencing.

Sequence	Canal	Reach	Target Draw-Down Level (feet NGVD)
1	L-31(N)	S-331 to S-176	4.0
1	C-111	S-176 to S-177	3.0
2	L-31(N)	G-211 to S-331	4.0*

Sequence	Canal	Reach	Target Draw-Down Level (feet NGVD)
2	L-31(N)	S-335 to G-211	5.0

* If the water surface elevation measured at 8.5 SMA LPG1 or LPG2 is 5.5 feet NGVD or below, then 4.0 would be the target, otherwise, 3.5 feet NGVD at the headwater of S-331 will be the target.

S-197: No change is suggested in the operational criteria for this structure 48 to 72 hours ahead of storm impact. The operational criteria is defined in **Table 7-3** and the SFWMD structure book for S-197.

12 to 24 Hours Prior to Forecast arrival of tropical storm force winds.

Continue operations as previously described, but with the following considerations:

S-331: Pump when downstream conditions allow.

S-332B/C/D: Continue Pumping. Operations are controlled from S-331, which is hardened.

S-197: Operation of this structure requires mobilization of field personnel and equipment to operate the gates, but is being automated now. The S-197 automation is projected to be completed prior to implementation of COP in August 2020. It will have a back-up generator as well as retain its ability to be manually operated. It is not safe to operate this structure during storm conditions.

Recovery (Conditions immediately after the storm ends or if the storm forecast changes such that Miami-Dade County is no longer likely to be affected.)

Operations during Recovery consist of: 1) Maximizing releases at water control structures to minimize flooding and 2) make the transition back to operational regime in place prior to the storm. (see **Table 7-6**)

Operations may also be returned to levels prior to implementing pre-storm operations as soon as the Miami-Dade County is no longer within the average forecast error swath.

Plan for Worst Case: Recovery will be necessary if storm conditions result in significant rainfall in the Miami-Dade County area. The target for operations would be to return to operational regime in place prior to the storm. However, use of water control structures (e.g., S-332B) under emergency flood control mode will begin or continue until recovery is complete. The following operations are suggested to continue to operate in emergency flood control mode:

Table 7-6. Recovery Operations.

Structure	Status
S-331	Pump when downstream conditions allow
S-197	Open depending on conditions
S-332B/C/D	Continue Pumping. Operation is from S-331, which is hardened

It is not possible to describe the sequence of operational actions during recovery prior to a particular storm event. The sequence of operational actions will depend largely on the rainfall distribution and rainfall amounts resulting from the storm.

Back to Normal Mode (Operational regime in place prior to the storm)

The following conditions must be met before ceasing emergency flood control mode and resuming normal mode:

1. The Department of the Interior (DOI) will advise USACE of any overflow problems or adverse impacts to the CSSS Subpopulation F that may be occurring for USACE to use in their decision regarding pumping reductions at S-332B and S-332C.
2. Otherwise, stages in canal reaches must be within the specified operating ranges in place prior to the change in pre-storm or storm operations to resume normal mode.

When these conditions are met, the normal mode, as defined by operational regime in place prior to the storm, may be resumed.

This document may be modified depending on additional information, as it becomes available.

7.5.3 Operations for Other than Named Events

SFWMD will monitor antecedent conditions, groundwater levels, canal levels and rainfall. If these conditions indicate a strong likelihood of flooding, SFWMD will make a recommendation to USACE to initiate pre-storm operations. USACE will review the data, advise ENP, FWS of the conditions, consult with the Miccosukee Tribe and make a decision whether to implement pre-storm drawdown or otherwise alter system wide operations from those contained in the table.

In addition, the Chairman of the Miccosukee Tribe of Indians of Florida or his designated representatives will monitor the conditions in WCA 3A and other tribal lands and predicted rainfall. If the Miccosukee Tribe determines these conditions indicate jeopardy to the health or safety of the Miccosukee Tribe, the Chairman will make a recommendation to USACE to change the operations of the S-12 structures. USACE will review the data and advise appropriate agencies of the conditions, and the District Commander will personally consult with the Chairman prior to making a decision whether to implement changes to the S-12 operations.

7.6 Consistency with the Identification of Water and Reservations or Allocations for the Natural System

The operating criteria in this WCP are consistent with the operating criteria used to identify the water made available for the natural system during wet, average, and dry periods and also consistent with the water reservations or allocations for the natural system made by the State in accordance with section 601 or WRDA 2000.

7.7 Consistency with Savings Clause and State Assurance Procedures

This WCP combines the 2012 WCP water management operations for WCA 1 and WCA 2 with the new water management operations developed for WCA 3, ENP, and the SDCS in the COP. COP developed the water management operations for the WCA 3A and WCA 3B outlets, structures in the L-31N and the C-111 basins constructed as part of the C&SF Project and the recently constructed components of the MWD and C-111 SD projects. WRDA 2000 provides the framework for all structural and operational changes to the C&SF project and there are no special operations necessary to fulfill the Savings Clause Provisions.

7.8 Drought Contingency Plan

Regional Drought Contingency Plans (DCP) are written to provide a decision making process to implement water-conservation measures during droughts, review the operational flexibility of the regional system in a drought, and address the potential problems associated with an extreme drought. The Drought Contingency Plan for WCAs, ENP, and ENP-SDCS can be found in Appendix C of this SOM. The SFWMD has established rules and regulations that establish priorities and define procedures for water conservation and restricting water use during conditions of water shortage. The "Water Shortage Plan" published by the SFWMD is part of the Drought Contingency Plan and can be found using the following link:

https://www.sfwmd.gov/sites/default/files/documents/40e-21_0.pdf

SFWMD's Water Supply Plan also represents the majority of the water management-related contents of the Drought Contingency Plan and can be found using the following link:

http://www.sfwmd.gov/portal/page/portal/xweb%20-%20release%203%20water%20supply/water%20supply%20planning

7.9 Flood Emergency Action Plan

The project's Flood Emergency Action Plan outlines operating criteria for projects that require flood damage reduction operations. The plans include an explanation of existing and proposed operating criteria, release scheduling procedures during a flood, use of storage, downstream notification procedures, and special safety concerns. Although there are currently no Flood Emergency Action Plans in the region, it is anticipated that CERP projects will include these plans.

7.10 Deviation from Normal Operating Criteria

The USACE Jacksonville District Commander is occasionally requested by the non-federal sponsor to approve deviations from normal operating criteria. The Water Management Section is responsible for handling the deviation requests and transmitting them through the District Commander to the Division Engineer (USACE, SAD) for final decision. Prior approval for a deviation is required from USACE, SAD, except as noted below. Deviation requests usually fall into the categories emergenices, unplanned minor deviations, or planned deviations.

7.10.1 Emergencies

Examples of emergencies that may result in a need to deviate from normal operating criteria include: drowning and other accidents; failure of the operation facilities; chemical spills; treatment plant failures; and other temporary pollution problems. Water control actions necessary to abate the problem should be implemented immediately unless such action would create equal or worse conditions. USACE, Jacksonville District must be informed of the problem and the emergency operating changes as soon as practicable. A written confirmation showing the deviation and conditions will be furnished to USACE, Jacksonville District by the operating agency after the incident. USACE, Jacksonville District will communicate with USACE, SAD as appropriate. In addition, the operating agency should inform the non-federal sponsor, the State of Florida (DEP and SFWMD), and the DOI as appropriate.

7.10.2 Unplanned Minor Deviations

There are unplanned instances that create a temporary need for minor deviations from the normal operating criteria, although they are not considered emergencies. Construction accounts for the major portion of these incidents requiring minor deviations. Examples of activities that may require short-term deviations include construction of utility stream/canal crossings, bridge work, and major construction contract. Changes in releases are sometimes necessary to carry out maintenance and inspection of facilities. Requests for changes in release rates generally involve time periods ranging from a few hours to a few days. Each request is analyzed on its own merits. In evaluating the proposed deviation, consideration is given to upstream watershed conditions, potential flood threat, the existing condition of the lake/reservoir/storage area, and possible alternative measures. In the interest of maintaining good public relations, requests for minor deviations are generally granted, providing there are no adverse effects on the overall regulation of the project for the authorized purposes. Approval for these minor deviations normally will be obtained from USACE, Jacksonville District Water Management Section by telephone. Written confirmation explaining the deviation and its cause will be furnished to the USACE, Jacksonville District Water Management Section by the operating agency. USACE, Jacksonville District will communicate with USACE, SAD as appropriate. In addition, the operating agency should inform the non-federal sponsor, the State of Florida (DEP and SFWMD), and the Department of the Interior as appropriate.

7.10.3 Planned Deviations

Each circumstance should be analyzed on its own merits. The requesting agency will provide sufficient data on flood potential, lake/reservoir/storage area and watershed conditions, possible alternative measures, benefits to be expected, and probable effects on other authorized and useful purposes, letter to USACE, Jacksonville District. USACE, Jacksonville District will analyze each proposed deviation and will request approval from USACE, SAD as appropriate. In addition, the operating agency should inform the non-federal sponsor, the State of Florida (DEP and SFWMD), and the DOI as appropriate.

7.11 Rate of Release Change

Generally, a daily step change of 500 cfs is the maximum amount of change desired. Gradual transitions are intended to support the health of wildlife.

7.12 Seepage Control

There are many areas throughout the project area that are highly porous and overlie the Biscayne Aquifer. Seepage into the canals can reduce the conveyance capacity but the normal operations specified in **subection 7.4** take into account seepage control.

7.13 Aquifer Storage and Recovery System Plan

This section is not applicable to the PSRP which does not include an Aquifer Storage and Recovery System.

7.14 Adaptive Management

Adaptive management has been recognized as a critical element of CERP since promulgation of the enabling legislation (WRDA 2000). Congress authorized the use of an adaptive management approach for CERP, to allow the Plan to proceed in the face of existing uncertainties and incomplete scientific data.

Adaptive Management for the Plan is defined as the "continuous improvements to the Plan to respond to new information, new or updated modeling; information developed through the assessment principles contained in the plan; and future authorized changes to the Plan in order to ensure that the goals and purposes of the Plan are fulfilled."

The adaptive management strategy for CERP is intended to guide the implementation of the Comprehensive Plan. It will be used to assess the responses of the south Florida ecosystem, and to determine whether these responses match expectations, including anticipated performance levels. An essential element of adaptive management is the development and conduct of a scientifically rigorous assessment program to analyze and understand responses of the system to implementation of the Comprehensive Plan which includes monitoring component to address biological, hydrological, and water quality parameters. In accordance with the programmatic regulations, Restoration Coordination and Verification (RECOVER) is required to prepare a technical report, at least once every five years, that presents an assessment of whether the goals and purposes of the Comprehensive Plan are being achieved, including whether the interim goals and interim targets are being achieved or are likely to be achieved. Based upon results of the monitoring and assessment efforts, operational changes may be recommended to improve individual project performance and/or Comprehensive Plan performance. Although the MWD project, C-111 SD project, and COP are not part of CERP, COP developed an AMMP (Appendix C of the COP EIS) and its primary objective is to identify the monitoring necessary to inform decision-makers, COP partner agencies, and the public on achieving project success.

COP's planning process was based on knowledge of the greater Everglades; understanding of the problems and opportunities; and the evaluation of alternatives and estimation of the potential project performance. However, while the WCP and Environmental Impact Statement (EIS) are based on a wealth of knowledge, some uncertainty inevitably exists in such a complex system. Such uncertainties include fine-tuning the computer models used to accurately predict performance and meet constraints under real world conditions, determining how to best optimize actions to meet the needs of competing objectives and use the water available safely to the best advantage (e.g., flood control versus flows into Everglades National Park (ENP)), and how to address and adapt COP to changes in both the environment (e.g., sea level rise) and due to human activities (e.g., additional operational structures implemented through CEPP). The COP adaptive management process is a tool to help address such remaining uncertainties.

7.15 References

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APPENDIX C. COMBINED OPERATIONS PLAN (COP) ADAPTIVE MANAGEMENT AND MONITORING PLAN

C.1 INTRODUCTION TO APPENDIX C

C.2 COP ADAPTIVE MANAGEMENT

C.3 ECOLOGICAL MONITORING PLAN

C.4 WATER QUALITY AND HYDROLOGY MONITORING PLAN

C.5 WATER QUALITY AND HYDROLOGY MONITORING PLAN SOUTH OF S-331

C.6 WATER QUALITY AND HYDROLOGY MONITORING PLAN FOR 8.5 SMA FLOOD MITIGATION

C.7 CULTURAL RESOURCES MONITORING PLAN

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List of Acronyms

ADaPT	Automated Data Processing Tool Software
ADVM	Acoustic Doppler Velocity Meter
AM	Adaptive Management
AMMP	Adaptive Management and Monitoring Plan
BAMM	Baseline and Modification modeling
BO	USFWS Biological Opinion
BWRF	Biweekly if Recorded Flow
C&SF	Central and Southern Florida
CDOM	Chromophoric (Colored) Dissolved Organic Matter
CEPP	Central Everglades Planning Project
CERP	Comprehensive Everglades Restoration Plan
Cfs	Cubic feet per second
Chl	Chlorophyll
COP	Combined Operations Plan
CSSS	Cape Sable Seaside Sparrow
DO	Dissolved Oxygen
DOI	Department of the Interior
DQO	Data Quality Objectives
EA	Environmental Assessment
EB	Equipment Blank
ECB	Existing Condition Baseline
EDEN	Everglades Depth Estimation Network
EIS	Environmental Impact Statement
EM	Engineering Manual
ENP	Everglades National Park
ERTP	Everglades Restoration Transition Plan
FB	Field Blank
FCEB	Field Cleaned Equipment Blank
FDACS	Florida Department of Agriculture and Consumer Services
FDEP	Florida Department of Environmental Protection
FDOT	Florida Department of Transportation
FEB	Flow Equalization Basin
FL Bay	Florida Bay
FWM	Flow Weighted Mean
HSI	Habitat Suitability Index
LECSA	Lower East Coast Service Area
LRR	Limited Revaluation Report
LTL	Long Term Limit
MAP	RECOVER Monitoring and Assessment Plan
MOM	Management Options Matrix
MWD	Modified Water Deliveries Project
MWD GDM	Modified Water Deliveries General Design Memorandum
NEPA	National Environmental Policy Act
NESRS	Northeast Shark River Slough
NGVD	National Geodetic Vertical Datum
NPS	National Park Service

P.L.	Public Law
PDT	Project Development Team
PDT+	Project Delivery Team, Plus
PIR	Project Implementation Report
PLMP	Project-Level Monitoring Plan
PM	Performance Measure or Constraint
QA	Quality Assurance
QAOT	Quality Assurance Oversight Team
QASR	Quality Assurance System Requirements
QC	Quality Control
RACU	Remote Acquisition and Command Unit
RECOVER	CERP Restoration, Coordination & Verification Program
RS	Replicate Samples
SDCS	South Dade Conveyance System
SET	Soil or Surface Elevation Table
SFCN	NPS South Florida / Caribbean Network
SFWMD	South Florida Water Management District
SMA	Square Mile Area
SRF	Systematic Reconnaissance Flights
SRS	Shark River Slough
TBD	To Be Determined
TP	Total Phosphorous
TS	Taylor Slough
UNC	Uncertainty
USACE	U. S. Army Corps of Engineers
USEPA	U. S. Environmental Protection Agency
USFWS	U. S. Fish and Wildlife Service
USGS	U. S. Geological Survey
UTS	Upper Taylor Slough
WADEM	Wading Bird Distribution Evaluation Model
WBS	Work Breakdown Structure
WCA	Water Conservation Area
WCP	Water Control Plan
WRDA	Water Resources Development Act
WRF	Weekly if Recorded Flow

C.1 Introduction to Appendix C: Adaptive Management and Monitoring plans for COP

The primary objective of the Combined Operations Plan (COP) Adaptive Management and Monitoring Monitoring Plan (COP-AMMP) is to identify the monitoring necessary to inform decision-makers, COP partner agencies, and the public on achieving project success. A successful COP will protect existing resources, as well as address uncertainties related to project performance that can be addressed with efficiently structured hypothesis testing strategies. The COP-AMMP meets the needs for a monitoring plan to evaluate success and an adaptive management plan required by U.S. Army Corps of Engineers (USACE) implementation guidance (USACE 2009) for the Water Resources Development Act (WRDA) 2007 Section 2039 (WRDA 2007). COP's planning process was based on knowledge of the greater Everglades; understanding of the problems and opportunities; and the evaluation of alternatives and estimation of the potential project performance. However, while the COP Water Control Plan and Environmental Impact Statement (EIS) are based on a wealth of knowledge, some uncertainty inevitably exists in such a complex system. Such uncertainties include: fine-tuning the computer models used to accurately predict performance and meet constraints under real world conditions; determining how to use available water to the best advantage while maintaining flood control; and anticipating how to adapt COP to changes in both the environment (e.g., sea level rise) and due to human activities (e.g., additional operational structures implemented through CEPP). The COP adaptive management process is a tool to help address such remaining uncertainties.

C.1.1 COP Objectives, Constraints and Planning Considerations

Monitoring and adaptive management in this plan must be tied to projects goals and objectives or linked to compliance with regulations or agreements and clearly linked to management decision-making. Below are the goals, objectives, constraints, and planning considerations including in the development of the COP-AMMP.

Goal of the Combined Operation Plan: The purpose of the COP is to define water management operations for the Water Conservation Area (WCA-3A) and WCA-3B outlets, structures in the L-31N and C-111 basins constructed as part of the Central and Southern Florida (C&SF) Project and the recently constructed components of the Modified Water Deliveries (MWD) and C-111 South Dade Projects.

Objectives of the COP include:

1. Improve water deliveries (timing, location, volume) into ENP and take steps to restore natural hydrologic conditions in ENP given current C&SF infrastructure and features expected to be completed by the time of implementation, to the extent practicable by
    a) Changing schedule of water deliveries so that it fluctuates in consonance with local meteorological conditions, including providing for long term and annual variation in ecosystem conditions in the Everglades (Timing) (P.L. 101-229, Section 101b)
    b) Restoring Northeast Shark River Slough (NESRS) as a functioning component of the Everglades hydrologic system (Location) (P.L. 101-229, Section 101b)
    c) Adjusting the magnitude of water discharged to ENP to minimize effects of too much or too little water (Volume) (1992 MWD GDM, Section 44)
2. Maximize progress toward restoring historic hydrologic conditions in the Taylor Slough, Rocky Glades, & eastern Panhandle of ENP.

3. Protect the intrinsic ecological values associated with WCA-3A and ENP.
4. Minimize the damaging freshwater flows to Manatee Bay/Barnes Sound through the S-197 structure and increase flows through Taylor Slough and coastal creeks (1994 C-111 GRR, Section 5.2)
5. Include consideration of cultural values and tribal interests & concerns within WCA-3A and ENP.

Constraints: Additional constraints considered during AMMP development include:

1. Maintain the authorized purposes of the C&SF project
2. 1962 Flood Control Act (P.L. 87-874) Authorizing Project Works in South Dade County
3. 1968 Flood Control Act (P.L. 9-483) Authorizing the South Dade Conveyance System (SDCS)
4. 1989 ENP Expansion Act (Everglades National Park Protection and Expansion Act of 1989, P.L. 101-229)
5. 1992 MWD GDM (1992 General Design Memorandum): mitigation for project induced flood damages for the 8.5 Square Mile Area (SMA), the Osceola Indian Camp, and the Tiger Tail Indian Camp.
6. Maintain the level of flood reduction associated with the 1994 C-111 GRR: flood damage reduction Project recommended plan.
7. Everglades Restoration Transition Plan (ERTP) WCA-3A Regulation Schedule (pending results of the Baseline and Modification Modeling [BAMM]). Maintain Zone A of the WCA-3A Regulation Schedule to not exceed the 1960 WCA-3A 9.5 to 10.5 feet, National Geodetic Vertical Datum (NGVD) Regulation Schedule, as specified within the ERTP Interim Water Management Criteria for WCA-3A Zone A and measured by the 3-gage average (Sites 63, 64, and 65). (Source: USACE Draft 2011 ERTP EIS, Appendix A-5: Analysis of Standard Project Flood, WCA-3A). Additional USACE guidance resultant from the USACE WCA Regional Flood Routing Analysis Study (Baseline and Modification Modeling, or BAMM) will also be incorporated into the planning constraints if relevant new information from this analysis is available prior to completion of the COP.
8. L-29 Canal maximum stage (8.5 feet NGVD) (2008 Tamiami Trail LRR). Based on coordination between the USACE, the Florida Department of Transportation (FDOT), and other state agencies conducted for the LRR, while the target stage for the L-29 Canal is 8.5 feet, it is understood that the average October wet season elevation is expected to be approximately 7.89 feet NGVD based on multiple years (36-year simulated period-of-record). Since this elevation is an average, during some individual years the average October elevation may exceed the 7.89 feet stage and other years it would be below 7.89 feet. The average elevation will be dependent on the meteorological conditions of that year. However when considering multiple years the October average should be at or below 7.9 feet NGVD. (Source: 2008 TTM Limited Revaluation Report [LRR]). The LRR additionally specifies operational scenarios during which all inflow structures to L-29 Canal will be closed and all inflows terminated, allowing the canal to naturally recede (the complete excerpt from the 2008 LRR, Section 6.1.3)
9. 2008 Tamiami Trail Modifications Relocation Agreement (FDOT/USA)
10. 2000 General Re-evaluation Report for the 8.5 SMA
11. 2016 Canal 111 South Dade Final Limited Reevaluation Report

Planning Considerations: COP planning considerations taken to account are listed below.

1. Burial Resources Agreement
2. Avoid or minimize adverse effects to cultural resources. Explore opportunities to develop monitoring protocols for "at risk" cultural resources
3. Water Quality Standards (CEPP language - Section 6.3.2 Paragraphs 1-4)
4. Maintain multi-species objectives (2012 WCP) and comply with requirements of the applicable BO from USFWS to include the July 2016 ERTP BO and the CERP C-111SC Western Project
5. Consider compatibility with future restoration actions including CEPP. Reasonably connect the planning under this project authority to other near-term changes that are likely to be implemented in the system in the next few years using an Adaptive Management framework.
6. Explore opportunities for enhancing the recovery of federally and state listed species under the Endangered Species Act, the USACE's authorities for MWD and C-111 projects and operational considerations.
7. Explore opportunities to enhance flood control and mitigation.

U.S. Fish and Wildlife Service (USFWS) Biological Opinion: The COP - AMMP will contain the monitoring and associated costs required under the USFWS Biological Opinion (BO) and other agency permits that are needed to protect and conserve natural resources. Currently the monitoring recommended reflects the 2016 ETRP BO. This monitoring is considered a "placeholder" as monitoring required under the BO is not yet included in the Draft EIS. However this monitoring will be updated once a new BO is received. A BO will be received after submittal of a Biological Assessment by USACE to USFWS concurrent with release of the Draft EIS for public review.

Coordination with CERP Restoration, Coordination, and Verification (RECOVER) Monitoring and Assessment Plan (MAP), CEPP, and other programs: The COP-AMMP is and will continue to be closely coordinated with the CERP RECOVER MAP and draws strongly from monitoring identified for the Central Everglades Planning Project (CEPP) Adaptive Management and Monitoring Plans as this CERP project occurs in the same action area as COP. Although COP is legally defined as a pre-CERP project, the spatial footprint and objectives overlap strongly. Thus this effort took advantage of work done in the CERP-RECOVER MAP and CEPP to use already developed conceptual models, high priority uncertainties identified by CEPP, and existing monitoring where they were consistent with the needs, objectives, and scope of COP. Local adaptations of existing monitoring are suggested if necessary. This allows the COP-AMMP to take advantage of existing monitoring efforts, knowledge, and information and thereby leverage dollars committed and spent elsewhere to avoid redundancies and ensure cost-effectiveness.

C.1.2 Definitions of Adaptive Management and Types of Monitoring

The definition of adaptive management for the COP-AMMP is as follows:

Adaptive Management – A scientific process for continually improving management policies and practices by learning from their outcomes; Adaptive Management links science to decision making to improve restoration performance, efficiency, and probability of success. In the context of Everglades restoration, adaptive management is a structured approach for addressing uncertainties by testing for

best project designs and operations to achieve restoration goals and objectives, linking science to decision making, and adjusting implementation, as necessary, to improve the probability of restoration success.

The COP-AMMP involves several types of monitoring:

- *Uncertainty Monitoring* – Also called adaptive management monitoring (or a targeted study) to provide resolution to a question faced during planning or implementation regarding the best actions to take to achieve desired goals and objectives within constraints.
- *Performance Monitoring* – Performance monitoring is used to determine if the project is meeting its goals and objectives.
- *Compliance / Constraint Monitoring* – Compliance and constraint monitoring is used to determine whether the project is meeting its requirements and constraints under applicable laws and agreements.

Some overlap exists between performance monitoring and uncertainty monitoring, especially in the ecological arena as there is uncertainty whether "getting the water right" is sufficient to restore other natural resources such as wading birds across the landscape. In this document monitoring of wading birds across the landscape is addressed as an adaptive management uncertainty.

C.1.3 Structure of the COP Adaptive Management and Monitoring Plan

The COP-AMMP is an appendix to the COP EIS document and contains seven sections organized by major topic category, followed by references:

C.1 Introduction;

C.2 COP Adaptive Management;

C.3 Ecological Monitoring Plan;

C.4 Water Quality and Hydrology Monitoring Plan;

C.5 Water Quality and Hydrology Monitoring Plan South of S-331;

C.6 Water Quality and Hydrology Monitoring Plan for 8.5 SMA Flood Mitigation;

C.7 Cultural Resources Monitoring Plan.

Where possible, COP monitoring described here relies on existing monitoring resources including physical instrumentation, stations, locations, servicing, and analysis efforts funded by RECOVER, CERP sponsors, and partner agencies. Therefore the monitoring requirements described and budgeted in the COP adaptive management and monitoring plan are limited to the additional, marginal increase in monitoring resources and analysis efforts needed to address COP-specific questions. The COP adaptive management and monitoring plan relies on other monitoring in order to keep its monitoring costs to a minimum and assumes these other monitoring efforts will continue at least for the period required by COP.

Section C.2: Adaptive Management – the COP Adaptive Management section (Section C.2), provides the strategies to address prioritized project uncertainties that will be faced as COP progresses toward

achieving goals and objectives while remaining within constraints. Each strategy follows a scientific approach that identifies the questions to be answered, methodology, triggers and/or thresholds to inform progress and support decisions regarding the need to adjust COP to improve performance, and recommendations for management options.

The types of management options included in the COP Adaptive Management Plan can be described as the following:

- *Inform Operational Decisions*– results inform changes to operations within the flexibility already allowed for within the Water Control Plan.
- *National Environmental Policy Act (NEPA) Covered COP Adaptive Management Contingency Options* - if observed conditions in the system indicate a need to implement contingency options described within the adaptive management strategies or management options matrix (MOM), several of the more limited contingency options that are described in sufficient detail (and do not require construction modifications) are implementable under the authority of this document.
- *Actions requiring additional NEPA permitting and review* – Actions requiring additional construction or otherwise not covered with sufficient specificity in the EIS will require additional environmental review and public comment and potentially additional modeling or analyses.
- *Informing CEPP or Other Project Implementation* - results may inform CEPP or other agencies regarding the next phase of CEPP project sequencing or other advisable actions that are beyond the scope of COP, such as construction of additional seepage barriers.

Management Options Matrices (MOMs) are provided as a quick reference to the adaptive management options and to link monitoring, triggers and thresholds, and the management options. The descriptions and summary matrices are intended to inform decision-makers, COP partner agencies, and the public on potential actions to improve restoration performance. ***Implementation of adaptive management options is not automatic; the options are suggestions that capture current understanding of potential future issues and solutions. A few AM options, as identified in Table C.2-23 are currently defined within the COP Water Control Plan and are supported in the environmental effects analysis contained in the EIS.***

The monitoring identified in this plan is considered part of the adaptive management strategies in accordance with WRDA 2007 and its subsequent implementation guidance. The monitoring is specific to uncertainties raised during COP planning which require refined data to address, and which will inform feasible options to adjust COP as identified in the COP Adaptive Management and Monitoring Plan (COP-AMMP). Per USACE planning guidance ER-1105-2-100 Appendix E, the intent of focusing on the uncertainties is to address questions and reduce the uncertainties. For COP in particular, the purpose is to ensure that water in south Florida is distributed optimally to meet the requirements for flood control, a reliable water supply, and effective environmental restoration.

Section C.2.6 describes the processes and institutional structures through which adaptive management will be implemented. These processes include feedback from Adaptive Management Uncertainties, the Ecological Monitoring Plan, and the Water Quality and Hydrology Monitoring Plans, which for simplicity are presented together in this section.

Part C.3: Ecological Monitoring Plan – The primary purpose of the COP Ecological Monitoring Plan is to identify the monitoring necessary to inform decision-makers, COP partner agencies, and the public on COP's achievement of its project objectives, i.e. its achievement of success. This monitoring will be

leveraged as much as possible to contribute to COP adaptive management. However, given the scope and scale of COP, the ecological monitoring and the monitoring identified in the COP adaptive management uncertainties are not one-and-the-same as that identified in the COP Ecological Monitoring Plan because the ecological monitoring plan focuses on COP's success at meeting project objectives (per WRDA 2007 guidance) while the monitoring specified in the adaptive management plan focuses on addressing project uncertainties (per WRDA 2007 and subsequent guidance) that may be more specific in their location and/or scale than the overall project objectives. Also, the adaptive management uncertainties focus on project adjustments that could be made relatively easily within WCP flexibility to improve project performance and/or ecological outcomes, and the monitoring described in the corresponding section of the AMMP will inform such adjustments. Whereas monitoring for overall project success for a project as large as COP may not provide the level of detail needed to answer the specific adaptive management questions to inform location-specific adjustments. In summary, since the project objectives and the uncertainties are not redundant then neither is the monitoring, but the plans have been designed to work together and inform each other as much as possible and it is encouraged that any future refinements of these plans include continual improvements of the streamlining between plans.

The ecological performance measures identified for COP are derived from the modeling performance measures used during Increment 1 and Increment 2 alternative comparisons.

The ecological monitoring plan also contains the monitoring expected under the USFWS BO and other agency permits required to protect and conserve natural resources. This monitoring will be updated once the USFWS Biological Opinion on this EIS is received.

Part C.4: Water Quality and Hydrology Monitoring Plan – This plan identifies the necessary water quality, hydrologic monitoring needed to operate COP project structures and evaluate compliance with State and Federal regulations. The monitoring plan is directly derived from the COP Increment 2 monitoring plan.

Part C.5: Water Quality and Hydrology Plan South of S-331 – Identifies the necessary water quality, hydrologic monitoring needed to operate COP project structures and evaluate compliance with State and Federal regulations in the area south of S-331. The monitoring plan is directly derived from the COP Increment 2 monitoring plan.

Part C.6: Water Quality and Hydrology Plan South for 8.5 SMA Flood Mitigation – Identifies the necessary water quality, hydrologic monitoring needed to operate COP project structures and evaluate compliance with State and Federal regulations in the 8.5 SMA. The monitoring plan is directly derived from the COP Increment 2 monitoring plan.

Part C.7: Cultural Resources Monitoring Plan – The plan contains the necessary monitoring to better understand the response of archaeological deposits to changes in water elevation for future operational plans.

C.2 COP Adaptive Management

C.2.1 How the COP-AMMP was developed: Identification, Screening and Prioritization of COP Uncertainties

The COP-AMMP was developed through a workshop in July 2019 during which adaptive management uncertainties were identified and prioritized and workshop attendees where broken into three sub-teams to detail the strategies of the adaptive management uncertainties and to develop plans for performance monitoring and monitoring for compliance and other constraints.

A large list of possible uncertainties was developed prior to the workshop. The initial list was screened using the following criteria:

1. Must be directly related to COP goals, objectives, or 'constraints'.
2. Must be at project-scale. Although COP is large, it is not system-wide scale.
3. Must have adaptive management options, i.e., ability to be addressed during implementation, improved by adjusting COP. In some cases additional ability to address the uncertainty with a future increment of restoration can be noted as a "future opportunity", but this feature is not sufficient in itself to pass this COP AM criteria.
4. Must be an uncertainty. Don't include items that are already known.
5. The uncertainty needs at least one attribute that is measurable that will provide information to resolve the uncertainty, i.e. the attribute must be a trait able to change in the timeframe of the adaptive management plan, and one that is distinct from the 'background noise' of natural variability. Long-term (multi-decadal) changes need a faster responding surrogate-measure for the adaptive management plan.
6. Some items may remain on the uncertainties list to "Keep them in view". Some examples a) observing effects of flow in NESRS on peat dynamics, which is important but hard to link to management options; b) remaining watchful of the potential for COP to cause hydrologic changes in the Pennsuco wetlands east of the project area. Due to the need to keep these important topics in view, they are kept on the uncertainties list due solely to this criterion.

The workshop attendees reviewed the initial list of potential COP adaptive management uncertainties, added additional uncertainties, and then proceeded to rank each uncertainty according to level of "Risk", "Knowledge" and "Relevance to Adaptive Management" using the criteria defined below.

Risk: What is the risk (high, medium, low) of not meeting COP restoration goals if this uncertainty is not addressed?

- Low risk means that even if the uncertainty isn't addressed, it doesn't pose much risk to achieving COP goals and objectives.
- Medium risk means that if the uncertainty isn't addressed it may or may not affect achievement of a goal/objective.
- High risk means that without addressing this uncertainty, there is a high risk to achieve COP goals and objectives.

Knowledge: What is the level of (high, medium, low) understanding of this uncertainty (i.e., how much is known about this uncertainty)?

- Low understanding means little is known about the question/issue or how to address it;
- Medium understanding means some information is known in some geographical areas, but not all;
- High understanding means a lot is known about addressing this question in multiple geographical areas.

Relevance to Adaptive Management for COP: What is the level of confidence (high, medium, low) that anything could be done to address the uncertainty? The team's preliminary identification of management options helped to determine this.

- Low confidence means that even if this uncertainty is addressed, COP or operations will not be able to be modified given the results of COP implementation.
- Medium confidence means if this question is addressed, a connection to future CERP project implementation is established/documented but future adjustments to the COP may or may not be limited, especially if indicator response is longer than 10 years and is more relevant to RECOVER system-wide monitoring.
- High confidence means if this question is addressed, COP design, implementation, and/or operations can be modified to improve restoration results.

Each uncertainty was assigned a Tier 1, 2, or 3 designation based on the rankings identified for each of the above criteria (Risk, Knowledge, and Relevance) using the scenarios in **Table C.2-1**. The workshop attendees discussed the rankings and finalized them. Those with a Tier 3 ranking were not carried forward into the COP-AMMP. Note: the uncertainty ID numbers below refer to the ID numbers assigned to each uncertainty during adaptive management screening, and therefore may not appear sequential since those that did not pass screening are no longer included. The ID numbers were maintained for organizational purposes. The identification, screening, and prioritization process resulted in a final prioritized list of uncertainties. In some cases during the filling out of the adaptive management uncertainty template, an uncertainty was split into two uncertainties either at the workshop or subsequently to assist clarity. In such cases the uncertainties are labeled with the workshop number followed by an "a" or "b". In the case of uncertainties #1 and #21 identified in the workshop, subsequently those filling in the uncertainty template determined there was a high degree of redundancy and chose to combine them. The final prioritized list appears in **Table C.2-2**. This list was used to develop strategies, management options, and costs for the COP-AMMP.

Table C.2-1. Prioritization scenarios for identified uncertainties. Uncertainties ranked as Tier 3 were not developed further in the COP-AMMP.

Scenario	Risk	Knowledge	Relevance	Tier
1	High	Low	High	1
2	Med	Low	High	1
3	High	Low	Med	1
4	High	Med	High	1
5	High	Med	Med	2
6	Med	Med	High	2
7	High	High	High	2
8	High	High	Med	2
9	Med	High	High	2
10	Med	Low	Med	2
11	Med	Med	Med	2
12	High	Low	Low	2
13	High	Med	Low	3
14	Low	High	High	3
15	High	High	Low	3
16	Med	Low	Low	3
17	Low	Med	High	3
18	Low	Med	Low	3
19	Med	Med	Low	3
20	Low	Med	Med	3
21	Med	High	Med	3
22	Med	High	Low	3
23	Low	High	Med	3
24	Low	High	Low	3
25	Low	Low	High	3
26	Low	Low	Low	3
27	Low	Low	Med	3

Table C.2-2. COP Adaptive Management Uncertainties identified during July 2019 workshop. Note the uncertainty ID numbers below refer to the ID numbers assigned to each uncertainty during the workshop, and therefore may not appear sequential since those that did not pass screening are no longer included.

COP ID#	COP AM Uncertainty	Final Tier Group	Breakout Group
1 / 21	Flows, Salinity and Peat Collapse: Will predicted COP flows mitigate saltwater intrusion and associated coastal wetland vegetation, soil stability, and nutrient retention or release? How do changes in salinity influence nutrient availability and what are the ecological consequences?	1	Ecology
8	Tree Islands: Can COP create hydrology favorable for tree island elevation requirements?	1	Ecology
20	WCA-3B Vegetation: Are COP operations likely to decrease hydroperiods and water depths in WCA-3B and cause the expansion of sawgrass in the remnant ridge and slough area?	1	Ecology
2	S-197 / Manatee Bay Discharges: How can the quantity, timing, duration, distribution and quality of discharges into Manatee Bay and overland flow into northeast Florida Bay be managed to promote restoration, sustain seagrass habitat, and avoid harmful algal blooms?	2	Ecology
9	Hydrologic Transmissivity: Can vegetation management south of Tamiami Trail be used to increase flow and manage flow direction from the Tamiami Trail Canal?	2	Ecology
11a	Pennsuco Wetlands: Will COP reduce surface and/or groundwater base flows and wetland/groundwater recharge to the east of the L-30 in areas such as the Pennsuco Wetlands?	2	Ecology
23	Soil Oxidation and Peat Fires: Are inundation and hydroperiod sufficient to reduce current high rates of soil oxidation and peat fires?	2	Ecology
18	Wading Birds in Alligator North Colony: Will changes in hydrology under COP negatively influence the Alligator Alley North Colony in WCA-3A?	1 or 2	Ecology
24	Water flow, salinity and algal blooms in Whitewater Bay, Florida Bay, and southwest coast estuaries. What are the water quality impacts and ecological benefits of changing patterns of freshwater flow into estuarine waters of the southern Everglades?	1 or 2	Ecology
25	Wading Birds: How much will hydrologic restoration result in potential changes in wading bird foraging conditions and nesting under COP?	1 or 2	Ecology
6	Seepage: Do COP operations, while leveraging existing seepage management infrastructure, sufficiently support project objectives and constraints?	1	Hydrology/ Modelers
10	NESRS & TS: Will increased flows to northeastern Shark River Slough and toward the southeastern Everglades (Taylor Slough and lower C-111 basin) yield natural distribution of waters and moderate recession rates? Are flows towards Taylor Slough sufficient to alter the anticipated flows or stages (recession rates)?)	1	Hydrology/ Modelers

COP ID#	COP AM Uncertainty	Final Tier Group	Breakout Group
12a	Tamiami Trail Flow Formula – General: Based on consideration of the existing water budget used to formulate COP, is there an opportunity to improve the Tamiami Trail Flow formula such that desired ecological targets are more universally achieved?	1	Hydrology/ Modelers
12b	Tamiami Trail Flow Formula and Drought: Based on consideration of the upstream water availability is there an opportunity to deliver water to NESRS in a specific manner such that the delivery enhances freshwater flows to Florida Bay by delivering more water during the dry season without harming the ecological condition of WCA3?	1	Hydrology/ Modelers
5b	FDOT constraint on Tamiami Trail: Can L-29 canal elevations be raised to 8.5 feet NGVD for more than 90 days per water year without adversely impacting safety and stability of the Tamiami Trail roadway between S-333 and S-334? Following completion of the roadway re-construction under the DOI Tamiami Trail Next Steps project, to what extent, if any, does the 8.5 SMA flood mitigation requirement limit the ability to operate the L-29 Canal up to 8.5 feet NGVD beyond the 90-day restriction assumed in-place through at least the 2020 wet season?	2	Hydrology/ Modelers
7	Saltwater intrusion: What are the effects of sea-level rise on COP operations, resulting salinity patterns in Florida Bay, water supply risks associated with saltwater intrusion, and ability to meet flood protection constraints?	2	Hydrology/ Modelers
16a	Water Quality in Taylor Slough - Will there be downstream biogeochemical effects associated with modifying inflows and hydrologic conditions in ENP, that result in detrimental effects on nutrient movement, availability, and ecological responses?	2	Water Quality / Hydrology
16b	Water Quality in NESRS - Will there be downstream biogeochemical effects associated with modifying inflows and hydrologic conditions in ENP, that result in detrimental effects on nutrient movement, availability, and ecological responses?	2	Water Quality / Hydrology

Adaptive management strategies for each uncertainty are provided in **C.2.2 Ecological Adaptive Management Uncertainties, Section C.2.3 Hydrological Adaptive Management Uncertainties** and **C.2.4 Water Quality / Hydrological Adaptive Management Uncertainties**. This section provides 1-5 page strategy descriptions for each uncertainty and summary tables of suggested management options matrices to improve restoration performance, as illustrated in the example below.

C.2.1.1 Example AM Strategy Template

AM Uncertainty and ID#. The uncertainty is a question faced during planning or implementation regarding the best restoration actions to achieve desired goals and objectives within constraints, which cannot be fully answered with available data or modeling. Uncertainties were screened and prioritized to determine which to include in the AM Plan.

COP Objective or Constraint: Uncertainties needed to relate to project objectives or constraints, among other criteria, to be included in the AM Plan. This rule helped to focus the scope of the AM Plan.

Region(s): Area of project footprint to which the uncertainty and strategy pertain.

Associated Features: Structures or measures to which the uncertainty and strategy pertain.

Driver or Uncertainty Type: Unlike most AM Plans, not all project AM uncertainties and strategies are ecological. Types such as Engineering and Operations are identified.

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? Why the uncertainty needs to be addressed in the project.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each: A scientific approach begins with a well-informed, pointed, detailed statement that will be tested. For the purposes of the project's AM Plan the statement can be referred to as an expectation or hypothesis. Approaching uncertainties scientifically is efficient because it is targeted; a properly identified hypothesis statement is the most important step to lead to effective, efficient methodology to address an uncertainty. It leads to proper identification of what to measure, how, how often, how to analyze, etc.

More Information on attributes to be measured:

- What is expected to be learned by measuring this attribute, i.e., how will the project benefit from knowledge gained about this attribute?
- What is the time frame in which changes to this attribute are expected to be measurable?
- Is this attribute complimented by other monitoring programs within and/or outside of the project? If so, provide reference to other monitoring. Note the monitoring paid for by others in the project AM budget spreadsheet.
- When during the project's life cycle should this monitoring begin and end?

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: More information on what to measure, how, how often, how to analyze, and when and how to report results. PLEASE NOTE: the project AM Plan varies in the level of methodology detail provided; in

several cases the details will be formed during the project's detailed design phase. In ALL cases, methodology will be reviewed, updated and adjusted if needed by agency subject experts, before initiation, to best meet the intent of the AM Plan.

Triggers/thresholds that indicate good COP performance or need for adaptive management action: Triggers or thresholds are a point, range, or limit that signifies when restoration performance is veering away from expectations and is trending toward an unintended outcome. Triggers/thresholds should be described per attribute to be monitored because each should result in an outcome that informs management decisions.

Management options that may be chosen based on test results: Management Options are provided in case a performance trigger or threshold is crossed, which would indicate that the project performance needs to be adjusted. The Management Options are suggested paths forward and adjustments that can be made to keep the project progressing toward objectives and within constraints. The Management Options are summarized in tables after each region's strategies.

C.2.2 Ecological Adaptive Management Uncertainties

C.2.2.1 COP AM Uncertainty #1 and #21 (Flows, salinity, and peat collapse): Will predicted COP flows mitigate saltwater intrusion and associated coastal wetland vegetation, soil stability, and nutrient retention or release? How do changes in salinity influence nutrient availability and what are the ecological consequences?

There are two closely related uncertainties relevant to the COP objective for the restoration of flow patterns, surface water depths, and hydroperiods downstream of control structures to reduce saltwater intrusion, soil subsidence, and nutrient release. Addressing this uncertainty about water level and salinity influences on saltwater intrusion will support maintenance of associated coastal wetland vegetation, soil stability, and nutrient availability/retention. Specifically:

COP Uncertainty ID #1: Will predicted COP flows mitigate saltwater intrusion and associated coastal wetland vegetation, soil stability, and nutrient retention or release?

COP Uncertainty ID #21: How does changes in salinity influence nutrient availability and what are the ecological consequences?

COP Objective or Constraint: COP Objectives 1a, 1b, 1c, 2, 3

Region(s): COP Uncertainties #1 and #21 are focused on the biogeochemical effects of sea level change/saltwater intrusion into the southern coastal wetlands (lower portions of Shark River and Taylor Sloughs) adjacent to Florida Bay and the Lower Southwest Coast, its potential mitigation by increased flows across Tamiami Trail, and its impact on soil stability and nutrient release to the estuaries. Unmitigated sea level change has the potential to impact Shark River and Taylor Sloughs miles inland of the current southern coastline.

Associated Features:

- The L-30, L-31N, C-111, LECSA 2 & 3 SFWMD Canal System canals;
- The S-12 Structures, S-356, G-211, divide and coastal water management structures of LECSA 2 & 3 SFWMD Canal System

Driver or uncertainty type: Hydrology, Ecology

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? Benefits to COP will optimize restoration by understanding current conditions and rates of change for specific attributes and determining if they are changing as CERP projects are implemented. At the core of this uncertainty is that longer hydroperiods and lower salinities in the southern Everglades marsh and adjacent estuaries from restored flows will mitigate saltwater intrusion and protect coastal wetland vegetation and soil stability in this region. Sea level rise and saltwater intrusion as well as extended dry down can lead to increased porewater salinity and is of great concern in the southern coastal wetlands as it has the potential to negatively impact restoration success. Increased salinities in the southern coastal wetlands and their subsequent effect on the mangrove and sawgrass coastal vegetation communities are being documented. In addition, increased salinities in the coastal wetlands also have the potential to negatively impact the soil elevation, amplifying the effects of sea level change. Elevated salinity has been found to reduce gross ecosystem productivity and belowground root growth of sawgrass, and extended dry down or drought stimulates organic matter

mineralization and CO_2 loss from the marsh, which culminates in peat collapse. In areas where peat collapse is prevalent, former marsh habitat can transition to open water.

However, uncertainties remain if flows delivered by COP to the southern coastal wetlands: 1) are sufficient to maintain or reverse the current spatial extent of surficial saltwater intrusion and associated mangrove-"white zone" expansion; 2) will influence plant growth and soil decomposition processes to increase rates of soil accretion, elevation increase, and minimize nutrient and material releases caused by peat collapse, mitigating the effects of sea level rise; and 3) can minimize the inland extent of the groundwater salt wedge resulting in a decreased rate of internal phosphorus release to surface water and subsequent transport to the estuaries, decreasing the probability of an algal bloom event, especially on eastern Florida Bay where nitrogen levels are relatively high.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each: Hydrologic patterns, sediment characteristics, and ecological attributes are selected to better understand the effects of COP hydrologic modifications to the volume of freshwater delivery south of Tamiami Trail and saltwater intrusion on the biogeochemistry, soil accretion, and coastal wetland vegetation dynamics within the southern coastal wetlands. The southern coastal wetlands include lower portions of Shark River and Taylor Sloughs adjacent to Florida Bay and the Lower Southwest Coast. The attributes were selected based on existing knowledge of 1) surface/groundwater hydrology in Shark River and Taylor Sloughs and adjacent estuaries; 2) biogeochemical processes and nutrients in sediment and water; 3) soil accretion dynamics and mechanisms in marsh communities that lead to peat collapse in Shark River and Taylor Sloughs; and 4) mangrove-white zone movement and changes to vegetation coverage. Many of the attributes listed are currently monitored in this region by other agencies or USACE projects and may provide, in part, input to the testing of the hypotheses associated with this uncertainty. Costs for the additional monitoring have been included in the Table C.2-3. The timeframe in which the attributes listed below will be able to measure changes as a function of the project range from a minimum of yearly (water level and salinity) to a maximum of 5 years (soil nutrients, mangrove-white zone and other vegetation changes, soil elevation). Estimated timeframes to begin perceiving changes are listed following each attribute in parentheses along with complementary monitoring programs that measure the attribute:

1. *Hydrology (1-5 years) Uncertainty #1: What is the hydroperiod and frequency of elevated salinity in NESRS and ENP? What are the discharge rates into southern estuaries? What is the change in soil elevation, accretion, and depth?*
    - Water level: Increased, more sustained, and improved timing of freshwater flows are expected to increase hydroperiods and improve wetland inundation to prevent extended periods of dry down in the brackish marsh. The prevention of dry down is expected to decrease vulnerability of marsh elevation by preventing root loss and decomposition which are primary contributors to peat collapse.
    - Salinity: Restoration of freshwater flows is expected to prevent the surface/ground saltwater wedge from encroaching landward as well as prevent or limit frequency of elevated salinity (~20 psu) occurrence in brackish marsh, which decreases plant productivity and facilitates root loss, preventing marsh elevation from "keeping pace" with sea level rise.
2. *Biogeochemistry (5 years)-Uncertainties #1/#21: What is the size/extent of the P pool in soils and what are effects of groundwater salt wedge on P release?*

- Soil and plant nutrients: With the prevention or lowered frequency and duration of elevated salinity events, porewater C and nutrients will remain consistent and contribute to plant and soil productivity that helps maintain peat elevation. Stabilization and the stoppage or slowing of salt wedge encroachment will limit phosphorus release to surface waters.
- Porewater nutrients: Restoration will limit increase of SO_4 in brackish marsh porewater that will help reduce loss of organic matter that helps to maintain peat elevation.

3. *Soil elevation/Peat accretion (5 years)-Uncertainty #1: What is the change in soil elevation, accretion, and depth?*

- As a result of longer hydroperiods and limited dry down, vegetation productivity is expected to increase and contribute to sediment and peat accretion rates that exceed subsidence rates and prevent peat loss and transition of marsh habitat to open water.

4. *Mangrove-White Zone movement and marsh vegetation changes (5 years)-Uncertainty #1: What is the rate of mangrove-white zone expansion inland and vegetation distribution along the surface/groundwater wedge?*

- With restoration, no change or a decrease in the rate of mangrove-white zone expansion will occur.
- Hydrological restoration of Taylor Slough improves the southeastern Everglades marsh community with increased *Eleocharis* density, a species coinciding with fresher salinities and longer hydroperiods.

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: Monitoring is needed concurrent with implementation of COP to better understand the interaction of surface water and groundwater conductivity on hydrology, biogeochemistry, soil decomposition processes, and vegetation changes in the southern coastal wetlands. Monitoring includes hydrological and biogeochemical sampling and monitoring, soil elevation measurements, and the determination of historical mangrove-white zone movement and vegetation mapping and monitoring.

Hydrological and Biogeochemical Monitoring: A program of surface water quality monitoring operated by multiple agencies (ENP, USGS, SFWMD) exists across ENP. Continuous conductivity/salinity and water depth in brackish and freshwater marsh will be accessed monthly at established stations (NMP and NP62, respectively; ENP), to which additionally selected stations in areas of concern may be added as necessary. Currently, discharge into the southern estuaries is monitored based on stage measurements at coastal water management structures in Biscayne Bay and Manatee Bay and a USGS network of measuring flow velocity at the mouths of creeks and rivers in Everglades National Park. Monitoring of discharge from the C-111 Canal into Manatee Bay via its terminal structure, S-197, is central to COP, as minimizing damaging discharges from C-111 is a COP (and C-111 South Dade Project) objective. COP is expected to improve flows to coastal wetlands and estuaries, mostly via Taylor and Shark River Sloughs and thus has a reliance on USGS creek and river flow monitoring and a small set of upstream flow monitoring stations (Upper Taylor River and Taylor Slough Bridge) stations. In addition to the supply of freshwater from the watershed, coastal wetlands are influenced by the extent and magnitude of the P pool and effects of the groundwater salt wedge on P release to surface waters in the southern coastal wetlands needs to be determined to identify any change in the rate and extent of P mobilization resulting from implementation of COP. Quarterly soil phosphorus, surface and groundwater conductivity, and below ground resistivity will be determined in the areas of concern (e.g. Model Lands to Lostman's River). It may be necessary to determine sources of freshwater (i.e., precipitation, runoff, groundwater) following implementation of

COP at specific locations. In this case, freshwater inputs would be determined using 18O and 2H stable isotopes following Price et al. (2012). See also Price et al. (2006) and Dessu et al. (2018).

Elevation: Annual soil elevation and depth monitoring in the areas of concern are needed to document any change in the soil elevation resulting from the increase in deliveries past Tamiami Trail. Elevation will be measured throughout the coastal area over time using Trimble GPS referenced to benchmarked Surface Elevation Tables (SETs) sites already established and monitored for the last 15 years by the SFWMD along the southern coast, in addition to two relatively new established locations, one each in brackish and freshwater marsh sites (near Nine Mile Pond and Pay-Hay-Okee, respectively, in ENP). Soil depth will be determined by probing (depth to bedrock) at SET locations, adjacent to vegetation transects (see vegetation changes, below), and selected locations where it was examined previously (e.g., Hohner and Dreschel 2015).

Mangrove-white zone Movement and Vegetation Changes: The current rate and extent of mangrove-white zone expansion and surface/groundwater intrusion into the southern coastal wetlands is not known. Analyses of historic and current databases and/or aerial photos to determine the current rate and extent of mangrove and "white zone" expansion and surface/groundwater intrusion are necessary to set the baseline condition for COP. Vegetation transects that are monitored in the ENP panhandle as part of the SFWMD C-111 restoration plan will continue to be monitored annually and integrated with new landscape-scale aerial vegetation mapping every 3-5 years. Changes in vegetation, including transition of marsh to open water, will be spatially compared with existing porewater and groundwater conductivity and resistivity data to document any changes to the vegetation distribution and the location of the surface/ground saltwater wedge.

Triggers/thresholds that indicate good COP performance or need for adaptive management action: The triggers and baseline thresholds for the implementation of adaptive management measures for the region are listed below. If a trigger is detected, this will necessitate the implementation of first, a scientific peer-review of the data to determine the relationship between the trigger metric, COP implementation, and the environmental drivers and second, the implementation of one or more specific adaptive management measures to improve the environmental situation. These AM triggers listed below are based on the best professional judgment of scientists familiar with the region, actual environmental monitoring data, modeled scenario data, and scientific research. However, every 2-3 years an adaptive management data review will be conducted (possibly managed by RECOVER) to see if specific thresholds to those listed below may be added or refined as new research and data are analyzed and incorporated by the PDT.

Triggers:

- Alteration of current spatial distribution of soil and vegetation nutrient pools relative to current conditions
- Increase in the rate of mangrove expansion in the white zone
- Increase in soil loss and/or elevation reduction
- Change in spatial extent of wetland surface water or groundwater salinity relative to two similar rainfall years from the period of record

Baseline Thresholds:

- Movement of spatial nutrient front or increase in nutrient rate of release from soils as observed along soil and/or vegetation transect

- White zone expansion rate exceeds Ross rate (3 km/50 yr west of US1, 1km/50 yr east of US1) and mangrove zone expansion rate exceeds current rate of expansion
- Increase in rate of coastal soil loss over the existing rate
- Magnitude of wetland surface or groundwater salinity exceeds equivalent rainfall conditions for the past 2 years from the period of record
- Inland movement of the saltwater wedge from current location

Additional Proposed Specific Thresholds:

- Salinities in brackish marsh ≥ 20 psu for ≥ 2 consecutive months in a calendar year, for 2 consecutive years.
- Median daily water level 0cm or below ground >2 months in brackish water marsh (Nine Mile Pond station; ENP)
- Decrease in below ground resistivity (i.e., increase in conductivity) from the prior 2 years of the period of record
- Any accelerated loss of elevation and accretion rates compared to previous measurements at established SET locations.
- Evidence of peat collapse along vegetation transects (e.g., exposed Cladium culms)
- Decreased sawgrass density or transition of vegetated marsh habitat to open water in 3 to 5-year aerial vegetation mapping and surface vegetation analyses.
- Retraction or decreasing density of *Eleocharis* (spike rush) in freshwater marsh and Taylor Slough

Management options that may be chosen based on test results: Suggested adaptive management options listed below are not in any particular order and can be implemented simultaneously, as appropriate. Reference **Table C.2-3**.

- Spatial redistribution of water into less sensitive areas
- Reduce point source discharges (e.g., S-12A, S-12B, S-12C, S-12D) and shift more water to the NESRS
- Redistribution of water to more closely match historic timing of flows to the coastal wetlands and estuaries
- Adjustments to operations along Tamiami Trail and the LECSA 2 & 3 SFWMD Canal System to improve water deliveries to Biscayne Bay, Florida Bay, and the Lower Southwest Coast

Table C.2-3. COP AM Uncertainty ID#1 and #21 (Flows, salinity, and peat collapse) management option matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
These two closely related uncertainties were combined. COP UNCERTAINTY ID #1 - Flows, salinity & peat collapse: Will COP flows mitigate saltwater intrusion and associated coastal wetland vegetation, soil stability, and nutrient retention or release? COP UNCERTAINTY ID #21 - Water level, water quality and ecological consequences: How does changes in salinity influence nutrient availability and what are the ecological consequences?	Inundation Duration and Salinity in Coastal Marsh	Water level and salinity measured continuously at permanent installed hydro gages NMP and NP62, others as identified	1-5 years	NESRS, Taylor Slough	Salinities in brackish marsh ≥ 20 psu ≥2 consecutive months in a calendar year, for 2 consecutive years; Median daily water level 0 cm or below ground >2 months in brackish water marsh (Nine Mile Pond station; ENP)	Existing	• Spatial redistribution of water into less sensitive areas • Redistribution of water to more closely match historic timing of flows to the coastal wetlands and estuaries • Refinement of existing hydrologic and hydrodynamic models in the southern coastal wetlands, Florida Bay, and the Lower Southwest Coast to evaluate options for dealing with changing sea levels. • Adjustments to operations along Tamiami Trail and the LECSA 2 & 3 SFWMD Canal System to improve water deliveries to Biscayne Bay, Florida Bay, and the Lower Southwest Coast

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
Same as above	Discharge and salinity from Taylor Slough	Discharge (flow rate) and salinity measured continuously at permanent installed Hydro gage NP-TSB (northern Taylor Slough), ENPTR (Taylor River) and TaylorS3 (downstream near Florida Bay)	1-5 years	ENP(TS)	Is there a change in flow relative to two similar rainfall years from the period of record?	existing	Same as above

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
Same as above	Soil P pool relation to groundwater salt wedge	Soil, surface water, and groundwater P; Surface and groundwater conductivity; Groundwater resistivity monitored with quarterly samples in "areas of concern (e.g., Model Lands, Lostman's River)"	5 years	NESRS, ENP(TS), ENP(SC)	Is there a change in soil P from the prior 2 years of the period of record? Does this coincide with areas with elevated surface/ groundwtaer conductivity and belowground resistivity?	$100,000	Same as above
Same as above	Soil elevation and depth change	Soil elevation and depth at SETs established along the southern coast, NMP station in brackish marsh	3-5 years	ENP(TS), ENP(SC), Florida Bay	Is there an increase in soil loss or a reduction in elevation?	Existing	Same as above

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
Same as above	Mangrove-white zone movement and marsh vegetation changes	Mangrove-white zone movement; marsh vegetation composition and density; Open-water area in marsh at mangrove-white zone at Everglades-Florida Bay transition zone; monitored with 5 year aerial vegetation mapping surveys and annual vegetation transect surveys	3-5 years	ENP, ENP(TS), ENP(NESRS), ENP(SC), Florida Bay	Is there an increase in rate of mangrove-white zone expansion? Is vegetated marsh habitat transitioning to open water?	$80,000	Same as above

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
Same as above	Source of freshwater (Tentative/if necessary)	Normalized isotopic compositions (stable isotopes (18O and 2H)) in surfacewater and rainfall grab samples at "areas of concern (e.g., Model Lands, Lostman's River)".	5 years	NESRS, ENP(TS), ENP(SC)	This is not a trigger or a threshold. It is a hydrologic evaluation measure to assist in the selection of an adaptive maanagement option, if necessary.	Cost range depending on scale of investigatio n is between $50,000 and $100,000	Same as above

C.2.2.2 COP AM Uncertainty #8 (Tree Islands). Can COP create favorable hydrologic conditions to sustain individual islands and increase soil elevation on tree islands?

COP Objective or Constraint: COP Objectives 3 and 5.

Region(s): WCA-3A, WCA-3B, ENP-SRS

Associated COP Features: S-333, S-356, Tamiami Trail, S-12D, and S-12C (outflow of WCA3/inflow to Shark River Slough portion of ENP, as well as S-11 A-C, S-8, and S-140 (inflows into WCA3).

Driver or uncertainty type: Hydro-ecological

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? The COP adaptive management monitoring plan will set the stage for closely related CEPP AM activities. Monitoring and targeted ecological studies conducted in CEPP should help to unravel the mechanisms of tree island restoration and sustainability in order to a) manage hydrological parameters (i.e., depth, hydroperiod, flow) downstream of major operational structures and b) promote ecological processes such as, peat accumulation and soil accretion rates, vegetation diversity, seedling recruitment and tree growth rates. Sustainability of the ridge/slough landscape is dependent upon the ability of the regional system to redistribute sediments, decrease peat oxidation rates, prevent peat fires, produce microtopography and create the diversity of habitats needed by all plant and animal communities. According to the ecological theory of Dynamic Equilibrium, the creation of historic water depths and hydroperiods will help to restore historic tree island peat depths and plant diversity.

COP initiates landscape scale changes in Northeast Shark River Slough driven by increasing hydroperiods and up to 1.5 ft increase in water depths (driven by 1.5 ft increase in stage constraint on Tamiami Trail, from 7.0 to 8.5 ft NGVD29). CEPP is expected to increase stages another 1.2 ft (driven by a 1.2 ft increase in stage constraint on Tamiami Trail, from 8.5 to 9.7 ft NAVD). These landscape scale changes are underway in NESRS (since incremental testing elevated the stage constraint at Tamiami Trail to 7.5 ft beginning October 2015). A maximum stage of 8.5 ft was reached first in January 2016 as part of an emergency operational deviation. Vegetation monitoring in NESRS provides the basis for initial detection of subtle changes in tree island boundaries, maximum tree size, and functional composition. Initial insights will be used to help inform longer term, more comprehensive monitoring through CEPP.

COP drives water levels in WCA3 closer to the range of hydrologic conditions estimated to occur in the pre-drainage system (Park and Brown 2013). A higher proportion of mapped tree islands in WCA3 should experience inundation less than 10% of the time (over a 5-10 year time horizon). As a result of COP fewer tree islands with hardwood hammock species will be inundated for long periods in WCA3.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each: Changes to tree island size, forest structure, species composition, and boundary characteristics will provide a low cost/high frequency landscape scale perspective on shifts in vegetation in both tree islands and marshes across the landscape. Testing these hypotheses will inform how to determine longer-term monitoring strategies in CEPP. We expect tree island vegetation density to increase (independent of hurricane effects – which will selectively impact large trees), edges to sharpen (i.e. become more regular and defined), structural complexity to increase in 5-10 year periods following rehydration.

For COP we will be monitoring water depths for 371 mapped tree islands that were used to support the performance indicator that was evaluated to support the design of COP operations. Additional information about tree island change over time may be collected in RECOVER monitoring, and establishment/development of new tree islands will be monitored through landscape-scale vegetation mapping.

What is expected to be learned by measuring this attribute, i.e., how will COP benefit from knowledge gained about this attribute?

- The performance of COP is evaluated in terms of ecological benefits. Documenting the expected benefits to tree islands will help inform subsequent hydrological restoration efforts in WCA-3A, WCA-3B, and ENP under CERP. By reducing perceived risks associated with restoration actions, resource managers may choose to expedite additional large scale restoration actions.

What is the time frame in which changes to this attribute are expected to be measurable?

- 10 year increments

Is this attribute complimented by other monitoring programs within and/or outside of COP? If so, provide reference to other monitoring. Note the monitoring paid for by others in the COP Management Options spreadsheet.

- Yes, monitoring is complemented by RECOVER tree island monitoring, RECOVER hydrologic monitoring, and proposed CEPP monitoring in addition to the vegetation mapping conducted by COP.

When during COP's life cycle should this monitoring begin and end?

- Monitoring was initiated in 2010 – prior to operation of the Tamiami Trail 1-mile bridge. Vegetation mapping is scheduled to occur every 2-3 years through FY2024.
- Attributes: Tree Island Attributes (Peat Accretion, Soil Nutrients, Community Structure, GW flows)

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: Vegetation mapping consists of accumulating imagery from Worldview 2/3 satellites. Each satellite is tasked to collect 2-3 cloud free images during each dry and wet season. Composite maps are accumulated and classified using an algorithm based process. Ground truthing of maps is conducted using a combination of 6 permanent star transect systems and the use of flights to sample closely related vegetation groups, using a data driven approach for maximizing mapping accuracy. These maps spatially aggregate 2 meter pixels to accumulate reasonably homogeneous patches of vegetation across the landscape, producing classified objects that are 12-100 m^2. Summary statistics on cumulative vegetation change and class-specific vegetation change are reported. Two of these vegetation mapping reports have already been developed and filed (see Gann et al. 2015, 2019)

Triggers/thresholds that indicate good COP performance or need for adaptive management action: We've confirmed that no observable ecological degradation has occurred as a result of initial COP actions. Specific thresholds for vegetation change will be developed as part of the CEPP effort, as sufficient information to inform these thresholds does not yet exist.

An existing threshold of avoiding more than 60 days of inundation of high elevation tree islands in two consecutive years or 120 days of inundation in any single year. It is desirable to add water depth criteria

to these duration thresholds in the future, as it is clear that for many species, the depth of inundation is a clear stressor that amplifies the effect of long durations on inundation.

Management options that may be chosen based on test results: Feedback to resource managers for COP will be provided as an outcome of an annual meeting and in regular reports every 1-2 years developed by NPS staff, shared with partner agencies, and submitted by USACE as part of permit compliance reporting.

Feedback to regional water managers could include informing operational decisions such as timing of water deliveries, pulsing of water deliveries, managing FEB/STA water to either enhance or reduce tree island hydroperiods, or routing water through an area slightly differently than originally specified. Suggested adaptive management options for tree islands downstream of COP water control structures listed below are not in any particular order and can be implemented simultaneously, as appropriate. Some options that would need additional authorization to improve restoration beyond COP are presented in the management options matrix.

- Create moat-like sloughs around tree islands using vegetation management options (e.g., fire, harvesting, herbicide, physical stress) as tested in the Loxahatchee Impounded Landscape Assessment (LILA) Everglades ecological experiments.
- Increase operational flexibility to maximize flow velocities in the key areas including: 1) hydrological pulsing, 2) Vegetation clearing or management.
- Incremental increases to WCA-3B hydroperiods to create more resilient tree islands with higher elevations in anticipation of a future increment of CERP.
- Adjust operations along the northern boundary of WCA-3A by redistributing water into the S-8.

Table C.2-4. COP AM Uncertainty ID#8 (Tree Islands) management options matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC #8 Tree Islands.	Tree island size; Structural complexity; Species composition; Boundary shifts	Mapping every 2-3 years of change in • Tree island boundaries and area • Maximum tree height/island, • Functional vegetation composition (e.g., presence of short hydroperiod, late succession hardwood hammock species) • Locations of additional new or missing tree islands	5-10 years	WCA-3A, WCA-3B, ENP-SRS	• Change in tree island number, size, and boundary firmness that indicates ecological degradation of tree islands is occurring and where. • Occurrence of more than 60 days of inundation of high elevation tree islands in two consecutive years or 120 days of inundation in any single year. • Specific thresholds for vegetation change will be developed as part of the CEPP effort.	Existing monitoring	• Create moat-like sloughs around tree islands using vegetation management options (e.g., fire, harvesting, herbicide, physical stress) as tested in the Loxahatchee Impounded Landscape Assessment (LILA) Everglades ecological experiments. • Increase operational flexibility to maximize flow velocities in the key areas including: 1) hydrological pulsing, 2) Vegetation clearing or management. • Incremental increases to WCA-3B hydroperiods to create more resilient tree islands with higher elevations in anticipation of a future increment of CERP. • Adjust operations along the northern boundary of WCA-3A by redistributing water into the S-8.

C.2.2.3 COP AM Uncertainty #20 (WCA-3B Vegetation): Are COP operations likely to decrease hydroperiods and water depths in WCA-3B and cause expansion of sawgrass in the remnant ridge and slough area?

COP Objective or Constraint: This uncertainty is related to the COP constraint of maintaining C&SF project purposes (Constraint 1).

Region(s): WCA-3B

Associated Features: S-151, S-152

Driver or uncertainty type: Hydrology/Operations, Ecological

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? Are COP operations likely to decrease hydroperiods and water depths in WCA-3B and cause the expansion of sawgrass in the remnant ridge and slough area?

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each: It is expected that drier conditions in WCA-3B will cause the remnant sloughs to transition to sparse sawgrass communities within a 5-year period, but it is uncertain how much the projected conditions will actually affect slough transitions. Specific attributes to be measured are: local water depths in remnant slough area from EDEN water surfaces and % change in slough coverage within the remnant ridge and slough area from aerial/satellite imagery on an annual basis. A ridge and slough multistate transition model will be used to predict the most vulnerable sloughs/areas and how they might change over time. Monitoring of % change in slough coverage will validate model predictions and provide data to increase model efficiency and for future water management options.

Changes in slough coverage may or may not happen within the 2-3 year time frame of COP, but the effects from decreased water levels during COP is expected to be reflected in vegetation changes within 5 years of implementation. Monitoring should end 5-8 years after the project.

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: Sloughs will be delineated from aerial photography or satellite imagery every year and the multistate transition model will be run for each year. The results will be compared and used to provide feedback to water management in case the option of providing more water to WCA-3B is available and the model/results from slough delineation determine it would have a positive impact on WCA-3B sloughs.

Triggers/thresholds that indicate good COP performance or need for adaptive management action: Signs of significant slough loss from remote sensing or results from the multistate model could provide a trigger for more water to be allowed into WCA-3B.

Management options that may be chosen based on test results: More water could be provided to WCA-3B through S-152. This water would reach the southwestern side of WCA-3B that has the most remnant sloughs.

This uncertainty is further summarized in **Table C.2-5**.

Table C.2-5. COP AM Uncertainty ID#20 (WCA-3B Vegetation) management options matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC #20 - WCA-3B Vegetation	Slough percent coverage (filling in of the sloughs); multistate transition probabilities for slough to ridge	WCA-3B sloughs mapped every year using remote sensing and compared with multi-state transition model run.; EDEN gages and surfaces within WCA-3B	5-8 years	Within remnant ridge and slough section of WCA-3B (southwest)	Signs of significant slough loss from remote sensing or results from the multistate model could provide a trigger for more water to be allowed into WCA-3B.	Existing	Input of water from S-152

C.2.2.4 COP AM Uncertainty #2 (S-197 / Manatee Bay Discharges): How can the quantity, timing, distribution, duration, and quality of discharges into Manatee Bay and overland flow into northeast Florida Bay be managed to promote restoration, sustain seagrass habitat, and avoid harmful algal blooms?

COP Objective or Constraint: COP Objectives 1a, 1c, 2, 4

Region(s): Manatee Bay / Barnes Sound, ENP (Taylor Slough), Northeastern Florida Bay

Associated Features: S-197, S-18C, C-111, C-111 Spreader Canal Western Project structures, L-31N and L-31W detention areas and associated structures.

Driver or uncertainty type: Hydro-ecological

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? A central COP goal is to improve freshwater inflow regimes into NESRS and Taylor Slough, while maintaining levels of flood control for adjacent developed lands (U.S. Army Corps of Engineers, 2017). This goal now is expected to be achieved, with completion of critical infrastructure construction and modifications by the C-111 Spreader Canal Western Project (SCWP), the MWD and C-111 South Dade projects and implementation of these features via COP. S-197 is the terminal structure of the C-111 Canal, discharging into Manatee-Barnes Sound in the southernmost portion of the Biscayne Bay system. The structure is used to alleviate the flood risk to private lands along the eastern border of ENP and South Dade County (**Figure C.2-1**). S-197 water discharges freshwater to Manatee Bay as a point source, and during large rainfall event or in anticipation of such events, discharge pulses can be large and have the potential to cause downstream ecological harm via the stress of rapid salinity change, water column stratification and dissolved oxygen depletion, and nutrient enrichment that can stimulate damaging algal blooms. In contrast, water flows diffusely to northeast Florida Bay overland via Taylor Slough and the ENP panhandle, with conveyance via numerous coastal creeks near the Florida Bay shoreline.

COP is expected to benefit northeastern Florida Bay as a consequence of improved and more natural flows through Taylor Slough. Operation of seepage management features of the C-111SD Project and C-111SCW project are expected to decrease seepage losses from Taylor Slough into the C-111 Canal, decreasing the need for discharges via S-197. Benefits are expected with COP establishing an increased proportion of flow through Taylor Slough and decreasing proportion of flow via C-111 and through S-197. Thus, key uncertainties of COP implementation are the amount and distribution of flow into northeast Florida Bay along with S-197 discharges, benefits derived from this change in distribution, and any negative water quality impacts in downstream estuarine waters. Addressing these uncertainties will contribute to COP adaptive management, optimizing the effectiveness of the South Dade Conveyance System to benefit Florida Bay, reducing risks of potential harm to Manatee Bay and Barnes Sound, while still meeting the needs of south Florida hydrological operations to provide flood control and a reliable water supply.

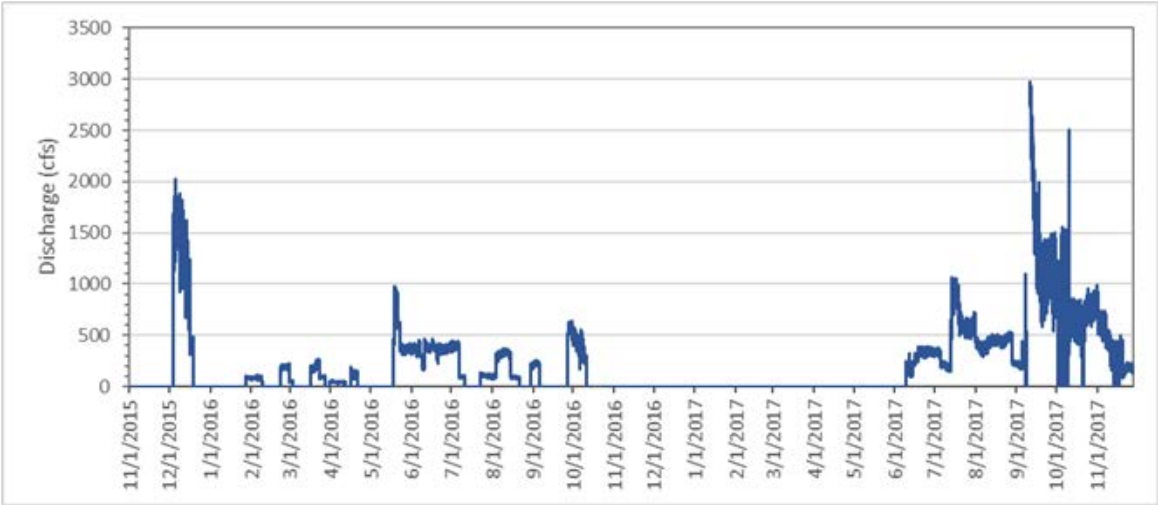


Figure C.2-1. Inflows from S-197 structure on C-111 canal into Manatee Bay, southern Biscayne Bay.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each: COP is expected to benefit northeastern Florida Bay by increasing the relative distribution of water, along with the absolute quantity of water flowing overland to the bay. Concurrently, COP is expected to decrease the proportion of water discharged through S-197 into Manatee Bay, and especially decrease large water pulses to this bay. These hydrologic changes are expected to decrease salinity in northeastern Florida Bay and minimize rapid salinity changes in Manatee Bay, improve ecological conditions in Florida Bay in a manner similar to that described in Uncertainty #24, and minimize ecological harm in Manatee Bay.

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: Methodologies and data sources for assessing responses to changing freshwater flow, salinity, seagrass habitat, and water quality (specifically algal blooms, as estimated from chlorophyll *a* measurements) are described in Uncertainty #24 of this appendix and summarized in Table C.2-6 below. Measurements specific to assessing S-197 discharge effects include both routine (fixed frequency) monitoring and episodic monitoring that will be done in association with large discharge events (800 cfs or more for one week through S-197) and/or the detection of algal blooms. The timing of event-based sampling may be determined by the timing of large discharge events, detected biological events (such as algal blooms) or the combination of such events. The duration of event sampling will be sufficient to determine whether a problem persists or has diminished, see **Table C.2-6**.

Triggers/thresholds that indicate good COP performance or need for adaptive management action. Triggers and thresholds that indicate good COP performance for Florida Bay are described in Uncertainty #24. Triggers spurring adaptive management action include phytoplankton blooms or excessive nutrients, also described in Uncertainty #24, or large S-197 discharges that rapidly decrease Manatee Bay salinity and/or cause stratification events with DO depletion (hypoxia or anoxia) in this bay's bottom waters. This likely requires sustained discharges exceeding 800 cfs for at least one week, and are more likely if such discharges are a time of high water temperature and high bay salinity. Event-driven assessment will be necessary in order to establish robust numerical thresholds for discharge rates and durations. These events may include large discharge events, detected biological events (such as algal blooms) or the combination of such events. The duration of events sampling will be determine whether a problem persists or diminished.

Table C.2-6. Field components, study sites, ecological parameters, frequency and mode associated with data collection.

Component	Sites	Parameters	Frequency
C-111 and creek flow	S-18C, S-197, Manatee Bay Creek , West Highway Creek, Trout Creek	Temperature, salinity, flow velocity	Continuous from C-111 stage gauges; 20 minute from USGS creek flow velocity meters
Salinity and Water Quality (fixed sites)	Manatee Bay, Barnes Sound, Long Sound, Little Blackwater Sound, Joe Bay, Trout Cove; S-197, S-18C	Salinity, temperature, pH, dissolved oxygen (DO), turbidity, nutrients, chlorophyll a (Chl a)	NPS MMN hourly salinity, temperature; SFWMD monthly and event-driven DO, pH, turbidity, Chl a, nutrients (with vertical profiles during events)
Salinity and Water Quality (Dataflow mapping)	Manatee Bay, Barnes Sound, Long Sound	Salinity, temperature, DO, Chl a, pH, CDOM, turbidity, phycoerythrin/phycocyanin	Quarterly and event-driven
Seagrass habitat, light	Manatee Bay, Barnes Sound, Long Sound, Little Blackwater Sound, Joe Bay, Trout Cove	Seagrass cover, species, light attenuation	4 times per year

Management options that may be chosen based on test results: Recommendations to benefit northeast Florida Bay and minimize harm from pulse discharges into Manatee Bay are:

1. Avoid discharges through S-197 in order to maintain sufficient flows in Taylor Slough and into northeastern Florida Bay and avoid eastward seepage of water from Taylor Slough.
2. If discharges through S-197 are unavoidable and when not otherwise constrained by safety and flood control requirements,
    a. Minimize discharge rates and durations, especially over 800 cfs t and over a week duration. Several smaller releases (e.g., < 500 cfs) are preferred over large, pulsed releases.
    b. Avoid two or more discharge events within six months that are magnitude 800 cfs or more for a week duration.

See Uncertainty #24 for more details regarding metrics and management options to benefit Florida Bay and **Table C.2-7** for Manatee Bay options, relevant to Manatee Bay, Barnes Sound and northeastern Florida Bay.

Table C.2-7. COP AM Uncertainty ID#2 (S-197 / Manatee Bay Discharges) management option matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Time-frame to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Esti-mated Addi-tional Annual Cost	Management Action Options Suggestions
UNC #2 – (S-197 / Manatee Bay Discharges)	C-111, S-197, and adjacent or downstream creek discharge	Discharge estimates (daily, monthly, and annual) from flow velocity or rating curve, with tracking of proportion of total discharge from S-197 and specified creeks.	For the duration of COP imple-mentation (estimated 5 years)	S-18C, S-197, Manatee Bay Creek, West Highway Creek, Trout Creek	For S-197, discharges into Manatee Bay that: • cause rapid salinity changes sufficient to cause a faunal or seagrass mortality event; • water column stratification with development of hypoxic or anoxic bottom waters; • chlorophyll *a* concentrations with red stoplight indicator or exceeding Numerical Nutrient Criteria thresholds	Existing	Operate the SDCS in ways less likely to damage the ecosystem: • Avoid discharges through S-197, distributing sufficient flows in Taylor Slough to northeastern Florida Bay and minimize eastward seepage of water from Taylor Slough. • If discharges through S-197 are unavoidable and when not otherwise constrained by safety and flood control requirements, o Minimize discharge rates and durations, especially over 800 cfs and over a week duration. Several smaller releases (e.g., < 500 cfs) are preferred over large, pulsed releases. o Avoid two or more discharge events within six months that are magnitude 800 cfs or more for a week duration

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Time-frame to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Esti-mated Addi-tional Annual Cost	Management Action Options Suggestions
Same as above	Continuous salinity and temperature monitoring	Daily average: temperature, conductivity, salinity	Same as above	Manatee Bay, Barnes Sound, Long Sound, Little Blackwater Sound, Trout Cove	Same as above	Existing	Same as above
Same as above	Salinity, temperature, and water quality	Regular & Event driven sampling, with grab samples, vertical profiles and surface mapping: temperature, salinity, pH, DO, Chl *a*, turbidity, light, CDOM, inorganic and organic nutrients	Same as above	Manatee Bay, Barnes Sound, Long Sound, Little Blackwater Sound, Joe Bay, Trout Cove	Same as above	Existing plus $10,000 / year for event-driven sampling	Same as above
Same as above	Seagrass habitat	Seagrass cover and species composition	Same as above	Random sites in Manatee Bay, Barnes Sound, Long Sound, Little Blackwater Sound, Joe Bay, Trout Cove	Same as above	Existing plus $10,000 / year for seasonal sampling	Same as above

C.2.2.5 COP AM Uncertainty #9 (Hydrologic Transmissivity): Can vegetation management south of Tamiami Trail be used to increase flow and manage flow direction from the Tamiami Trail Canal?

COP Objective or Constraint: COP Objectives 1a, 1b, 1c.

Region(s). ENP – Immediately south of water control structures (S-12s) and both existing and new culvert sets along the entire Tamiami Trail.

Associated Features: Vegetation "halos" immediately south of water control structures and culverts along Tamiami Trail.

Driver or uncertainty type: Hydrology and Vegetation

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? Whether the vegetation halos at the culvert sets through the Tamiami Trail act as a barrier to water flow.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each. In order to restore North East Shark River Slough as a functioning component of the Everglades ecosystem, barriers to water flow downstream of Tamiami Trail must be removed. It is uncertain as to whether the vegetation downstream of the culverts and structures impedes southward water flow into Shark River Slough.

More Information on attributes to be measured: Flow velocity through the culvert sets. This work is on-going through the USGS and ENP. These data will be compared to historical data from when the L-29 was constrained at 7.5' NGVD.

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: Work is currently on-going to determine the hydrologic effects of dredging and removing vegetation south of S-12B. This is a five-year study with the objectives of:

1) Environmental quality: how does dredging and vegetation removal affect P transport into downstream wetlands?
2) Water residence times: are downstream water velocities increased by expanding tailwater pond area?
3) Project conditions: how is the discharge capacity of the structure affected?

Annual reports will be provided.

Additionally, analyses performed for the EVER Pilot Spreader Swale Project (ENP 2008) indicated that field observations at several culvert sets, including the far eastern culvert 59, show that although there is a significant tree canopy, there are ample channels between the trees to allow water to flow through to the undisturbed marsh areas downstream.

Triggers/thresholds that indicate good COP performance or need for adaptive management action. Is the difference in stage north and south of the Tamiami Trail structures consistent with expectations during modeling (of performance) or is additional management of vegetation required to facilitate water flow?

Difference in stage at canal to 10k downstream is greater than expected or takes longer to achieve expected stages downstream than expected when compared with historical datasets.

Management options that may be chosen based on test results.

- Conduct a dye study to determine where water flow is being impeded.
- Managing agency conducts controlled fire to remove impeding vegetation.

Suggested adaptive management options listed below in **Table C.2-8.**

Table C.2-8. COP AM Uncertainty ID#9 (Hydrologic Transmissivity) management options matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC #9 – Hydrologic Transmissivity	Flow velocity at Tamiami Trail	Flow velocity through culverts; Difference in stage drop north to south of Tamiami trail versus expectations compared with historical datasets.	Near real time	ENP - Vegetation "halos" immediately south of water control structures and culverts along Tamiami Trail.	Difference in stage at canal to 10 km downstream is greater than expected or takes longer to achieve expected stages downstream than expected compared with historical datasets	No new monitoring will be required to address this uncertainty. Current on-going gages will be used to monitor this uncertainty.	• Conduct a dye study to determine where water flow is being impeded. • Managing agency conducts controlled fire to remove impeding vegetation.

C.2.2.6 COP AM Uncertainty #11a (Pennsuco wetlands). Will COP reduce surface and/or groundwater base flows and wetland/groundwater recharge to the east of the L-30 in areas such as the Pennsuco wetlands?

COP Objective or Constraint: This uncertainty is related to the COP constraint of maintaining C&SF project purposes (Constraint 1).

Region(s) and Associated Features: This uncertainty relates to the Pennsucco wetlands. Pennsuco is located between the Dade-Broward Levee, Krome Avenue, and Tamiami Trail (U.S. 41) and covers approximately 13,000 acres.

Driver or uncertainty type: Hydrology

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? The Pennsuco Wetlands provide groundwater recharge to the Northwest Wellfield public water supply for Miami-Dade County. Implementation of COP needs to sufficiently maintain the current levels of surface and groundwater in the Pennsuco Wetlands to where there is no change in the ecological conditions of this area. Under COP, the operations of S-335 and the L-30N canal will change from the existing water control plan which may influence seepage to the east in Pennsuco.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each: The implementation of the COP will be analyzed to test for any potential adverse effects on the hydrology of the Pennsuco wetlands.

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: Near real-time analyses of operational changes of the S-356 pump, S-151, S-337 and S-335 and their potential effect on surface and ground water flows and the ecosystems east of the L-30 is needed to evaluate the ecological conditions of the Pennsuco Wetlands. Focus of the analyses are on the distribution, magnitude, and timing of surface and groundwater flows and stage elevation at water management structures and select wetland stage gages (e.g., G-975, G-3818).

Triggers/thresholds that indicate good COP performance or need for adaptive management action: Results will be reported in the context of what is expected given the improvements to hydrology in comparison to established assessment parameters and targets. Results will be provided on an annual basis to COP project managers, agency leads and the general public through appropriate forums. Conclusions and recommendations for adaptive management actions will be provided and will evaluate the triggers/thresholds that indicate good COP performance.

Management options that may be chosen based on test results: Feedback to COP management will include providing information that can inform project decisions such as timing of water deliveries, the pulsing of water deliveries, or routing water through an area slightly differently than originally specified but within the approved COP study area to maintain hydroperiods and water depths in the Pennsuco wetlands. The goal is to keep water level variability in the Pennsuco wetlands consistent with pre-COP conditions, with the option to provide additional water from WCA-3B when the risk of going below these water level thresholds is expected. Monitoring and adaptive management actions are summarized below in **Table C.2-9**.

Table C.2-9. COP AM Uncertainty ID#11a (Pennsuco wetlands) management options matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC #11 – Pennsuco Wetlands	Hydroperiod; Water Depth	• Hydroperiod (Surface and Ground water) observed across a water year as measure at an identified set of gages in the study area. • Water depth (surface and ground water) observed across a water year as measured at an identified set of gages in the study area. • Depth and duration of dry season below ground across a year, as measured at an identified set of gages in the study area.	2-3 Years	Pennsuco wetlands	Deviation from historic conditions	No new monitoring will be required to address this uncertainty. Current on-going EDEN gages will be used to monitor this uncertainty.	Modify and/or adjust operations to include additional flows through S-151 to reduce potential negative effects on areas of decreased hydroperiod and water depths

C.2.2.7 COP AM Uncertainty ID #23 (Soil oxidation and peat fires): Are inundation and hydroperiod sufficient to reduce current high rates of soil oxidation and peat fires?

COP Objective or Constraint: Objectives 1a, 1b, 1c, 3.

Region (s) and Associated Features: While this uncertainty relates to all regions of COP, it is most specific to northeast WCA-3A and WCA-3B, where modeled performance indicated the potential for increased risk of soil oxidation and in ENP within NESRS and Taylor Slough where the potential for improved water depths and hydroperiods under COP may result in peat accumulation.

Driver or uncertainty type: Hydro-ecological

What is expected to be learned by addressing this uncertainty, i.e. how will COP benefit from addressing this uncertainty? Fire is a component of almost every type of terrestrial habitat in Florida and is a primary ecological driver in many of those habitats. If water levels decrease far enough below ground to dry out the surface of organic soils, peat or muck fires, can occur. Suppressing fires during extremely dry conditions is essential for protecting organic soils. Major canal and levee systems cause areas to be more vulnerable to drought and intense peat fires which can be ecologically damaging. COP simulations suggest that the frequency of soil consuming fire events should decrease compared to pre-COP operations. Reduced frequency of soil consuming fires should decrease the potential of a shift in community composition from the ridge-slough-tree island landscape that is the historical (and target) condition to flattened/disturbed sawgrass plain that becomes dominant when the landscape is under hydrated.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each: A performance measure was used to evaluate the risk of soil oxidation across WCA-3 and ENP during plan formulation efforts for COP. Cumulative drought intensity is the sum of the daily depth of stage below ground (negative ponded depth) across the modeled period of record. Cumulative drought intensity was evaluated at indicator regions located in WCA 3 and ENP. Model results from COP were observed to decrease drought intensity at locations in NESRS and in Taylor Slough relative to the existing condition baseline (ECB19RR); however model results were also observed to increase drought intensity at locations in WCA-3A and WCA-3B relative to ECB19RR.

Expectations: Decreased frequencies and durations of dry outs leading to decreased rates of organic soil loss through oxidation and/or peat fires in portions of NESRS and Taylor Slough where improvements in cumulative drought intensity were observed. The expectation under COP is to maintain rates of organic soil loss and/or peat fires in portions of the study area where cumulative drought intensity was observed to increase, which includes portions of northern WCA-3A including indicator regions 190, 114, 115, 116, 118, the southeast portion of WCA-3B represented by indicator region 128, and the distal portions of Taylor slough represented by indicator regions 133S, 144N and 144S.

Methodology for testing each expectation or hypothesis (including frequency of monitoring) for reporting: The cumulative intensity of dry down will be calculated each year and compared to expectations set for years with similar rainfall levels and antecedent conditions in Alternative Q+.

Triggers/thresholds that indicate good COP performance or need for adaptive management action: Results will be reported in the context of what is expected given the improvements to hydrology in comparison to established assessment parameters and targets. Results will be provided on an annual basis to COP project managers, agency leads and the general public through appropriate forums.

Conclusions and recommendations for adaptive management actions will be provided and will evaluate the triggers/thresholds that indicate good COP performance.

Management options that may be chosen based on test results: Muck fire events are broadly accepted as negative. Feedback to COP management will include providing information that can inform project decisions such as timing of water deliveries, the pulsing of water deliveries, or routing water through an area slightly differently than originally specified but within the approved COP study area to improve hydroperiods and water depths. The goal is to determine whether such management actions would significantly improve cumulative drought intensity. Suggested adaptive management options listed below in **Table C.2-10** are not in any particular order and can be implemented simultaneously, as appropriate.

Table C.2-10. COP AM Uncertainty #23 (Soil oxidation and peat fires) management option matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC #23 - Soil oxidation and peat fires	Hydroperiod; Water Depth; Soil Oxidation; Peat Accretion; Fire Frequency	• Hydroperiod (Surface and Ground water) observed across a water year as measured at an identified set of gages in the study area. • Depth Water depth (surface and ground water) observed across a water year as measured at an identified set of gages in the study area. • Depth and duration of dry season below ground water levels across a year, as measured at an identified set of gages in the study area. • Soil moisture content • Peat accretion • Fire mapping • Soil decomposition	3 Years	• Areas directly west of the Miami Canal and north of WCA-3B and northern WCA-3B are of particular concern due to observed model results • Areas within NESRS and Taylor Slough in ENP are most likely to be affected; however monitoring within all of WCA 3 and ENP should be conducted	• Statistically significant decrease in soil moisture content • Organic soil content decrease • Sediment elevation decrease in ridges and tree islands • Statistically significant increase in frequency of peat soil consuming fires.	No new monitoring will be required to address this uncertainty.	• Modify and/or adjust operations to include (1) additional flows through S-150 and/or S-11A, S-11B, S-11C to reduce potential negative effects on areas of decreased hydroperiod and water depths; (2) alteration in flows to NESRS through S-333N/S-333; (3) adjustment in flows at S-335 • Prioritize backfilling of Miami canal to reduce dryout of northern WCA-3

C.2.2.8 COP AM Uncertainty ID#18 (Wading Birds in Alligator Alley North Colony): Will changes in hydrology under COP negatively influence the Alligator Alley North Colony in WCA-3A?

COP Objective: COP Objective 3.

Region(s) and Associated Features: This uncertainty is specific to northeast WCA-3A, where the Alligator Alley North Colony is currently located (see **Figure C.2-2** and **Figure C.2-3**). This colony is the largest in the Everglades and one of the largest wading bird colonies in the world. The ecological significance of this colony can be considerable when conditions are conducive both at the local island level and at the regional scale within a foraging flight of this island. In 2018 this one colony contained nearly 60,000 nesting pairs which is more than the CERP goal for the entirety of the Everglades system (Cook 2018).

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? Addressing this uncertainty will test whether COP operations can be targeted toward preserving an important natural resource on a flexible case-by-case basis that may vary among years. Northern WCA-3A is expected to experience increased dryness under COP operations, and addressing this uncertainty will protect the Alley North and other important colonies in WCA-3A that may be negatively impacted by increasing dryness during a critical period. This uncertainty should be addressed even if overall wading bird numbers show a positive response to COP operations in order to benefit the project's overall goal of protecting the ecological values of the WCA.

Expectations or hypotheses to be tested and attribute(s) that will be measured to test each: The hypothesis is that expected water levels under COP operations may dry the area around the Alley North or other important colonies at a critical time, but temporarily altering operations to improve conditions adjacent to the colony can avoid negative impacts due to COP operation. The specific attributes and expectations for this area includes maintaining: appropriate hydroperiods for wading bird nesting adjacent to the colony; appropriate recession rates for wading bird foraging adjacent to the colony; and appropriate water depths adjacent to the colony.

The Wading Bird Distribution Evaluation Model (WADEM) was utilized during plan formulation efforts for COP to identify potential improvements for wading birds within the study area as a result of COP implementation. From 1985-2012, Systematic Reconnaissance Flights (SRF) have been used to document the abundance, flock composition, and spatiotemporal distribution of foraging wading birds across the Greater Everglades system. To develop WADEM (Beerens 2014 and Beerens et al. 2015), SRF occurrence data for great egrets, white ibis, and wood storks, are paired with daily hydrological variables calculated from water depths generated by the Everglades Depth Estimation Network (EDEN). Output from this type of model, averaged over the landscape, serves as a surrogate measure of the abundance of high-quality foraging patches. WADEM was developed to predict how Great Egrets, White Ibis and Wood Stork distributions respond to prey resources linked to hydrologic variables. Results from the model have been used to determine locations where hydrologic restoration improves the capacity of the habitat to produce prey densities suitable for wading bird foraging success.

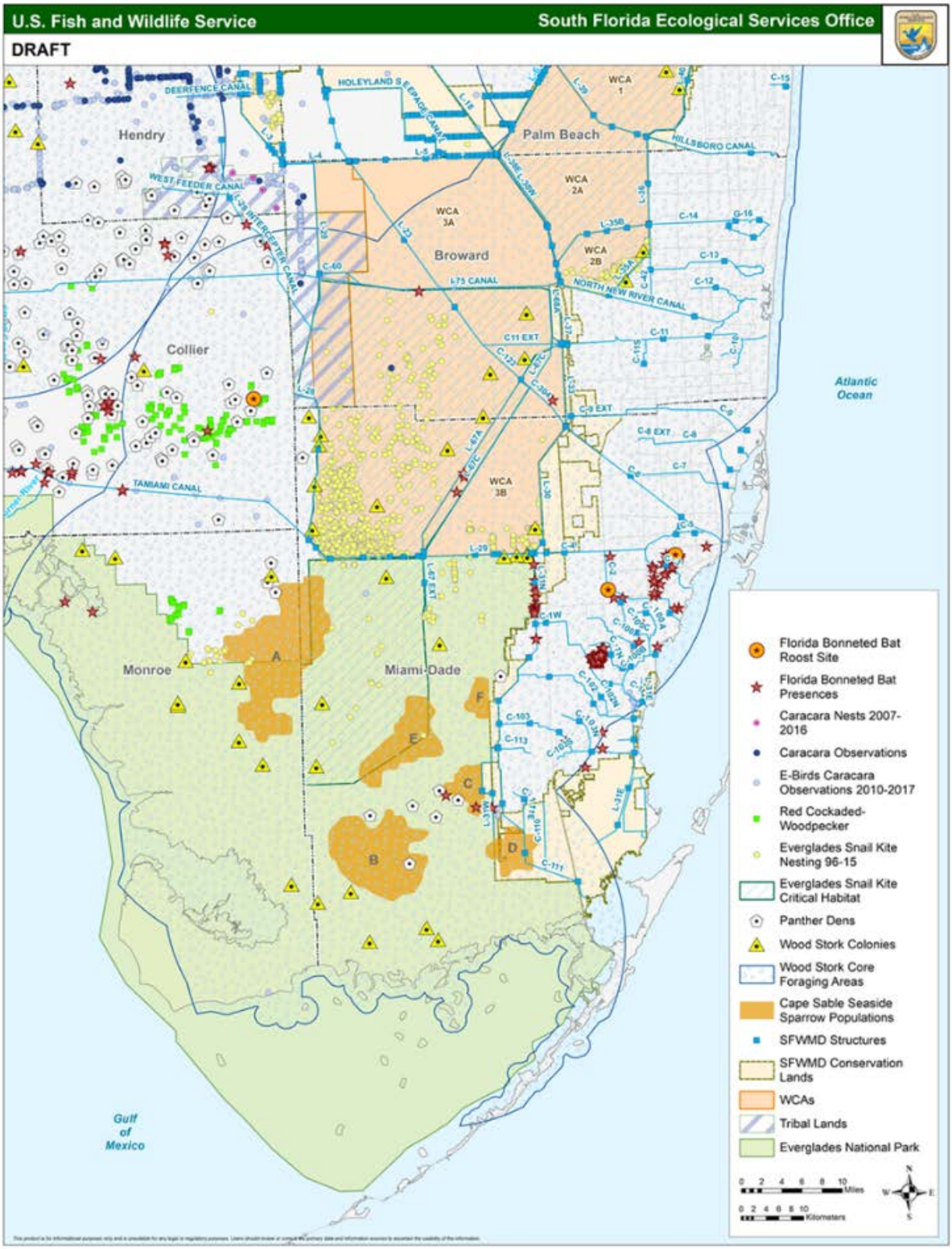


Figure C.2-2. Federally listed threatened and endangered species with the potential to occur within the COP action area (Provided by USFWS 2018). Yellow triangles note active Wood Stork colonies within the study area.

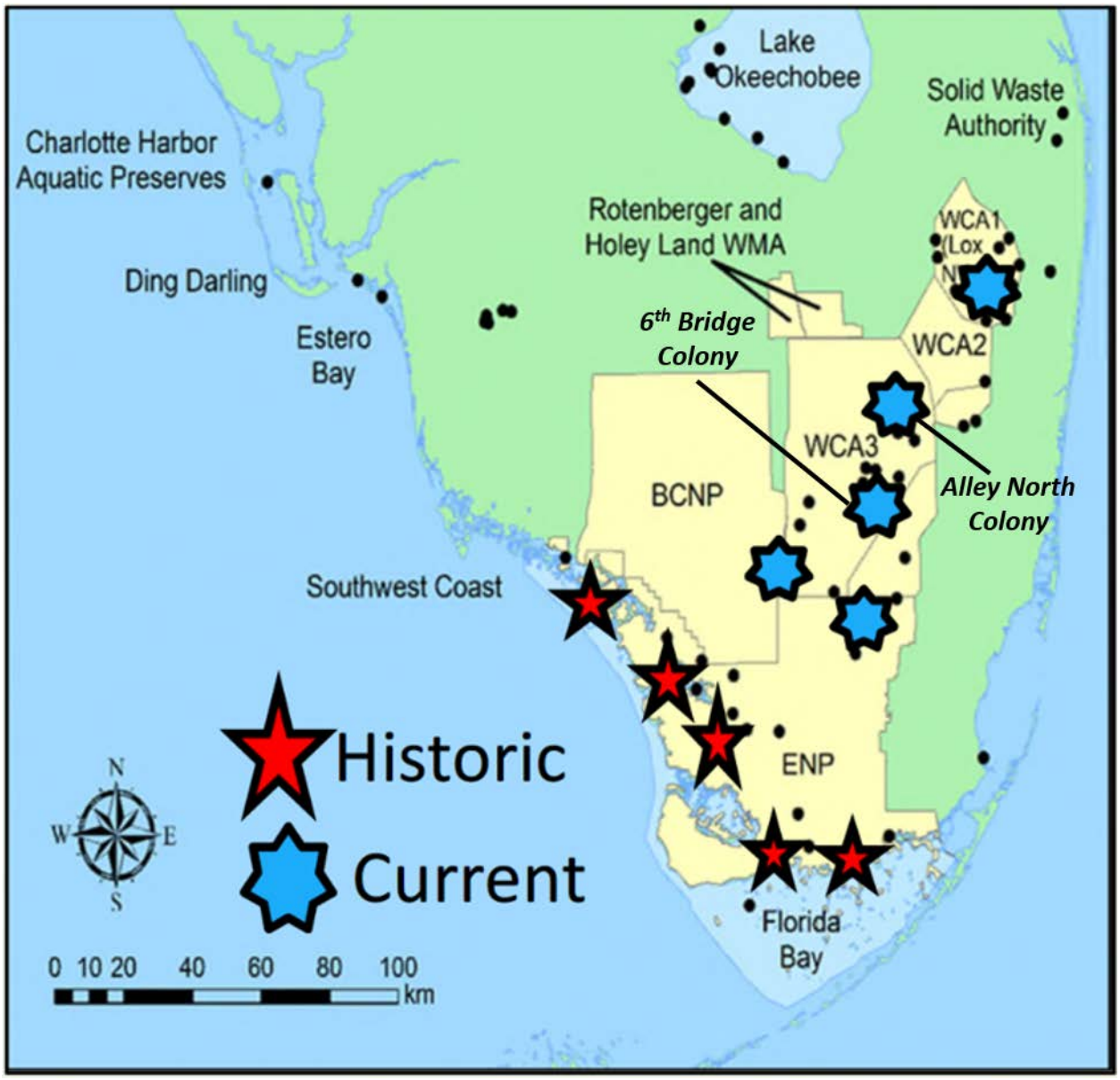


Figure C.2-3. Current and historic wading bird colony locations, with the Alley North and 6th Bridge colonies labeled. Red five pointed stars represent historic colony locations. Blue seven pointed stars represent current colony locations. Black dots represent smaller wading bird colony locations.

Specific attributes and expectations for these areas include:

Foraging Conditions and Nesting Success: Where hydrologic change leads to diminished water depths and hydroperiod a decrease in prey density is expected. This will be reflected by a decrease in the number of wading birds found foraging in those areas and a decrease in nesting success. The highly variable set of hydrologic parameters necessary to create suitable foraging conditions cannot be done solely through operational flows. The proper depths for the initiation of nesting and foraging related to nesting can only be established by the seasonally dependent regional climate driven precipitation. In some years the hydrology of the region surrounding the Alley North colony cannot support wading bird foraging conditions and no level of AM assisted water management could or should change that, this is natural variability. However, when suitable conditions are present at the beginning of the wading bird nesting season and nesting is initiated at the Alley North colony, it is expected that AM assisted water management may be able to accomplish three important functions.

1. Extend the hydroperiod in the marsh surrounding and upstream of Alley North (Foraging conditions).
2. Slow the recession rate in the marsh and at the Alley North island (Foraging conditions).
3. Provide standing surface water around the Alley North island that serves to protect the nests from mammalian predators (Nesting Success).

Pre-project monitoring and historical data will establish baselines for determining what suitable hydrologic conditions are necessary for wading bird nesting at Alley North. It is expected that a hydrologic as well as wildlife behavior trigger would be developed. This trigger would indicate that AM assisted water management has the potential to be efficacious.

The expectation under COP is to maintain and/or increase the total number of pairs of nesting birds in mainland colonies within ENP as determined by pre-project monitoring. It is reasonable to assume that given the model output of the alternatives, COP will have a deleterious impact on the foraging conditions and the nesting success of the Alley North colony. As COP isn't bringing in additional water volumes into WCA-3A only a change in the infrastructure would make significant difference in the hydrologic conditions near the colony. In a parallel effort to COP the SFWMD is undergoing the installation of a single canal plug in the L-38W (**Figure C.2-4**) and initial modeling with this feature (not modeled in COP) in place suggests improvement in at least extending the hydroperiod and slowing the recession rates in the marsh upstream of the colony. The installation of the plug as well as nine surface water wells in the vicinity of the plug and island are planned.

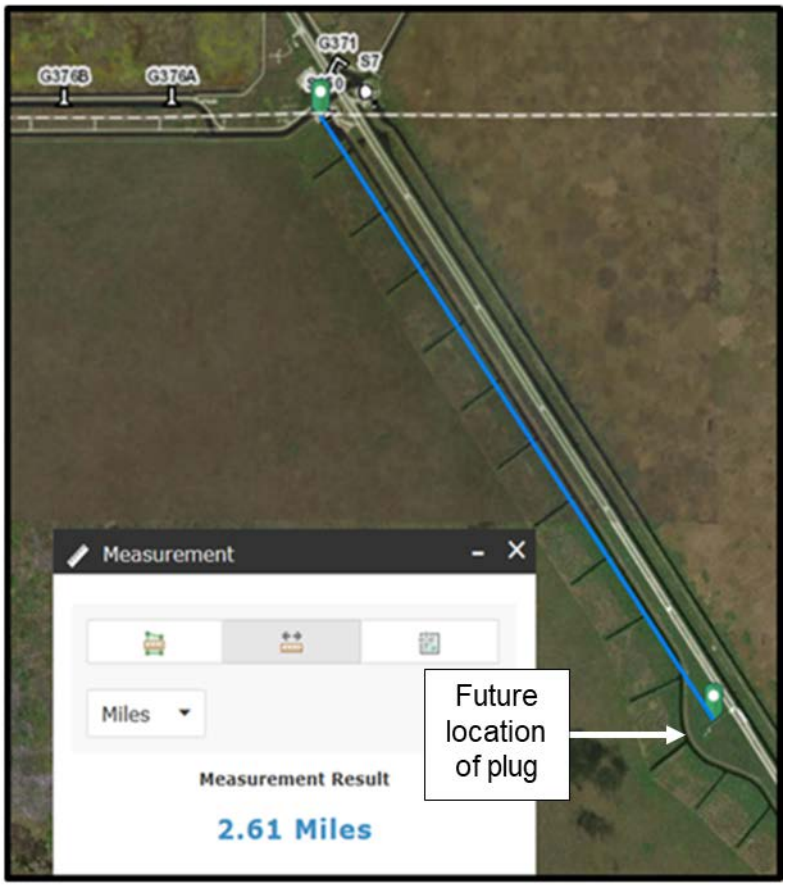


Figure C.2-4. Location of plug in L38W Canal, scheduled for spring 2020.

<u>Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting:</u> A comparative historical analysis will be required to test COPs potential to have a negative impact on wading bird foraging and nesting success at the Alley North Colony. In this approach, the before period is defined by measurements made annually 10 years prior to the initiation of COP operations that will affect the study area, and the after is the period 10 years following implementation. RECOVER's MAP and wading bird monitoring by the partner agencies will be utilized as appropriate to document historical wading bird foraging and nesting at the Alley North Colony and the surrounding marsh. That information will then be linked to the hydrologic conditions that led to suitable foraging and ultimately nest production at the Alley North Colony. As noted above the USGS's EDEN system and WADEM model as well as the SFWMD's wading bird (HSI) habitat suitability index based on SFWDAT can be used to determine the historical suitability of the hydrologic conditions for foraging. This analysis should provide baseline information for expected wading birds numbers utilizing the colony island given a set of hydrologic conditions, as well as information for the determination of a trigger for AM assisted water management.

As the conditions for wading birds will change given the institution of COP as well as the installation of the plug, it will be necessary to collect information from the sonde network installed as part of the SFWMD's L-38W plug. This network will provide the resolution required to determine the impact of these changes to this critical area for sustaining healthy populations of wading birds in the Everglades during transitionary periods between larger restoration efforts. The current scarcity of gage's located within the northwestern section of WCA-3A and the need for better information on the flux between the L-38W

canal and the marsh upstream and surrounding the Alley North colony makes the support of this new monitoring effort critical to determining whether or not COP will have a negative impact on the Alley North colony. The data will be collected from the sondes on a monthly basis. Post processing and storage of the data will take place within the SFWMD's Applied Sciences Division. The sondes will be maintained bi-annually or if a problem is detected. The information gathered will be used to assess current conditions as well as validate an ongoing SFWMD modeling effort undertaken to better understand and predict the hydrology associated with discharges into WCA-3A North and the impact of the plug.

Existing and ongoing monitoring conducted/funded by the partner agencies will be leveraged as much as possible to contribute to adaptive management under COP and to avoid duplication of monitoring efforts.

Water depths before the breeding season and recession rates during the breeding season will be monitored. Current gages under EDEN and related EDEN applications will be utilized to understand how hydrologic parameters (e.g. hydroperiod, water depth and recession rates) near and adjacent to Alley North are being influenced by current COP operations, and to inform decisions about how to alter COP operations within the current breeding season to avoid decreased nesting success and colony abandonment due to COP operations.

Triggers/thresholds that indicate good COP performance or need for adaptive management action (plus how results will be reported): Results will be reported in the context of what is expected given the improvements to hydrology in comparison to established assessment parameters and targets. Results will be provided on an annual basis to COP project managers, agency leads and the general public through appropriate forums. Conclusions and recommendations for adaptive management actions will be provided and will evaluate the triggers/thresholds that indicate good COP performance.

Water depths and forecast conditions will be discussed during periodic Multispecies operations calls hosted by USFWS, recommendations for operations will be made during these meetings and forwarded along to system operators. These meetings will likely occur weekly during the wading bird nesting season and then quarterly for the rest of the year and the specific schedule of meetings will be set based on the perceived need to make recommendations as defined by the wildlife biologists that contribute their observations of the system and conclusions drawn from analysis and synthesis.

Management options that may be chosen based on monitoring results: Feedback to COP management will be done in real time during Periodic Scientist Calls and weekly Multispecies Calls during the wading bird nesting season to determine whether operations need to be altered in the short-term. Management options include changes to the timing of water deliveries or routing water through an area slightly differently than originally specified to improve hydroperiods, water depths, and recession rates adjacent to wading bird colonies of concern in WCA-3A. Suggested adaptive management options listed below in **Table C.2-11** are not in any particular order and can be implemented simultaneously, as appropriate. Some potential dry season adaptive management assisted water management options/strategies include:

- Allow water from WCA-2A to back flow through the S-7 structure into the L3/L4 canal, to then be discharged through the S-150 into northwestern WCA-3A. This may mean deploying temporary pumps in order to be protective of stages in STA ¾ and ensure an effective volume of water is being moved into the S-150 (the nearest upstream water control structure to the Alley North Colony).
- Reprioritize the movement of water through the S-150 structure (vs. S-11s, S-140s, S-8, G-404)
- Install an additional plug

Table C.2-11. COP AM Uncertainty ID #18 (Wading Birds in Alligator Alley North Colony) management option matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC #18 – Wading Birds in Alligator Alley North Colony	Wading bird presence; Foraging conditions; Nest initiation;	Nesting numbers; Nesting success; Water depth/stage; Recession rate.	2 to 4 weeks	WCA-3A – Alligator Alley North colony and surrounding marsh	Evaluation of foraging conditions, nesting effort, previous years foraging conditions	9 X surface water wells and sondes (Existing). EDEN gages and SFWMD wading bird surveys are part of on-going monitoring. Additional costs = $50,000 / year.	• Modify and/or adjust operations to include (1) additional flows through S-150 and/or S-11A, S-11B, S-11C to reduce potential negative effects; (2) reduction in flows to NESRS through S-333N/S-333; (3) adjustment in flows at S-335 • Allow water from WCA-2A to back flow through the S-7 structure into the L3/L4 canal, to then be discharged through the S-150 into northwestern WCA-3A. This may mean deploying temporary pumps in order to be protective of stages in STA ¾ and ensure an effective volume of water is being moved into the S-s150 (the nearest upstream water control structure to the Alley North Colony). • Reprioritize the movement of water through the S-150 structure (vs. S-11s, S-140s, S-8, G-404) • Install an additional plug

C.2.2.9 COP AM Uncertainty ID #24 (Water flow, salinity and algal blooms in Whitewater Bay, Florida Bay, and southwest coast estuaries): What are the water quality impacts and ecological benefits of changing patterns of freshwater flow into estuarine waters of the southern Everglades?

COP Objective or Constraint: COP Objectives 1a, 1b, 1c, 2, 3

Region(s): Southern estuaries and near-shore southwest coastal waters, including Florida Bay, Whitewater Bay, Shark River and other southwest riverine estuaries influenced by COP, as far north as Lostman's River.

Associated Features: Tamiami Trail and ENP eastern boundary structures, including: S-333; S-12s, S-356 and L-31N seepage barrier; L-31N structures and adjacent detention areas, C-111 structures and C-111SCW features.

Driver or Uncertainty Type: Hydrology, water quality, ecology

What is expected to be learned by addressing this uncertainty, i.e., how will the project benefit from addressing this uncertainty? Implementation of the MWD, C-111 South Dade, and C-111 Spreader Canal Western Projects via COP is a foundational step toward restoring estuaries that depend on freshwater flow from Shark River Slough and Taylor Slough, including Florida Bay, Whitewater Bay, Shark River and other southwest riverine estuaries, likely as far north as Broad River. Based on model output used to evaluate COP alternatives, we expect COP will create more natural patterns of flow (especially distribution and timing, but also increased water quantity as a consequence of decreased seepage losses), resulting in more natural salinity patterns and associated restoration of estuarine ecological structure and function (especially seagrass habitat and associated fish populations). We also expect that water quality will be unaffected by COP implementation. However, there is a high degree of uncertainty regarding these expectations, as our expectations hinge on complex hydrologic models of the upstream watershed, statistical models to estimate salinity change, and various models that estimate ecological relationships with salinity. Estimates from such a chain of models within a large, complex, and dynamic watershed-estuarine ecosystem inevitably have high uncertainty. Uncertainty regarding estuarine responses is also a consequence of estuaries being strongly influenced by unmanaged coastal and ocean forces. Accelerating sea-level rise and climate change further increase this uncertainty. Better understanding of how the primary watershed driver of estuarine ecosystem change, freshwater flow, affects salinity, water quality, habitats and fauna will help COP and future restoration projects maximize benefits in these ecosystems.

Major categories of uncertainty to be addressed to promote COP success are:

1. Flow to the estuaries. How will patterns of flow distribution, timing, and quantity change with COP? Estuarine benefits from COP depend on improvement on flows from the Everglades watershed. Florida Bay restoration requires more water delivery toward the central bay. Monitoring of creek and river discharges to estuarine waters will inform future operational adaptations under COP and plans for CEPP, as well as improve hydrologic models that simulate coastal boundary conditions.
2. Salinity. How will salinity patterns be influenced by COP and will areas of critical concern have lower, more natural salinity? Will salinity be moderated in areas with a history of prolonged periods of extreme hypersalinity, especially north-central Florida Bay? Salinity monitoring and

tracking the relationship of flow and salinity will inform operational adaptations under COP and plans for CEPP, as well as improve understanding and projections of how changing water management can influence estuarine conditions.

3. Algal blooms. The effects of changing patterns of freshwater inflow on estuarine nutrient availability and phytoplankton productivity are highly uncertain. Coastal phytoplankton (algal) blooms are a major concern, as they can negatively impact seagrass habitat and fauna. Coastal water quality monitoring, including nutrient (P and N) and chlorophyll *a* measurements, along with assessment of potential upstream (watershed) nutrient sources, is essential to understand how restoration can best be achieved without compromising water quality, including algal bloom propagation. Other uncertainties in this Appendix (#16a, #16b, #23, #1/21) pertain to assessing upstream nutrient sources, including canal inputs, mobility of legacy nutrient enrichment, and nutrient release from soil oxidation or subsidence or fire. Also, the state of seagrass beds and their productivity, which is part of this estuarine uncertainty, has a strong interaction with algal bloom potential; healthy seagrass beds sequester nutrients and lessen bloom risk, while seagrass die-off releases nutrients and increase bloom risk.
4. Ecological benefits. How will changing patterns of freshwater flow and salinity improve seagrass bed habitat and fish populations, including economically important recreational fisheries? Monitoring of these critical ecological components, combined with information on flow, salinity, and water quality, will enable understanding of overall estuarine ecosystem responses to COP and inform operational adaptations under COP and plans for CEPP to maximize ecological benefits.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each: For each of the above categories of estuarine uncertainty, expectations and measurements to assess those expectations are as follows.

1. Flow to the estuaries. COP is expected to increase freshwater flow down Shark River Slough and Taylor Slough, with most of this increase occurring during the dry season. The uncertainty of realized flow delivery to the estuaries will be addressed with calculation of water discharge from the existing USGS network of flow velocity gauges in creeks flowing into Florida Bay and rivers flowing into Whitewater Bay and the Gulf of Mexico.

2. Salinity. With increased flow, especially during the wet season and early dry season, salinity in estuarine and coastal nearshore waters is expected to decrease with COP. In particular, dry season salinity maxima are expected to decrease. The uncertainty of COP's influence on salinity, in terms of magnitude, seasonality, and spatial distribution will be addressed via salinity monitored by the ENP Marine Monitoring Network. Additional spatial mapping may be conducted by SFWMD's shipboard Dataflow surveys.

3. Algal blooms. The initiation and duration of algal (phytoplankton) blooms with COP is dependent upon many factors, but often is controlled by nutrient availability. This availability is in turn influenced by several factors, including storm disturbance, nutrient content of freshwater flow from the Everglades, and the demand and uptake of nutrients by seagrass and benthic algae in the estuaries (i.e., competitors for available nutrients). We hypothesize that COP and subsequent restoration efforts will improve both wetland and estuarine plant communities, yielding increased net nutrient uptake, as well as increased soil and sediment stability, which combined should increase wetland and estuarine nutrient sequestration in plants, soils, and sediments.

This sequestration will minimize phytoplankton productivity. Furthermore, phytoplankton productivity in Florida Bay is typically P limited, and P inputs from the Everglades to the bay are low and not expected to increase with COP. Phytoplankton productivity in Whitewater Bay and southwest coast riverine estuaries is more N limited, and Shark River Slough waters are relatively rich in N, with high N/P ratios. While N inputs to these estuarine and coastal waters from SRS are not expected to increase with COP, blooms may nevertheless occur. We expect such blooms will be no more frequent or long-lasting than has occurred before COP.

To address this set of uncertainties, coastal water quality monitoring that includes chlorophyll *a* measurements, and which is currently being conducted by SFWMD, should continue. This water quality sampling was done monthly for about 20 years, but the frequency was then decreased to every two months, except in a subset of eastern and central Florida Bay stations. Given the potential for rapid bloom development, resuming monthly monitoring at stations that may be influenced by COP is recommended in order to estimate bloom frequency, duration and intensity. Additional spatial mapping of chlorophyll *a*, conducted by SFWMD's shipboard Dataflow surveys, should continue in northern Florida Bay and be expanded to include southwest coastal and estuarine waters that appear prone to bloom activity.

4. Ecological benefits. The primary restoration targets for these coastal and estuarine systems is seagrass habitat and fish populations, including economically important recreational fisheries. Improvement of habitat and fauna is expected in near-shore portions of Florida Bay and the southwest coast. Currently, RECOVER's FHAP project assesses seagrass habitat through most of the area of potential COP influence, with the exception of Long Sound, Joe Bay, and Little Madeira Bay. These northeastern Florida Bay basins, which were previously monitored by Miami-Dade DERM, also should be assessed to address this uncertainty and uncertainty #2 in this Appendix. RECOVER's Juvenile Sportfish monitoring project, Florida Bay Marsh-Mangrove Interface Habitats for Fish project, and Hydrology, Aquatic Vegetation and Fauna in the Southern Everglades project assess fish communities in the COP zone of influence and should be continued.

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting:

1. Flow to estuaries. USGS directly measures flow to estuaries. Methodologies are established in the USGS Coastal Gradients project, sponsored by USGS and RECOVER. A network of 17 creek stations from Manatee Creek (flowing into Manatee Bay) to Lostman's River monitor flow velocity at approximately 15 min intervals and calculate net creek discharge. Most stations have telemetry with real time data availability. See: https://waterdata.usgs.gov/fl/nwis/current/?type=flow

2. Salinity. Salinity is monitored hourly in Everglades National Park's Marine Monitoring Network. There are 18 stations operated in Florida Bay and 15 stations in the estuaries of the park's southwest coast. See: https://www.nps.gov/ever/learn/nature/flbaymon.htm

3. Algal blooms. Water quality, including chlorophyll *a*, is monitored at a set of fixed sites in Florida Bay and estuaries of the southwest coast. Most stations are monitored every two months, but a subset of stations intended for C-111 Spreader Canal Western and C-111 South-Dade project monitoring are monitored monthly. For a map of stations, see: https://www.sfwmd.gov/sites/default/files/documents/wqm_swgrab1.pdf

For a description of this coastal monitoring and Dataflow continuous flow spatial mapping, see: https://www.sfwmd.gov/sites/default/files/documents/2018_sfer_florida_bay.pdf

4. Ecological benefits. Assessments of ecological benefits and relationship to COP implementation will depend on the analysis of changing seagrass cover and species and fish population in relation to COP implementation and time series results from monitoring efforts described above. Seagrass and fish in Florida Bay and the southwest coast are monitored in multiple RECOVER projects supporting COP assessment, including monitoring of seagrass habitat cover and community composition; juvenile sportfish abundance, biomass, community composition; mangrove wetland prey base abundance, biomass, and composition with local hydrologic conditions; and wetland and coastal fish utilization of marsh-mangrove habitats, with adult sportfish tracking. Sampling frequency varies among these projects, but generally is seasonal to annual. For details, see the 2014 System Status Report from RECOVER: https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll7/id/8694

Triggers/thresholds that indicate good project performance or need for adaptive management action: Protective triggers and thresholds, established or other programs, can help inform COP adaptive management, potentially leading to corrective operational actions or future structural modifications. Minimum Flows and Levels have been established by SFWMD and FEDP for northeast Florida Bay to prevent significant harm, with a regulatory salinity threshold at a single lower Taylor Slough pond site and an associated guidance threshold for annual (365 day running total) flow into the bay from 5 creeks with USGS velocity meters (https://www.sfwmd.gov/our-work/mfl). COP and subsequent CERP projects will influence salinity and flow in this region and well beyond it. The occurrence of salinity threshold exceedances should trigger scrutiny of COP performance. Guidance from the creek discharge sum may be more useful for COP AM, as this can be used to forecast salinity trajectories. However, the MFL flow threshold (105,000 acre-feet per 365 days) appears to be too low to trigger adaptive actions, as it was not met only once over the past 14 years (in 2015), concurrent with a major seagrass die-off event (an event with significant harm). Based on best professional judgement, and given that COP's objectives are to increase flow to advance restoration, a threshold of 200,000 acre-feet would be a more useful flow "floor" for COP guidance.

Protective thresholds for algal blooms have also been established by FDEP for coastal waters influenced by COP (https://floridadep.gov/dear/water-quality-standards/content/numeric-nutrient-criteria-development). For these waters, FDEP numerical nutrient and chlorophyll a criteria are annual geometric means that are not to be exceed more than once in a 3 year period. Geometric means for numerous sub-regions were derived from SFWMD water quality monitoring network measurements from 1996-2005. This statistical approach entails an underlying assumption that the intensity and frequency of algal blooms in the recent past is acceptable, but should not be systematically exceeded. In the context of COP adaptive management, this provides a threshold that can be used to assess whether a "do no harm" objective for coastal water quality is being met. The phytoplankton bloom indicator reported in the Everglades Restoration system-wide ecological indicators report (https://www.evergladesrestoration.gov/sweir/) has similar properties and serves a similar function, although at a coarser spatial scale (especially on the southwest coast).

These and other triggers and thresholds can also be used to indicate good COP performance. This includes trends of increasing freshwater flow, decreasing salinity (especially in areas with extreme hypersalinty), and decreasing chlorophyll *a* in areas with a history of phytoplankton blooms. A set of ecological indicators has also been established to assess restoration progress

(https://www.evergladesrestoration.gov/sweir/), including indicators for Florida Bay seagrass habitat, roseate spoonbills, and crocodiles. A juvenile spotted seatrout performance measure has also been established in RECOVER (https://www.saj.usace.army.mil/Portals/44/docs/Environmental/RECOVER/Southern_Coastal_Systems_Seatrout_Performance_Measure_Final_021617_web.pdf?ver=2017-02-21-123410-380). While these ecological indicators do not have specific thresholds to trigger COP adaptive management actions, they collectively can be tracked over time to assess the extent to which COP is driving Everglades Restoration progress in the southern coastal system.

Management options that may be chosen based on test results:

- Modify operations to increase flow either via changing distribution or timing. This includes distribution of water from WCA-3A or -3B to ENP or distribution within ENP (inflow to Shark River Slough vs Taylor Slough). This entails potential modifications of operation of structures along Tamiami Trail and the ENP eastern boundary.
- Additional actions could be taken to improve seepage management, especially on ENP eastern boundary, by raising L-31 and/or C-111 stages or, in future projects, building seepage barriers.

This uncertainty is further summarized in Table C.2-12.

Table C.2-12. COP AM Uncertainty ID#24 (salinity, water flow, algal blooms in Whitewater and Florida Bays) management options matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC ID #24: Water flow, salinity, algal blooms and ecological benefits in Florida Bay, Whitewater Bay and southwest coast estuaries.	Water inflow from creeks and rivers	Flow velocity, with estimates of discharge (approximately 20 minute intervals)	2 to 4 years	Mangrove ecotone of Florida Bay, Whitewater Bay and southwest coast rivers (to Lostman's River)	• Flows insufficient to prevent high salinity events that cause ecological harm. The Minimum Flows and Levels flow threshold can be considered, but for COP success, higher flows (perhaps near the 25th percentile of MFL creek flow data distribution) should trigger adaptive action. • Trend in deviation from expected relationship with rainfall (using double mass curves) could show good or poor performance	Existing (USGS, RECOVER)	• Modify operations to increase flow either via changing distribution or timing. This includes distribution of water from WCA-3A or -3B to ENP or distribution within ENP (inflow to Shark River Slough vs Taylor Slough). This entails potential modifications of operation of structures along Tamiami Trail and the ENP eastern boundary. • Additional actions could be taken to improve seepage management, especially on ENP eastern boundary, by raising L-31 and/or C-111 stages or, in future projects, building seepage barriers.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC ID #24: as above	Salinity regime	Specific conductivity and temperature to estimate salinity (hourly measurements)	2 to 4 years	Florida Bay, Whitewater Bay, southwest coastal rivers (to Lostman's River)	• Minimum Flows and Levels salinity threshold is a starting point, but broader spatial criteria are needed. • Trend in deviation from RECOVER FL Bay salinity performance measure could show good or poor performance	Existing (ENP)	See above
UNC ID #24: as above	Algal blooms	Chlorophyll *a* (monthly for grab sample network; seasonal for spatial mapping)	2 to 5 years	Florida Bay, Whitewater Bay, southwest coastal rivers (to Lostman's River)	Chlorophyll *a* concentrations with red stoplight indicator or exceeding Numerical Nutrient Criteria thresholds	Existing (SFWMD); estimated $30,000 for monthly interval change	See above
UNC ID #24: as above	Seagrass community	Bran-Blanquet cover metric, species composition (annual)	3 to 5 years	Florida Bay, Whitewater Bay	Trends in seagrass cover scores plus salinity and temperature indicative of increased seagrass die-off risk	Existing (RECOVER)	See above

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC ID #24: as above	Faunal indicators	• Fish abundance, biomass, and species composition (monthly to seasona) • Fish movement and location relative to salinity (monthly) • Fish prey base concentration with recession (monthly to seasonal) • Roseate spoonbill nesting success (dry season) • Crocodile abundance, nesting success, growth and survivorship (dry season?)	1 to 5 years	Florida Bay, Whitewater Bay, Shark River	Trends in fish, spoonbills, or crocodiles could indicate good or poor performance	Existing (RECOVER)	See above

C.2.2.10 COP AM Uncertainty ID #25 (Wading Birds): How much will hydrologic restoration result in potential changes in wading bird foraging conditions and nesting under COP?

COP Objectives and Constraints: COP Objective 3.

Region(s) and Associated Features: While this uncertainty relates to all regions of COP where wading birds foraging and nesting currently take place, it is most specific to WCA-3A and areas in ENP to include NESRS. **Figure C.2-2** illustrates the location of wood stork nests and core foraging areas currently located within the COP study area boundary that may be potentially affected by COP. And **Figure C.2-3** shows the current major wading bird colonies locations and where they were historically.

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? Addressing this uncertainty provides information that will enhance the ability of COP to improve the timing of and spatial patterning of foraging conditions which could help optimize nest initiation increase nest numbers and success for wading birds including the Great Egret, White Ibis and Wood Stork. Wading birds are currently not utilizing the study area for foraging and nesting to the same extent that has been documented to occur prior to implementation of the C&SF project (i.e. formation of wading bird super colonies) (Cook 2018), and model results indicate COP may have an undesirable impact on foraging conditions in WCA-3A. The COP adaptive management plan will provide a way to determine more specifically how operations of current water management infrastructure influence wading bird populations by altering hydrologic parameters (hydroperiod, water depth and recession rates) and ecological parameters (prey density and vegetation).

Expectations or hypotheses to be tested to address the uncertainty and attribute(s) to be measured to test each: Central to this uncertainty is the hypothesis that more natural hydrologic patterns will improve foraging conditions and increase nest number and nesting success for wading birds such as the wood stork. Restoration of multi-year hydroperiods is expected to result in increases in dry season prey availability, increased nesting, and earlier nest initiation (November/December). Another goal of restoration is to encourage nesting in larger numbers at the historic coastal colonies.

The Wading Bird Distribution Evaluation Model (WADEM) was utilized during plan formulation efforts for COP to identify potential improvements for wading birds within the study area as a result of COP implementation. From 1985-2012, Systematic Reconnaissance Flights (SRF) have been used to document the abundance, flock composition, and spatiotemporal distribution of foraging wading birds across the Greater Everglades system. To develop WADEM (Beerens 2014 and Beerens et al. 2015), SRF occurrence data for great egrets, white ibis, and wood storks, are paired with daily hydrological variables calculated from water depths generated by the Everglades Depth Estimation Network (EDEN). Output from this type of model, averaged over the landscape, serves as a surrogate measure of the abundance of high-quality foraging patches. WADEM was developed to predict how Great Egrets, White Ibis and Wood Stork distributions respond to prey resources linked to hydrologic variables. Results from the model have been used to determine locations where hydrologic restoration improves the capacity of the habitat to produce prey densities suitable for wading bird foraging success.

Areas expected to offer improved foraging conditions under COP based on WADEM include portions of NESRS within ENP. Potential changes in foraging conditions within WCA-3A and WCA-3B under COP fell within +/- 10% relative to the existing condition baseline (ECB19RR); however decreases in stage and hydroperiod were observed in portions of WCA-3A in the vicinity of the Alligator Alley North Colony

located west of the Miami Canal and north of WCA-3B during modeling efforts to support alternative analysis. While the potential improvement in foraging conditions within NESRS is encouraging, it is not the goal of COP to redistribute wading birds away from the interior colonies (Alley North) and towards the coast. Pre-project monitoring will establish baselines in key areas of the COP study area that are expected to be influenced by COP.

Foraging Conditions, Nesting Success, and Nest Initiation: Where a restored hydrology creates suitable conditions, an increase in prey density is expected. This will be reflected by an increase in the number of wading birds found foraging in those areas and an increase in nesting success. Pre-project monitoring will establish baselines in key areas of the COP study area. The expectation under COP is to maintain and/or increase the total number of pairs of nesting birds in mainland colonies within ENP as determined by pre-project monitoring. Shifting the timing of nesting in mainland colonies to more closely match pre-project conditions is also desirable. Specific recovery objectives would be to initiate nesting no later than January in most years (as early as December in some years).

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: A BACI (Before-After-Control-Impact) methodology will be used for testing the model based expectation that COP will affect foraging in some regions thus impacting nesting timing and success in that location. Control and impacted colonies will be chosen based on all the model output used for COP based on predictions that nearby foraging would or would not be impacted. For example it is clear that the Alley North colony has the potential to be negatively impacted, and the colonies near NESRS may be positively affected. As noted above the USGS's EDEN system and WADEM model as well as the SFWMD's wading bird (HSI) habitat suitability index based on SFWDAT can be used to determine the historical suitability of the hydrologic conditions for foraging near the colonies selected as controls or impacted (Alley North). Baselines can be established from the historical analysis for the colony locations chosen as controls or impacted sites and thresholds of concerns or triggers for action will be established. Problematic will be the lack of SRF flights after 2012 that systematically monitored foraging locations across the Everglades. Current monitoring must be more selective and targeted as time and financial constraints prevent a systematic reconnaissance of the complete Everglades landscape. Therefore the banner wading bird year of WY2018 was not captured in the calibration of WADEM, nor could SRF data be made use of in the future to track the change in foraging locations and change in the number of birds making use a particular habitat over time.

Triggers/thresholds that indicate good project performance or need for adaptive management action: Results will be reported in the context of what is expected given the improvements to hydrology in comparison to established assessment parameters and targets. Results will be provided on an annual basis to COP project managers, agency leads and the general public through appropriate forums. Conclusions and recommendations for adaptive management actions will be provided and will evaluate the triggers/thresholds that indicate good COP performance.

Management options that may be chosen based on monitoring results: Feedback to COP management will include providing information that can inform project decisions such as timing of water deliveries, or routing water through an area slightly differently than originally specified but within the approved COP study area to improve hydroperiods, water depths and recession rates adjacent to wading bird colonies of concern. The goal is to determine whether such management actions would significantly improve foraging and nesting conditions for wading birds in the study area. Suggested adaptive management options listed below in **Table C.2-13** are not in any particular order and can be implemented simultaneously, as appropriate.

Table C.2-13. COP AM Uncertainty ID#25 (Wading Birds) management option matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC #25 – Wading Birds	Wading Birds	Hydroperiod; Water Depth/ Stage; Recession Rates; Numbers of foraging wading birds; Number wading bird nests; and Nesting success (monitoring to include aerial and ground surveys conducted monthly during breeding season)	4 to 6 Years	Wading bird colonies within WCA 3 and ENP	• Decrease or no improvement in numbers of foraging birds based on evaluation of baseline data • Decrease or no improvement in nesting success (nest abandonment) based on evaluation of baseline data	No new monitoring will be required to address this uncertainty. Current on-going RECOVER Monitoring occurs in Lake Okeechobee, the WCAs, ENP, and Florida Bay at a cost estimate of $500,000 per year.	• Evaluate distribution of water between WCA-3, NESRS and Taylor Slough; modify regional operation of the system. • Modify and/or adjust operations to include (1) additional flows through S-150 and/or S-11A, S-11B, S-11C to reduce potential negative effects; (2) reduction in flows to NESRS through S-333N/S-333; (3) adjustment in flows at S-335.

C.2.3 Hydrological Adaptive Management Uncertainties

C.2.3.1 COP AM Uncertainty ID #6 (Seepage / Flood Protection): Do COP operations, while leveraging existing seepage management infrastructure, sufficiently support project objectives and constraints?

COP Objectives or Constraints: COP objectives 1a, 1b, 1c, 2.

COP planning constraints related to this uncertainty is as follows:

#5.1992 MWD GDM (1992 General Design Memorandum): mitigation for project induced flood damages

COP planning considerations related to this uncertainty are as follows:

#5. Consider compatibility with future restoration actions including CEPP. Reasonably connect the planning under this project authority to other near-term changes that are likely to be implemented in the system in the next few years using an Adaptive Management framework.

#7. Explore opportunities to enhance flood control and mitigation.

Region(s): WCA-3B, Northeast Shark River Slough (NESRS), 8.5-Square-Mile Area (8.5 SMA), and areas along the L-31N, L-30, and C-111 Canals

Associated Features:

- L-30 Canal and associated water control structures (S-335)
- Partial seepage barrier south of Tamiami Trail along L-31N
- L-31N Canal, detention areas, and associated water control structures (S-356 and S-332B/C/D structures).
- 8.5 SMA Canals and associated water control structures (S-357, S357N)
- C-111 Canals, detention areas, and associated water control structures (S-199, S-200)

Driver or Uncertainty Type: Hydrology/Operations, Flood Control

What is expected to be learned by addressing this uncertainty, i.e., how will the project benefit from addressing this uncertainty? 8.5 SMA: By addressing this uncertainty, the effectiveness of seepage management features, and their effects on regional surface and subsurface hydrology will be better understood. There are remaining uncertainties about the effectiveness of seepage management measures in the project area due to complex interactions among the water control infrastructure, geology, and natural variables. While the numerical models showed any expected seepage should be within authorized level of flood mitigation, the pumping strategies and constraints in the COP are purposely conservative in order to prevent problems due to any potential inaccuracies in the models. Continued monitoring and testing during actual implementation, as conducted during the Incremental Field Test, may show the operations in the COP are overly conservative and additional deliveries into NESRS can be allowed without creating risk for flood mitigation. Such field verification of the models may allow additional operations within WCP flexibility and allowing increases in beneficial flows to NESRS.

L-31-N and C-111: There is uncertainty whether installation of further seepage barriers would be a cost-effective way of reducing seepage management challenges in adjacent developed areas. Investigation of the effectiveness of the installed 5-mile seepage barrier along L-31N versus utilization of detention areas and pumping along the eastern boundary of ENP may indicate whether additional seepage barriers would be beneficial in achieving more environmental benefits in a cost-effective way. The lessons learned could inform the suitability of this type of infrastructure for future planned restoration projects.

A better understanding of effectiveness of COP seepage management measures can also provide information on:

- Extent of the influence of existing seepage management measures,
- If the current level of flood risk management provided by the C&SF system is maintained,
- Volume of surface water lost to the canal system and delivered to various regions of the project,
- Effect of seepage management on regional groundwater flow, wetland hydroperiods, extent of salt water intrusion, water quality, and water supply availability.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each:
Hypothesis 1: Existing infrastructure and water management operations effectively manage the seepage rates along L-31-N Canal, C-111 Canal, and eastern ENP.

Hypothesis 2: Existing infrastructure and water management operations achieve the authorized level of flood mitigation for 8.5 SMA.

What is expected to be learned by measuring this attribute, i.e., how will COP benefit from knowledge gained about this attribute?

Assessing the effectiveness of seepage management measures can support:

- Better operation of the water management system and its flood risk management and water supply functions,
- Better accounting of deliveries to various regions of the project area,
- Determination of additional needs for data monitoring or seepage management measures.

What is the time frame in which changes to this attribute are expected to be measurable?

Continuous monitoring under various hydrologic conditions following installation of all monitoring gages (in 8.5 SMA, C-111 detention areas) are needed.

Is this attribute complimented by other monitoring programs within and/or outside of COP?

Continued monitoring data consistent with the requirements of Increment 2 Field test will be needed.

When during COP's life cycle should this monitoring begin and end?

Continuous monitoring of flow rates and water stages will be maintained through the COP process.

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: Monitored stage and structure flow rates will be analyzed to investigate the effectiveness of installed seepage barrier and operational changes to provide feedback to water managers on operational

decisions and their subsequent effect on flood control and water supply for the Lower East Coast. The focus of the analyses will be on:

- The distribution, volume, and timing of surface and groundwater flows and stages at water control structures and select sites.
- Evaluation of stages, and recession and seepage rates for 8.5 SMA to determine:
  - If additional adjustments to the water deliveries are needed to maintain the flood mitigation requirements.
  - If the existing numerical models adequately simulate the field conditions or future refinements of existing models is necessary to better forecast the effects of infrastructure and operational changes.
- Adjustments to canal levels and structure operating ranges to enhance flood control and mitigation within WCP flexibility.
- Comparison of functioning of 5-mile L-31N seepage barrier to control seepage versus the potential use of C-111 detention areas and pumping to the south to build a hydraulic ridge.
- Whether additional seepage barriers further south should be considered for future projects.

Triggers/thresholds that indicate good project performance or need for adaptive management action: The thresholds that signify the need for the implementation of adaptive management measures for project regions are listed below.

- Increased hydroperiod durations and/or peak stages in 8.5 SMA beyond historical observations and modeling results, which may necessitate operational changes in 8.5 SMA and/or S-331 Structure, or reductions in canal stages and flows into NESRS.
- Decreased hydroperiod durations and/or peak stages in 8.5 SMA compared to historical observations and modeling results, which can allow further relaxation of L-29 operational constraints for flows into NESRS.
- Performance evaluation of 2020 COP Biological Opinion RPA, potentially including dry nesting days, discontinuous hydroperiods, and water level reversal west of the C-111 detention areas (update following the ESA consultation).

Management options that may be chosen based on test results:

- Adjustments to operations in the L-29, L-30, L-31N, and C-111 to improve water deliveries to NESRS, Taylor Slough, the Biscayne Bay.
- Adjustments to operations for 8.5 SMA.
- Refinement/improvement of existing numerical models to improve ability to forecast effects of structures and operations, if needed.
- Recommend additional targeted groundwater modeling to evaluate need for additional segments of barrier wall or increases in pump capacity to control seepage due to expected increased flows to NESRS.

This uncertainty is further summarized in **Table C.2-14.**

Table C.2-14. COP AM Uncertainty ID#6 (Seepage) management options matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC ID#6 Seepage	Peak stage; Hydroperiod duration; Dry nesting days; Discontinous hydroperiods; Occurrence of water level reversals; Flood Risk; Conveyance Capacities; and Flood Stage Duration	Stage and structure flow rates	Event driven but continuous monitoring	WCA-3B; Northeast Shark River Slough (NESRS); 8.5-Square-Mile Area (8.5 SMA); and areas along the L-31N, L-30, and C-111 Canals	• Increased hydroperiod durations and/or peak stages in 8.5 SMA beyond historical observations and modeling results, which may necessitate operational changes in 8.5 SMA and/or S-331 Structure, or reductions in canal stages and flows into NESRS. • Decreased hydroperiod durations and/or peak stages in 8.5 SMA compared to historical observations and modeling results, which can allow further relaxation of L-29 operational constraints for flows into NESRS. • Performance evaluation of 2020 COP Biological Opinion RPA, potentially including dry nesting days, discontinuous hydroperiods, and water level reversal west of the C-111 detention areas (update following the ESA consultation).	Existing	• Adjustments to operations in the L-29, L-30, L-31N, and C-111 to improve water deliveries to NESRS, Taylor Slough, the Biscayne Bay. • Adjustments to operations for 8.5 SMA. • Adjustments to canal levels and structure operating ranges to enhance flood control and mitigation within WCP flexibility • Refinement/improvement of existing numerical models to improve ability to forecast effects of structures and operations, if needed. • Recommend additional targeted groundwater modeling to evaluate need for additional segments of barrier wall or increases in pump capacity to control seepage due to expected increased flows to NESRS.

C.2.3.2 COP AM Uncertainty ID #10 (Northeast Shark River Slough [NESRS] and Taylor Slough [TS]): Will increased flows to northeastern Shark River Slough and toward the southeastern Everglades (Taylor Slough and lower C-111 basin) yield natural distribution of waters and moderate recession rates? Are flows towards Taylor Slough sufficient to alter the anticipated flows or stages (recession rates)?)

COP Objective or Constraint: COP Objectives 1a, 1b, 1c, 2

Region(s): WCA-3A and WCA-3B, ENP (North East Shark River Slough), ENP (Taylor Slough), ENP (Spreader canal), Florida Bay

Associated Features:

- The L-30, L-31N, L-31W, C-111 Canals
- The S-12 Structures (A-D), S-333, S-356, G-211, S-331, S-332D, S-332C, S-332D, S-199, S-200

Driver or Uncertainty Type: Hydrology

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? There appears to be a threshold stage in NESRS that, when reached, Shark River Slough begins to contribute to flows in Taylor Slough. Resource managers think that when 9.7 ft NGVD is reached at Tamiami Trail, stage levels in the downstream marshes of NESRS should be high enough to contribute flows to Taylor Slough. Identifying this stage threshold with precision should help natural resource managers recognize when stages in NESRS are delivering flows to Taylor slough, and to develop more specific strategies for maintaining hydrologic support for NE and Central Florida Bay. The SFWMD's South Dade Initiative helped regional managers develop a new paradigm for managing canal levels and flood concerns along the eastern boundary of ENP with the intention of delivering more water to Florida Bay, and exploring this uncertainty in COP should enhance and broaden the discussion of how to effectively enhance the volume of water deliveries to the most sensitive portions of Florida Bay.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each:

What is expected to be learned by measuring this attribute, i.e., how will COP benefit from knowledge gained about this attribute?

- Measuring or estimating the volume of water delivered to Taylor Slough from NESRS should help us recognize the degree to which additional volumes can be delivered to Taylor Slough and Florida Bay. COP increases stages in NESRS to the 8.5 ft NGVD threshold where a nascent connection between these two basins may occur.

What is the time frame in which changes to this attribute are expected to be measurable?

- We should detect if the connection has occurred by examining data beginning in February 2016 (when 8.5 ft NGVD at Tamiami Trail was first reached) and in each year when the L29 canal level reached 8.5 ft NGVD (which occurs in almost all years).

Is this attribute complimented by other monitoring programs within and/or outside of COP? If so, provide reference to other monitoring. Note the monitoring paid for by others in the COP Management Options spreadsheet.

- Coastal creek monitoring by USGS. Stage monitoring throughout ENP, and flow monitoring at Taylor Slough Bridge. ENP Hydrologists do not currently think that monitoring flows at context road is likely to be sufficient to effectively detect volumetric contributions to Taylor Slough.

When during COP's life cycle should this monitoring begin and end?

- Monitoring will be continuous throughout COP, CEPP, and during much of the implementation of CERP.

Additional relevant information from CEPP AM plan: Each seasonal dry down provides an opportunity for ecologists and water managers to evaluate options and possibly pursue operations which address the uncertainty described above. The attributes to be measured and time needed to begin perceiving changes are the following (these time frames are indications of speed of response, not limits on the monitoring to be conducted):

1. Volumes delivered to S-332s (i.e. how much water focused on delivery to Upper Taylor Slough (UTS) actually reaches the marsh, measured each dry season).
2. Recession rates at UTS bridge (each dry season)
3. Estuarine Salinity (2 years)
4. Wetland and Canal/Creek Stage (7 days, is a response of dry season deliveries evident?)
5. Surface and Groundwater Flow (7 days, is a response of dry season deliveries evident?)
6. Stage / flow relationships between NESRS and eastern ENP including stages at CR2, etc…

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: The expectation (hypothesis) is that COP will slow recession rates in UTS and marginally improve salinity ranges in Florida Bay, as evidenced by project alternative plan modeling. The expectation will be verified by using real-time analyses of operational changes to S-333, S-334, S-335, and the S-332 structures and their subsequent effect on surface and ground water flows to the UTS.

Updates to the MD-RSM and the ENP M3ENP may be further supported by the COP AM monitoring.

Triggers/thresholds that indicate good COP performance or need for adaptive management action: Under COP operations we expect less than 1 psu (practical salinity unit) annual average change in Florida Bay over a decadal period. Changes in flows at Taylor Slough Bridge (TSB) and coastal creeks are more likely to be sensitive to COP operations and reveal patterns of change after 1-5 years of COP implementation. Stage levels in Shark River Slough, Taylor Slough, and the C-111 basin are also likely to respond within the first few years of COP implementation.

A summary of flows and stage levels will be presented at the annual PDT plus workshop. The development of thresholds and triggers can be developed by a task team if/when the PDT+ observes that sufficient data is available to identify durable thresholds/triggers. Expectation is that this uncertainty will become more relevant once Tamiami trail is modified to support 9.7 ft NGVD stage, after 2023 (current estimate is construction begins in 2022).

Management options that may be chosen based on test results: Suggested Adaptive Management Options listed below are not in any particular order and can be implemented simultaneously, as appropriate.

- Adjustments to operations from WCA-3B at S-335 and WCA-3A at S-334 and then conveyed towards Taylor Slough by the S-332's.
- Refinement of existing hydrologic and hydrodynamic models in Taylor Slough, the southern coastal wetlands, and Florida Bay.

This uncertainty is further defined in a management option matrix below in **Table C.2-15**

Table C.2-15. COP AM Uncertainty ID #10 (NESRS and TS) management option matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC #10 – NESRS and TS	Volumes delivered to S-332s (i.e. how much water focused on delivery to UTS actually reaches the marsh, measured each dry season).	Flow rates and stage measured continuously at structures.	Annual	S-332s	• Under COP operations we expect less than 1 psu (practical salinity unit) annual average change in Florida Bay over a decadal period. Changes in flows at Taylor Slough Bridge (TSB) and coastal creeks are more likely to be sensitive to COP operations and reveal patterns of change after 1-5 years of COP implementation. Stage levels in Shark River Slough, Taylor Slough, and the C-111 basin are also likely to respond within the first few years of COP implementation. • A summary of flows and stage levels will be presented at the annual PDT plus workshop. The development of thresholds and triggers can be developed by a task team if/when the PDT+ observes that sufficient data is available to identify durable thresholds/triggers. Expectation is that this uncertainty will become more relevant once Tamiami trail is modified to support 9.7 ft NGVD stage, after 2023 (current estimate is construction begins in 2022).	Existing	• Adjustments to operations from WCA-3B at S-335 and WCA-3A at S-334 and then conveyed towards Taylor Slough by the S332's. Additional NEPA will be needed if varies from the operations already developed in Alt Q, evaluated in the COP EIS, and subsequently included in the WCP • Refinement of existing hydrologic and hydrodynamic models in Taylor Slough, the southern coastal wetlands, and Florida Bay

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
Same as above	Recession rates at UTS bridge	Stage measured continuously at structure	Each dry season	UTS bridge	Same as above	Same as above	Same as above
Same as above	Estuarine Salinity	Salinity (ppb)	2 years	NE Florida Bay	Same as above	Same as above	Same as above
Same as above	Wetland and Canal/Creek Stage (is a response of dry season deliveries evident?)	Stage measured at continuously monitored stations	7 days	Taylor Slough	Same as above	Same as above	Same as above
Same as above	Surface and Groundwater Flow (is a response of dry season deliveries evident?)	Stage and ground water levels measured at continuously monitored stages	7 days	Taylor Slough	Same as above	Same as above	Same as above
Same as above	Stage / flow relationships between NESRS and eastern ENP including stages at CR2, etc.	Stage measured at continuously monitored stations	Annual	L-30, L-31N, L-31W, C-111, Canals, S-12s (A-D), S-333, S-356, G-211, S-331, S-332D, S-332C, S-332D, S-199, S-200,	Same as above	Same as above	Same as above

C.2.3.3 COP AM Uncertainty ID #12a (Tamiami Trail Flow Formula-General): Based on consideration of the existing water budget used to formulate COP, is there an opportunity to improve the Tamiami Trail Flow formula such that desired ecological targets are more universally achieved?

COP Objectives or Constraints: COP objectives 1a, 1b, 1c, 2.

Region(s): ENP, WCA3, southern Shark River Slough, and Florida Bay

Associated Features: All COP features that are included in the Tamiami Trail flow formula: S333, S12 C and D (outflow of WCA3/inflow to Shark River Slough portion of ENP,

Potentially also affects inflow structures to WCA3: S 11 A-C, S8, and S140.

Driver or Uncertainty Type: Hydrology/Operations

What is expected to be learned by addressing this uncertainty, i.e., how will the project benefit from addressing this uncertainty? For more than two decades, CERP and other plans have sought to implement more robust "rainfall driven operations" to complement traditional regulation schedules and current operational strategies like the Tamiami Trail Rainfall Plan (RFP). In planning, "natural system" and other targets and constraints can be leveraged to drive modeled operations, but the means to translate these concepts into real-time operations is a challenging problem. A variety of tools culminating in the iModel have been pro-actively developed through CERP's Interagency Modeling Center to address these challenges and were applied to support development of the COP. The COP TTFF is driven by the current week rainfall and last week's stage, and compared to the RFP, the formula is less sensitive to rainfall data. The TTFF uses last week's observed flow, in place of the use of last week's predicted flow within the RFP. The TTFF captures a combination of the COP plan's desired natural response combined with the current limited water budget (pre-CERP) and the need for a regulatory component. The development of the COP TTFF was informed by scientifically-based ecological targets (provided by the COP Ecological sub-team) and an understanding of system limitations (including available water budget, flood protection and Zone A of the WCA-3A Regulation Schedule).

During the development of the Tamiami Trail Flow Formula for COP, we explored more than 10 different forms of the Tamiami Trail flow formula. All methods used information from water stages, rainfall, potential evapotranspiration, and recent structure flows to predict upcoming weekly flow target volumes across Tamiami Trail. These approaches were derived from linear regression, non-linear regression, principle components analysis, and segmented regression. The full spectrum of models performed well, but none were clearly superior than all the rest. Instead there were different strengths and weaknesses associated with each different form of the model. Following COP implementation, the COP team recommends conducting an ongoing comparison of these flow formulas with the intention of recognizing and resolving the challenges associated with these variable modeling and statistical approaches, in an effort to normalize the use of some of the more sophisticated models for consideration during future Water Control Plan updates (e.g. CEPP) and/or other temporary planned deviation efforts. Addressing this uncertainty with the TTFF will help the COP Adaptive Management team, RECOVER, and water managers continue to improve operational planning to further enhance the ecological performance of the regional system without violating system constraints or considerations.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each: Statement of hypothesis: Through additional data analysis and continued collaborative efforts, the Tamiami Trail Flow Formula can be further refined or modified to guide future operational planning studies under COP and/or CERP for deliveries to ENP across Tamiami Trail, and a comparison of different approaches to the TTFF will help the COP Adaptive Management team, RECOVER, and water managers to identify and evaluate other effective strategies for maximizing shared benefits across WCA3 and ENP.

What is expected to be learned by measuring this attribute, i.e., how will COP benefit from knowledge gained about this attribute?

- Operational planning teams should clearly recognize the relevance of introducing non-linear flow estimates in low-flow conditions, and the subtle challenges of making delivery decisions during period of severe water scarcity.

What is the time frame in which changes to this attribute are expected to be measurable?

- Comparison of different forms of the TTFF should help identify possible improvements to the TTFF within 1-2 years following implementation of the COP. Implementation of these refinements and/or modifications to the TTFF is likely to occur during a project-specific update to COP, including supplemental NEPA as required, or as part of other future Water Control Plan updates (e.g. CEPP). Dependent on the nature of the changes to the TTFF, a temporary planned deviation may be considered, similar to the MWD Incremental Field Tests that informed COP development.

Is this attribute complimented by other monitoring programs within and/or outside of COP?

- Yes, our continuous monitoring of structure flows and water surfaces will be used to evaluate any suggested changes to the Flow formula.

When during COP's life cycle should this monitoring begin and end?

- Continuous monitoring of structure flows and water surfaces will continue throughout both COP and CERP activities. Water surface and structure flow monitoring will not end during the COP process.

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: The dominant method for testing this uncertainty is using hydrologic modeling simulations (e.g. RSM-GL) and other forms of simulating alternative analytical approaches.

Triggers/thresholds that indicate good project performance or need for adaptive management action: The COP TTFF has been determined to be responsive to the COP project objectives for WCA-3A and ENP, based on hydrologic modeling and technical evaluations conducted during COP development. No triggers or thresholds are appropriate for exploring this uncertainty.

Alternative forms of the TTFF will be analyzed and presented periodically at COP meetings. If/when significant differences between the formulas emerge, then focused hydrologic modeling simulations will be pursued with the results used to discern the likely consequences of employing a different approach.

Management options that may be chosen based on test results:
Option 1: Recommend an alternative form of the Tamiami Trail Flow Formula for making deliveries to ENP. Implementation of these refinements and/or modifications to the TTFF is likely to occur during a project-specific update to COP, including supplemental NEPA as required, or as part of other future Water Control Plan updates (e.g. CEPP).

Option 2: Maintain existing intuitive regression approach for TTFF based deliveries, as advocated for initial implementation of the COP TTFF based on technical team evaluations.

This uncertainty is further summarized in **Table C.2-16**.

Table C.2-16. COP AM Uncertainty ID#12a (Tamiami Trail Flow Formula-General) management options matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC #12a – Tamiami Trail Flow Formula (TTFF) - General	Seasonal timing of delivery of flows to NESRS	Daily averages of stage	Within 1-2 years	All COP features that are included in the Tamiami Trail flow formula: S-333, S-12 C and D (outflow of WCA3/inflow to Shark River Slough portion of ENP, Potentially also affects inflow structures to WCA3: S-11 A through C, S-8, and S-140.	Alternative forms of the TTFF will be analyzed and presented periodically at COP meetings. If/when significant differences between the formulas emerge, then focused hydrologic modeling simulations will be pursued with the results used to discern the likely consequences of employing a different approach.	$50,000	• Option 1: Recommend an alternative form of the Tamiami Trail Flow Formula for making deliveries to ENP. Implementation of these refinements and/or modifications to the TTFF is likely to occur during a project-specific update to COP, including supplemental NEPA as required, or as part of other future Water Control Plan updates (e.g. CEPP). • Option 2: Maintain to existing intuitive regression approach for TTFF based deliveries, as advocated for initial implementation of the COP TTFF based on technical team evaluations.

C.2.3.4 COP AM Uncertainty ID #12b (Tamiami Trail Flow Formula [TTFF] and Drought): Is there an opportunity to deliver water to NESRS in a specific manner such that the delivery enhances stages in Shark River Slough, and perhaps freshwater flows to Florida Bay by delivering more water during the dry season without harming the ecological condition of WCA3?

COP Objectives or Constraints: The COP objectives 1a, 1b, 1c, 3.

Region(s): NESRS, WCA 3, southern Shark River Slough, and Florida Bay

Associated Features: S-333, S-12 C and D (outflow of WCA 3/inflow to Shark River Slough portion of ENP), as well as S-11A-C, S-8, and S-140 (inflows into WCA 3).

Driver or uncertainty type: Hydrology/Operations

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? We are presented with the opportunity to learn whether the style of water delivery can produce measurable responses in southern SRS, and whether these responses can contribute meaningfully to reducing salinity concentrations in the chronically hypersaline portion of central Florida Bay.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each: Statement of hypothesis: Can delivering additional flows into NESRS during a transition from the wet season to the dry season result in measurably increased water levels in SRS without increasing detrimental low water impacts to WCA-3 ecological conditions and water supply ?

What is expected to be learned by measuring this attribute, i.e., how will COP benefit from knowledge gained about this attribute?

- If the seasonal timing of delivery to NESRS can be altered to reduce salinity concentrations in central Florida Bay then water managers will have developed a new tool for protecting Florida Bay during period of moderate water scarcity.

What is the time frame in which changes to this attribute are expected to be measurable?

- During a design test, results should be identifiable during a six month period, starting November and ending in May of the following year.

Is this attribute complimented by other monitoring programs within and/or outside of COP? If so, provide reference to other monitoring. Note the monitoring paid for by others in the COP Management Options spreadsheet.

- Yes, our continuous monitoring of structure flows and water surfaces will be used to measure the effects of the field test.

When during COP's life cycle should this monitoring begin and end?

- Continuous monitoring of structure flows and water surfaces will continue throughout both COP and CERP activities. Water surface and structure flow monitoring will not end during the COP process.

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: The design test was developed in response to concerns presented during development of the TTFF to better mimic the performance of ALT-O. Within the broader context of dynamic review of the COP TTFF planned through the COP Adaptive Management process and prescribed in the COP Adaptive Management and Monitoring Plan, parameters for a design test are proposed to test the hydrological and ecological response during a transition from the wet season to the dry season. The criteria for considering a test are:

Testing only occurs during the period between November 1 – May 30. Testing only occurs after we've had at least 80 days of seasonal closure in WCA 3 in the dry season prior to the test, indicating a dry antecedent condition with likely multi-year impacts requiring special considerations (this occurs only 3 times in the 41 year period of record used in COP simulations – **Figure C.2-5**. Testing may occur as we move into additional seasonal closures in WCA 3, and testing is considered anytime P35 in ENP is projected to move below 1.0 ft belowground, or P33 is projected to move below 0.5 ft belowground.

Testing will be stopped if any of the following drought intensity thresholds are reached:

- 0.8 ft belowground in northern WCA-3A (WCA3_NE and WCA3-3 gages)
- 0.5 ft belowground in southern/central WCA-3A (WCA3_3A-28 and WCA3_69 gages)
- 0.8 ft belowground in WCA-3B (WCA-3B_71 gage)

These thresholds correspond to the 93th-98th percentile low stage levels of these gages as defined by Alt Q and Alt O of the COP simulation models (**Figure C.2-6**). The triggers are rarely reached in the simulations of COP performance and are important because soil consuming peat fires become a risk when water levels are more than 1.0 ft belowground, and risk rises significantly after 1.5 ft belowground threshold is crossed (Smith et al. 2003). Simulations indicate that these thresholds are unlikely to be a concern during the November –January period that would typically be the "early" portion of the design test, but would become critically relevant during March – typically the peak of drought intensity in the system.

When the criteria for the design test have been met, the test period will allow general flexibility to increase the TTFF prescribed deliveries up to 400 cfs above the TTFF recommended flows for significant portions of the period, also allowed to introduce nonlinearities in lowest flow conditions (sometimes lower flows than suggested by the TTFF – during the driest of conditions, sometimes tripling-quadrupling very low - 25-100 cfs flows – perhaps during the early onset of the wet season). The ultimate design decisions should be described during the operational period based on comparison of modeled analogous conditions. Although our modeling provides the basis for the design of this field test, the actual implementation of the test must be done in the specific context that occurs, with specific physical limits and constraints imposed upon the test. Because there are strong limits on our ability to accurately forecast rainfall, the designed test is limited in duration to 6-8 week intervals and must be re-evaluated to ensure safe operating conditions every 6-8 weeks.

MONTHLY COUNT OF LOW WATER CLOSURE DAYS in WCA3A
COP ALTQ

Month	1	2	3	4	5	6	7	8	9	10	11	12	Total
Year													
1965	0	0	0	0	17	15	0	0	0	0	0	0	32
1966	0	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	1	31	6	0	0	0	0	0	0	38
1968	0	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	24	31	13	0	16	5	0	0	0	89
1972	0	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	20	31	30	1	0	0	0	0	0	82
1974	0	0	25	30	31	24	0	0	0	0	0	0	110
1975	0	0	15	30	31	30	1	0	0	0	0	0	107
1976	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	13	20	0	2	4	0	0	0	0	39
1978	0	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	31	30	20	0	0	0	0	0	81
1982	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	7	19	31	22	0	0	0	0	0	0	79
1986	0	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	4	20	14	30	17	0	0	0	0	0	85
1990	0	0	9	30	31	20	0	0	0	0	0	0	90
1991	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	8	24	0	0	0	0	0	0	0	32
2002	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	3	3	0	0	0	0	0	0	6
2005	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	0	0	60	195	326	223	41	20	5	0	0	0	870

Figure C.2-5. Monthly count of low water closure days in WCA3 – COP Alt Q, with years when TTFF drought conditions test would be implemented indicated by heavy black outline. Design test implementable only in 1973-1974, 1989-1990, and 1990-1991.

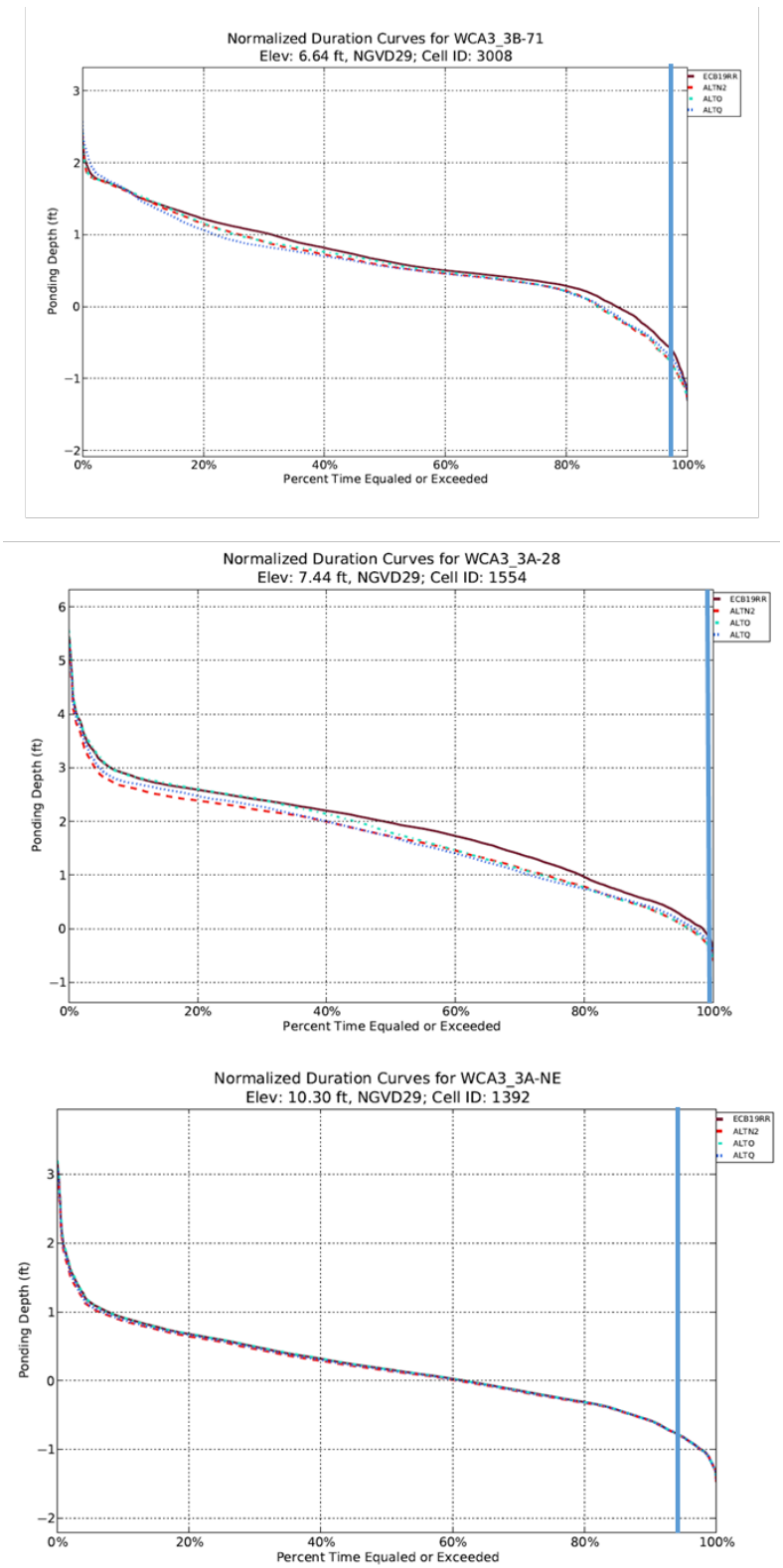


Figure C.2-6. Normalized duration curves of depths at specific gages in WCA3. a) Gage WCA3_3B_71 (top), b) WCA3_3A_28 (middle), and c) WCA3_3A-NE (lower). Curves for WCA_3_3-69 and WCA3-3 gages are similar but not shown.

Review of representative years from the modeling indicates that that the field test will increase expected deliveries by 32,000 – 80,000 acre feet over the entire November-May period above the level of delivery by the Tamiami Trail Flow Formula identified in Alt Q (which delivered 75,000 acre ft in 1973-74, 50,000 acre ft in 1989-90, and 180,000 acre ft in 1990-91 respectively during the November 1 – May 30 period). These additional deliveries correspond to the differences in deliveries observed in Alt O and Alt Q during these three specific years identified in **Figure C.2-5** (1973-1974, 1989-1990, and 1990-1991), and the anticipated effect of the design test may result in a minor-negligible effect on WCA-3A, in addition to a minor benefit realized by the SRS portion of ENP. A comparison between alternatives O and Q indicate that maximum effect of the design test would reduce stages in WCA 3A 0.1-0.5 ft over roughly 35% of WCA 3A. Stage level reductions no more than 0.3-0.5 ft occur within the first 0.5 miles upstream of the L29 canal, 2-4 miles upstream of the L-67 canal, while 0.1-0.3 ft stage reductions occur 0.5-3 miles upstream of the L29 canal and 4-10 miles upstream of the L67 canal respectively. Since our ability to predict rainfall volumes over a seasonal drydown is a significant uncertainty, water managers may stop the test if less than 2 inches of basin-wide average rain of WCA3 in any month and forecast rains present a significant risk of drying WCA-3A beyond the constraint thresholds outlined above.

Triggers/thresholds that indicate good COP performance or need for adaptive management action. These are described in the methodology of the test provided above, since the constraints and thresholds are central to the methodology of the design test.

At each PDT+ meeting the team will identify if a field test is possible in the upcoming wet-dry season transition (based upon closures in WCA-3A during the previous season and anticipated water levels in WCA3). If suitable conditions appear likely, the managers will be notified of intent to further investigate whether conditions warrant initiation of the field test, and a series of monthly meetings will be used to formulate the specific field test strategy. Results from the test will be summarized in a report and delivered to resource managers no later than 6 months after the completion of the field test, to ensure availability of this information in advance of the next dry season. The report will document the proposed design, the actual operations utilized, the hydrologic and ecologic effects on ENP and WCA3 (in terms of depth duration effects at key gages identified above).

Management options that may be chosen based on test results.
Option 1: Adopt operational strategy that provides a moderate increase to TTFF inflows into Central and Southern Shark River Slough during seasonal transitions.

Option 2: Based on consideration of constraints and forecast conditions, maintain adherence to the COP TTFF based delivery strategies.

This uncertainty is further defined in a management option matrix below in **Table C.2-17.**

Table C.2-17. COP AM Uncertainty ID #12b (Tamiami Trail Flow Formula and Drought) management option matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC #12b – Tamiami Trail Flow Formula (TTFF) and Drought	Seasonal timing of delivery of flows to NESRS	Daily averages of stage	Event driven when criteria for conducting test occur. Duration of test should be 6 months.	S-333, S-12 C and D (outflow of WCA3/inflow to Shark River Slough portion of ENP), as well as S-11 A-C, S-8, and S-140 (inflows into WCA3).	• If test is able to be successfully implemented without unexpected violation of constraints (e.g., causes water quality concerns), then the test operational strategy (with the drought intensity threshold constraints) will become part of the regular water control plan operational strategy. • If unexpected violation of constraints occur that appear unresolvable (e.g., water quality concerns or excessive drying of WCA-3A), then operations will return to using the Tamiami Trail Flow Formula as described in the Water Control Plan.	Existing unless additional model runs are required	• Option 1: Adopt operational strategy that provides a moderate increase to TTFF inflows into Central and Southern Shark River Slough during seasonal transitions. • Option 2: Based on consideration of constraints and forecast conditions, maintain adherence to the COP TTFF based delivery strategies.

C.2.3.5 COP AM Uncertainty ID #5b (Florida Department of Transportation constraint on Tamiami Trail): Can L-29 canal elevations be raised to 8.5 feet NGVD for more than 90 days per water year without adversely impacting safety and stability of the Tamiami Trail roadway between S-333 and S-334? Following completion of the roadway re-construction under the DOI Tamiami Trail Next Steps project, to what extent, if any, does the 8.5 SMA flood mitigation requirement limit the ability to operate the L-29 Canal up to 8.5 feet NGVD beyond the 90-day restriction assumed in-place through at least the 2020 wet season?

The evaluation of environmental effects during the COP plan formulation and hydrologic modeling were based on maintenance of the 90-day annual water year restriction, which is anticipated to remain in place through at least the 2020 wet season.

COP Objectives or Constraints: COP objectives 1a, 1b, 1c, 2, and 3.

COP planning considerations related to this uncertainty are as follows:

#8. L-29 Canal maximum stage (8.5 ft NGVD) (2008 Tamiami Trail LRR);

#9. 2008 Tamiami Trail Modifications Relocation Agreement (FDOT/USA), including coordination conducted between FDOT and the USACE coincident with development of the Increment 2 field test.

Region(s): WCA-3A, Northeast Shark River Slough (NESRS), 8.5-Square-Mile Area (8.5 SMA), and areas along the L-31N Canal

Associated Features:

- L-29 Canal and associated water control structures, S333, S356, S334, and S335.
- Interim FDOT constraint until completion of the roadway re-construction under the DOI Tamiami Trail Next Steps project. In accordance with this constraint, which was derived from the 2008 Relocation Agreement and coordination conducted between FDOT and the USACE coincident with development of the Increment 2 field test, which are retained for the COP Water Control Plan, the L-29 Canal inflow structures (S-333, S-355A/B, and S-356) will be operated with the intention of limiting event durations with L-29 Canal stages above 8.5 feet NGVD to a target maximum duration of 72 hours. Once the stage in the L-29 Canal reaches a stage of 8.5 feet, NGVD, input from all structures that discharge into the canal (S-333, S-355A/B, and S-356) shall be stopped until the level in the L-29 Canal recedes below 8.5 feet, NGVD. For each water year (May through April), the L-29 Canal inflow structures will be managed to limit the duration of L-29 Canal stages near 8.5 feet (as measured at the S-333 tailwater [TW]), NGVD to 90 cumulative days. The number of cumulative days in each period (only one period per water year) will be measured when L-29 stages exceed 8.3 feet, NGVD. Continued L-29 structure inflows which result in cumulative durations with L-29 Canal stages at 8.5 feet, NGVD for longer than 90 days will require written approval from the FDOT. The L-29 stage will be maintained at or below 8.5 feet, NGVD by ceasing inflow into L-29 when the L-29 stage rises above 8.5 feet, NGVD. Event driven criteria will be followed in accordance with Table 1 of the Increment 2 field test Operational Strategy (UPDATE FOR COP WCP). S-334 may be used to maintain the L-29 Canal stage at or below the FDOT constraint of 8.5 feet, subject to the availability of downstream canal conveyance capacity within the L-31N Canal (details are prescribed in the Increment 2 and COP Operational Strategy).

Continued L-29 structure inflows which result in consecutive durations with L-29 Canal stages above 8.3 feet for longer than 90 days will require written approval from the FDOT, given evaluation of the monitoring data by FDOT. Independent of the concurrence from FDOT, demonstration by the USACE of the capability of the completed MWD Project components (including S-357N) to maintain flood mitigation requirements for the 8.5 SMA under the raised L-29 Canal maximum operating limit of up to 8.5 feet, NGVD would also be required.

Driver or uncertainty type: Hydrology/Operations

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? Prior to completion of the TTNS roadway re-construction, which is anticipated for late 2022 or early 2023, addressing this uncertainty will resolve whether the canal stages in L-29 can be raised to 8.5 ft NGVD without adversely impacting safety and stability of the Tamiami Trail roadway between S-333 and S-334. Removal of this constraint will make higher NESRS deliveries possible, when upstream and downstream conditions allow following the TTFF.

Following completion of the roadway re-construction under the DOI Tamiami Trail Next Steps project, addressing this uncertainty will resolve whether the 8.5 SMA flood mitigation requirement limits the ability to operate the L-29 Canal up to 8.5 feet NGVD beyond the 90-day restriction assumed in-place through at least the 2020 wet season? The COP EIS and Water Control Plan allow increased durations up to 8.5 feet NGVD along the L-29 Canal subject to completion of the TTNS roadway re-construction if adherence to the 8.5 SMA flood mitigation constraint is demonstrated during real-time operations while following the evaluation methodology detailed in the COP Hydrometeorologic Monitoring Plan.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each. Hypothesis Statement: Based on the upstream water availability during COP implementation, the maximum operating limit of the L-29 Canal can be raised to 8.5 feet NGVD without adversely impacting safety and stability of the U. S. Highway 41 (Tamiami Trail) roadway in advance of the completion of Tamiami Trail Next Step construction, while managing 8.5 SMA flood mitigation in accordance with the COP Water Control Plan criteria for S-357, S-357N, and S-331

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: Operational constraints as outlined within the 2008 Relocation Agreement are minimum protective standards that were required to be included in the Increment 2 Operational Strategy, which initially raised the L-29 Canal maximum operating limit above 7.8 feet NGVD and up to a maximum of 8.5 feet NGVD. In coordination with FDOT, the Corps also implemented additional constraints that were not explicitly spelled out in the Relocation Agreement. Out of concern that the these additional constraints reduce the ability to meet field test goals and objectives of maximizing flows to NESRS, the Corps has worked with technical staff from the FDOT to further refine the restrictions as described within the Increment 2 Operational Strategy and committed to implement expanded hydrologic monitoring of water levels along this section of Tamiami Trail. Data collected in accordance with the Increment 2 monitoring plan developed in consultation with the FDOT were planned to inform L-29 Canal operations to be developed for COP.

In order to ensure no road damage is caused due to extended periods of high water stages, based on coordination with the Florida Department of Transportation (FDOT) concurrent with the development of the COP Operational Strategy, USACE will monitor the effects of the increased L-29 water levels on the Tamiami Trail roadway. To monitor the conditions of the roadway and its subway, piezometers, soil

moisture sensors (installed at the roadway sub-base elevation of 9.5 feet NGVD), and surface water stage recorders were installed during October-November 2018 at specified locations along Tamiami Trail between S-333 and S-334 Spillways, following design, contracting, permitting, and installation facilitated by the DOI. The locations for four transects along which the transducers are installed are provided in **Figure C.2-7** below. Additional installation details are provided in the COP Adaptive Management and Monitoring Plan.

Figure C.2-7. Locations of four transects of transducers along Tamiami Trail to monitor road condition.

Real-time monitoring data is continuously recorded at 15-minute intervals at each monitoring location. Soil moisture thresholds are under development in coordination between the USACE and FDOT concurrent with the Increment 2 field test that will continue through COP implementation in 2020 (UPDATE FOR FINAL COP EIS, BASED ON 2019 WET SEASON MONITORING). Piezometers along the roadway will be used to confirm that rainfall events which cause temporary exceedances of the L-29 maximum operating limit of 8.5 feet NGVD are able to be effectively managed with water levels receding below 8.5 feet NGVD within 72 hours.

Following the protocols established under the Incremental Field Test, ongoing data evaluations conducted by the USACE, SFWMD, and DOI will continue to be presented and discussed at monthly team meetings, and the conclusions from these evaluations will be reported to the interagency Adaptive Management team on a quarterly basis.

Triggers/thresholds that indicate good COP performance or need for adaptive management action. Criteria for damage to the roadway or its subbase, which will continue to be developed through review of the monitoring data collected during the Increment 2 field test (instrumentation was initially available for the 2019 wet season) (UPDATE FOR FINAL COP EIS).

Management options that may be chosen based on test results.

- L-29 Stages will remain limited to a maximum operating limit of 8.3 feet (except for the 90 day period each year when 8.5 feet NGVD is allowed) NGVD prior to completion of the Tamiami Trail Next Steps (TTNS) roadway modifications. This operation is consistent with the MWD Increment 2 field test.
- If no harm to the Tamiami Trail Roadway due to extended period of high water stages is observed, removal of FDOT constraint that limits L-29 stages to 8.3 feet NGVD will be recommended.
- For the 8.5 SMA, observed seasonal rainfall and hydro-period events which fall below the lower limit of the "acceptable" performance threshold following the conclusion of the corresponding wet or dry season period provide an indication that further operational changes are needed to ensure achievement of the required 8.5 SMA flood mitigation performance. Operational changes may include additional utilization of S-331 to reduce the necessity for S-357 pump operations, increased pump operations at S-357, and/or consideration of additional operational constraints at G-3273 for inflows to NESRS.

- If the 8.5 SMA flood mitigation criteria are determined as limiting the inflows to NESRS when the L-29 Canal is maintained up to 8.5 feet NGVD (the maximum operating limit for the COP Water Control Plan), following the earlier FDOT correspondence recommending removal of the FDOT constraint or completion of the TTNS roadway modifications, additional remedies for the 8.5 SMA flood mitigation will be explored through interagency coordination between USACE, SFWMD, and DOI. Exploratory hydrologic modeling using MD-RSM and the ENP M3ENP MIKE-SHE model are planned during 2019-2020 prior to implementation of the COP.

This uncertainty is further defined in a management option matrix below in **Table C.2-18**.

Table C.2-18. COP AM Uncertainty ID #5b (FDOT Constraint on Tamiami Trail) management option matrix.

Uncer-tainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Time-frame to detect change of attri-butes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Est-imated Annual Cost	Management Action Options Suggestions
UNC #5b – FDOT Con-straint on Tamiami Trail	Duration of stage above 8.3 ft and 8.5 ft in L-29; Roadway Stability measures	Stage in L-29; # cumulative days in water year >8.3 ft; # days stage > 8.5 ft; Ground water, surface water and soil moisture levels taken at 4 transect locations; Monitoring is real time in 15 minute intervals.	Event driven.	WCA-3A; Northeast Shark River Slough (NESRS); 8.5-Square-Mile Area (8.5 SMA), and areas along the L-31N Canal 4 transect locations on Tamiami Trail road and subway.	Criteria for damage to the roadway or its subbase, which will continue to be developed through review of the monitoring data collected during the Increment 2 field test (instrumentatio n was initially available for the 2019 wet season)	Existing	• L-29 Stages will remain limited to a maximum operating limit of 8.3 feet (except for the 90 day period each year when 8.5 feet NGVD is allowed) NGVD prior to completion of the TTNS roadway modifications. This operation is consistent with the MWD Increment 2 field test. • L-29 Stages will be limited to a maximum operating limit of 8.3 feet NGVD prior to completion of the TTNS roadway modifications, if necessary to protect the Tamiami Trail roadway. • If no harm to the Tamiami Trail Roadway due to extended period of high water stages is observed, removal of FDOT constraint that limits L-29 stages to 8.3 feet NGVD will be recommended.

Uncer-tainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Time-frame to detect change of attri-butes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Est-imated Annual Cost	Management Action Options Suggestions
Same as above	8.5 SMA flood mitigation performance relative to stage in L-29 and stages in NESRS; Hydroperiod performance in NESRS given seasonal rainfall	Stage in L-29; Stage in NESRS gages near and outside 8.5 SMA; Volume, depth, duration of seepage in 8.5 SMA; seasonal rainfall	Event driven	Northeast Shark River Slough (NESRS), 8.5-Square-Mile Area (8.5 SMA), and areas along the L-31N Canal.	Criteria for damage to the roadway or its subbase, which will continue to be developed through review of the monitoring data collected during the Increment 2 field test (instrumentation was initially available for the 2019 wet season)	Existing	• For the 8.5 SMA, observed seasonal rainfall and hydro-period events which fall below the lower limit of the "acceptable" performance threshold following the conclusion of the corresponding wet or dry season period provide an indication that further operational changes are needed to ensure achievement of the required 8.5 SMA flood mitigation performance. Operational changes may include additional utilization of S-331 to reduce the necessity for S-357 pump operations, increased pump operations at S-357, and/or consideration of additional operational constraints at G-3273 for inflows to NESRS. • If the 8.5 SMA flood mitigation criteria are determined as limiting the inflows to NESRS when the L-29 Canal is maintained up to 8.5 feet NGVD (the maximum operating limit for the COP Water Control Plan), following the earlier FDOT correspondence recommending removal of the FDOT constraint or completion of the TTNS roadway modifications, additional remedies for the 8.5 SMA flood mitigation will be explored through interagency coordination between USACE, SFWMD, and DOI. Exploratory hydrologic modeling using MD-RSM and the ENP M3ENP MIKE-SHE model are planned during 2019-2020 prior to implementation of the COP.

C.2.3.6 COP AM Uncertainty ID #7 (Saltwater intrusion): What are the effects of sea-level rise on COP operations, resulting salinity patterns in Florida Bay, water supply risks associated with saltwater intrusion, and ability to meet flood protection constraints.

Effects of sea-level rise on COP operations, resulting salinity patterns in Florida Bay, water supply risks associated with saltwater intrusion, and ability to meet flood protection constraints. Many other programs and projects at both the federal and state level have been initiated to investigate and address sea level rise and coastal resilience; as such, the COP AM plan does not seek to duplicate these efforts, but rather to monitor evolving science, programmatic efforts outside of COP and observed change conditions (SLR in coastal areas or movement of the saltwater front). This gathered material combined with observed operational experiences focused on the ability of COP to realize the canal levels and deliveries consistent with the COP WCP will allow AM team members to synthesize risks and formulate adaption efforts if required.

COP Objectives or Constraints: COP objectives 1a, 1b, 2, 3, and 4.

This uncertainty is related to the following COP constraints:
#1. Maintain the authorized purposes of the C&SF project
#6. Maintain the level of flood reduction associated with the 1994 C-111 GRR: flood damage reduction Project recommended plan.

Region(s): Coastal ENP, Eastern Panhandle of ENP (Spreader canal), and SE Miami Dade county.

Associated Features: Primary canal reaches within the L-31 and C-111 systems – identify any inability to maintain desired operating ranges due to backwater effects from tidal influences.

Observations of coastal saltwater intrusion into ENP (or associated peat collapse) or landward migration of the aquifer saltwater intrusion front as reported by USGS, SFWMD or Miami-Dade County.

Additional indicators likely to be developed by interagency team at an appropriate time in the future.

Driver or Uncertainty Type: Hydrology/Operations, Flood Control, and Water supply

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? Two simulation models were presented during the COP process with information relevant to coastal conditions/salt water intrusion. The RSM-GL – used for regional scale simulations is using a sea-level time series that represents the average condition over the 1965-2005 time period, so we know that sea-level in our simulations is lower than what is expected to occur during COP implementation. A second model – the MDRSM (or Miami-Dade RSM) was used to evaluate the effective level of flood protection to agricultural areas in Miami-Dade County. This model was applied for three recent candidate years representing dry, average, or wet conditions respectively. Observed sea level at outflow structures was used to represent the ocean for these simulations, and these sea-levels are minor underestimates of the sea-level that is likely to be observed during COP operations. We can expect sea-level to vary significantly each day, each year, and among years. Daily variation is associated with tidal cycles, annual differences in sea level are associated with the dynamics of tidal epochs and can be influenced by changing ocean temperatures producing a seasonal peak high tide during September-November, and levels are likely to continue to increase as melting glaciers continue to load the ocean with more water. By focusing on this uncertainty water managers should learn more about the degree to which

coastal structure operations are affecting their ability to remove water from the landscape, as well as identifying the systematic increase of key times when saltwater intrusion risks are particularly high. In addition, work conducted in support of this uncertainty should help us identify the degree to which flood protection operations are challenged by sea-level conditions – a factor that is outside the control of CERP.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each: COP operations will be successful at keeping canal operations within expected ranges, thus delivering the expected environmental benefits in ENP coincident with the estimated level of flood protection in the agricultural areas adjacent to ENP while protecting against saltwater intrusion into aquifers and canals and protecting existing water supply sources in Miami Dade County.

What is expected to be learned by measuring this attribute, i.e., how will COP benefit from knowledge gained about this attribute?

- Measuring SLR related operations risks before they become severe and chronic should help water managers and CERP planners recognize, scale, and compensate for SLR risks to the degree that compensation is possible.

What is the time frame in which changes to this attribute are expected to be measurable?

- SLR changes are directly measurable each year through an aggregation of coastal monitoring stations. The observed rate of SLR in the past century is 2.42 mm per year (+/- 0.14 mm), and this rate appears to be accelerating (https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=8724580). Forecast changes to sea-level have been identified (Park et al. 2017) and there is a clear basis for developing specific expectations of SLR effects. Checking the status of this issue on 5 year intervals seems appropriate for the next decade. Meaningful differences in coastal canal performance may occur at 5 year intervals.

Is this attribute complimented by other monitoring programs within and/or outside of COP? If so, provide reference to other monitoring. Note the monitoring paid for by others in the COP Management Options spreadsheet.

- Yes, water levels around structures are consistently monitored by SFWMD and USACE. Water levels in agricultural areas are monitored by SFWMD.

When during COP's life cycle should this monitoring begin and end?

- Monitoring should be consistent through the COP life cycle and into future operational plans.

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: Leveraging the other areas where SLR and coastal resilience are being prioritized, follow up activities for COP include the development of sensitivity simulations focused on a range of future sea-level conditions, potentially interacting with seepage management infrastructure. These sensitivity simulations will likely be pursued by the Interagency Modeling Center of CERP (comprised of SFWMD, USACE and DOI collaborators) to help identify the effects of future sea levels on existing infrastructure and help resource managers recognize if/when critical operational capacities are exceeded as well as a sense of the spatial context of the consequences of exceeding these operational capacities. The MDRSM has been identified as an appropriate candidate tool for conducting these simulations.

Coastal structure condition can be evaluated by comparing hourly headwater/tailwater elevations at each structure and accumulating this information over long time periods in order to determine whether drainage capacity is being diminished.

Flood protection performance can be identified by monitoring wells installed in agricultural areas and summarizing the number of days that groundwater is within 24" of the surface using spatial aggregation tools such as the Water Depth Assessment Tool (WDAT) currently used for C-111 Spreader Canal reporting.

Compiling records of telephone calls reporting flooding concerns along with information about the day/time, specific location, and degree of inundation occurring should help us connect monitoring of representative stations to specific parcels of land that may be experiencing particularly severe challenges.

Triggers/thresholds that indicate good project performance or need for adaptive management action:

- *COP L31 and C-111 Canal Reaches:* Should persistent difficulty be reported by water managers in the attempt maintain the anticipated water levels in the primary canal reaches be observed due to backwater effects from tidal or surge conditions limiting discharges through coastal structures, the COP AM team will summarize and characterize the nature of these limitations. Persistent challenges are explicitly defined as limited capacity to use coastal outflow structures within any 24 hour period, or the inability to drain a canal reach due to surge conditions, or any clear shift in the spatial pattern of flood impacts.
- *Protection of Critical Resources:* Should undesirable trends be observed due to saltwater impacts in the ENP marsh or the Biscayne aquifer, the COP AM team will form a task team to summarize and characterize the nature of these effects (e.g. episodic, exacerbated /accelerating trends, etc…).

Management options that may be chosen based on test results:

- Identify complementary projects and programs than may help to mitigate the effects. These may include:
  - CERP
  - Federal initiatives such as the USACE Coastal Atlantic or Back-Bay studies
  - State initiatives like the SFWMD's Level of Service program
  - County or local initiatives
- Identify potential operational changes within the scope of the original COP effort for further consideration.
- Identify potential infrastructure or regional operations that could be considered by complimentary efforts.

This uncertainty is further summarized in **Table C.2-19**.

Table C.2-19. COP AM Uncertainty ID#7 (Saltwater intrusion) management options matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC ID#7 – Saltwater Intrusion	"Keep in view" issue using existing monitoring, modeling, analyses, and reports by other entities involving: • Coastal structure difficulties in maintaining target water levels or desired discharge due to tide or surge; • Sea level rise; • Flood protection performance (groundwater monitoring); • Flooding concern reports via telephone	Many other programs and projects at both the federal and state level have been initiated to investigate and address sea level rise and coastal resilience; as such, the COP AM plan does not seek to duplicate these efforts, but rather to monitor evolving science, programmatic efforts outside of COP and observed change conditions (SLR in coastal areas or movement of the saltwater front). This gathered material combined with observed operational experiences focused on the ability of COP to realize the canal levels and deliveries consistent with the COP WCP will allow PDT+ team members	5-10 years	L-31, C-111, southern Miami-Dade County and ENP	• COP L-31 and C-111 Canal Reaches: Should persistent difficulty be reported by water managers in the attempt maintain the anticipated water levels in the primary canal reaches be observed due to backwater effects from tidal or surge conditions limiting discharges through coastal structures, the COP AM team will summarize and characterize the nature of these limitations. Persistent challenges are explicitly defined as limited capacity to use coastal outflow structures within any 24 hour period,	$0, Existing	• Identify complementary projects and programs than may help to mitigate the effects. These may include: o CERP o Federal initiatives such as the USACE Coastal Atlantic or Back-Bay studies o State initiatives like the SFWMD's Level of Service program o County or local initiatives • Identify potential operational changes within the scope of the original COP effort

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
		to synthesize risks and formulate adaption efforts if required.			or the inability to drain a canal reach due to surge conditions, or any clear shift in the spatial pattern of flood impacts. • Protection of Critical Resources: Should undesirable trends be observed due to saltwater impacts in the ENP marsh or the Biscayne aquifer, the COP AM team will form a task team to summarize and characterize the nature of these effects (e.g. episodic, exacerbated / accelerating trends, etc…).		for further consideration. • Identify potential infrastructure or regional operations that could be considered by complimentary efforts.

C.2.4 Water Quality / Hydrological Adaptive Management Uncertainties

C.2.4.1 COP AM Uncertainty #16a (Water Quality in Taylor Slough): Will there be downstream biogeochemical effects associated with modifying inflows and hydrologic conditions in ENP, that result in detrimental effects on nutrient movement, availability, and ecological responses?

Water quality concerns Taylor Slough and downstream ecological response: Will there be downstream biogeochemical effects associated with modifying inflows and hydrologic conditions in ENP, that result in detrimental effects on nutrient movement, availability, and ecological responses? This includes consideration of hydrologic effects on nutrient loading, nutrient release from soils, transport, and water-quality related ecological indicators, such as periphyton tissue nutrients, cattail expansion, and algal bloom events?

COP Objective or Constraint: COP Objectives 1a, 1b, 1c, 3.

Region (s): Taylor Slough

Associated Features: S-332D, S-332DX1, S-328, G-737; timing, location, and volume of deliveries

Driver or uncertainty type: Water quality delivered to Taylor Slough has historically been of good quality. However, two new structures, S-328 and G-737, have been added to the suite of structures delivering water to Taylor Slough. These structures deliver water directly to Taylor Slough and the direct impacts are presently unknown. Since 2000, water delivery to Taylor Slough had been through subsurface and rarely surface flow from the S-332D detention basin. Shifting to direct deliveries has the potential to increase nutrient loading in the receiving areas, which may result in unintended adverse biota shifts.

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? By observing ecosystem response for this uncertainty, impacts on downstream resources in the Taylor Slough will be illuminated. If adverse impacts are observed and operational deliveries addressed through AM options/strategies that are protective of the ecological values of Taylor Slough, then COP will benefit with higher potential for improved ecological conditions within Taylor Slough.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each: These hypotheses being tested include:

- Increased flow will not alter current periphyton system-wide indicator report status
- Additional flows will not result in an increase in algal bloom events (frequency, spatial extent, duration, and/or magnitude) in Florida Bay and Lower Southwest coast relative to current conditions
- No acceleration in cattail distribution expansion rate relative to current conditions
- No alteration of current spatial distribution of soil and vegetation nutrient pools relative current conditions

What is expected to be learned by measuring this attribute?

- Through monitoring flow and nutrients, COP will learn about nutrient response to structure operations
- Monitoring of periphyton in the downstream marsh will allow COP to learn about changes in the periphyton nutrient content or algal blooms as demonstrated in the CERP RECOVER System Status Report (CERP RECOVER 2014, 2019).
- Monitoring of macrophytes, such as cattail, will allow COP to learn about changes in rates of sensitive macrophyte expansion/retraction relative to current rates or presence/absence.
- Monitoring of the spatial nutrient front will allow COP to learn about movement of the spatial nutrient front or changes in nutrient rates of release from soils along soil and/or vegetation transect relative to existing conditions.

What is the time frame in which changes to this attribute are expected to be measurable?

- Flow and water quality monitoring at existing frequency. Discrete total phosphorus changes can be nearly immediately detected, but determination of any statistically significant change from historic levels could take 3 to 10 years, depending on the change magnitude.
- Periphyton (TP content, biomass, composition): 3 months to 1 year
- Cattail expansion: 3 to 5 years
- Soil nutrient front: 3 to 10 years

Is this attribute complimented by other monitoring programs within and/or outside of COP?

- COP should take advantage of existing monitoring which includes monitoring performed by the South Florida Water Management District, Everglades National Park, and cooperators.

When during COP's life cycle should this monitoring begin and end?

- It has already begun and should continue 10 years after complete implementation of COP.

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: A baseline monitoring period of 3 years for soil nutrient content (1 every year) to measure long-term nutrient trends and 3 years of bi-annual (wet/dry season) periphyton tissue nutrients in areas of concern (e.g. downstream of S-328, S-332 outflow for G-737, downstream of the southern stretch of L-31W canal) to measure early indication of nutrient changes is recommended to adequately establish existing conditions. Monitoring of soil nutrient content annually and bi-annual periphyton tissue nutrients beginning with implementation of S-328 and/or G-737 and carried through operation and management of COP protocol is necessary to document any changes in nutrient distribution resulting from increases in deliveries into Taylor Slough with each constructed feature.

Triggers/thresholds that indicate good COP performance or need for adaptive management action:

Structure Monitoring:

- Need for adaptive management action: increases in nutrients above existing conditions indicates potential for adverse impacts to downstream ecology;
- Good performance: maintaining or reducing nutrient levels represents good performance

Periphyton:

- TP content
    - Need for adaptive management action: if TP content in periphyton tissue increases above baseline;
    - Good performance: if TP content in periphyton tissue remains or declines below baseline
- Biomass
    - Need for adaptive management action: if biomass decreases below baseline;
    - Good performance: if biomass remains or increases above baseline
- Composition
    - Need for adaptive management action: if species composition shifts to more cyanobacteria relative to baseline;
    - Good performance: if species composition shifts to more desmids and diatoms relative to baseline

Cattail:

- Need for adaptive management action: if cattails expansion rate increases above rates observed during the base period;
- Good performance: if cattails expansion rate reduces or remains the same as baseline

Soil:

- Need for adaptive management action: if soil nutrient front expansion rate exceeds the baseline rate;
- Good performance: if soil nutrient front expansion rate remains or reduces below baseline rate

Management options that may be chosen based on test results: Adjust operations to change spatial and/or temporal distribution of water; model refinement and coupling to improve ability to forecast effects of operations and adaptive operational changes. Conceptually, adjusting water distribution has the ability to reduce or redirect nutrient loading to Taylor Slough. For example, reducing discharges from S328 or G737 and having that water routed through S332D into the detention basin prior to delivery to Taylor Slough has the potential to improve water quality delivered.

Table C.2-20 summarizes the monitoring recommendations and provides funding estimates.

Table C.2-20. COP AM Uncertainty ID#16A (Water Quality in Taylor Slough) management option matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC #16a – Water Quality in Taylor Slough	TP concentration at structures plus additional water quality measures	Flow, TP nutrient concentration, turbidity and other water quality measures in water flowing into park	3 to 10 years	ENP- Taylor Slough	• Need for adaptive management action: increases in nutrients above existing conditions indicates potential for adverse impacts to downstream ecology; • Good performance: maintaining or reducing nutrient levels represents good performance	Existing	Adjust operations to change spatial and/or temporal distribution of water; model refinement and coupling to improve ability to forecast effects of operations and adaptive operational changes
Same as above	Periphyton • TP content • Biomass • Composition	Periphyton in downstream marsh, biannual	3 months to 1 year	ENP- Taylor Slough areas of concern (e.g. downstream of S-328, S-332 outflow for G-737, downstream of the southern stretch of L-31W canal)	• TP content o Need for adaptive management action: if TP content in periphyton tissue increases above baseline; o Good performance: if TP content in periphyton tissue remains or declines below baseline • Biomass o Need for adaptive management action: if biomass decreases below baseline; o Good performance: if biomass remains or increases above baseline • Composition	Existing	Same as above

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
					o Need for adaptive management action: if species composition shifts to more cyanobacteria relative to baseline; o Good performance: if species composition shifts to more desmids and diatoms relative to baseline		
Same as above	Cattail expansion	Local mapping of cattail in downstream marsh	3-5 years	Same as above	• Need for adaptive management action: if cattails expansion rate increases above rates observed during the base period; • Good performance: if cattails expansion rate reduces or remains the same as baseline	$0, Existing	Same as above
Same as above	Soil nutrient front	Soil nutrient content in downstream marsh, annual	3-10 years	Same as above	• Need for adaptive management action: if soil nutrient front expansion rate exceeds the baseline rate; • Good performance: if soil nutrient front expansion rate remains or reduces below baseline rate	$0, Existing	Same as above

C.2.4.2 COP AM Uncertainty #16b (Water Quality in NESRS): Will there be downstream biogeochemical effects associated with modifying inflows and hydrologic conditions in ENP, that result in detrimental effects on nutrient movement, availability, and ecological responses?

Water quality concerns at S-333 and S-12D and downstream ecological response: Will there be downstream biogeochemical effects associated with modifying inflows and hydrologic conditions in ENP, that result in detrimental effects on nutrient movement, availability, and ecological responses? This includes consideration of hydrologic effects on nutrient loading, nutrient release from soils, transport, and water-quality related ecological indicators, such as periphyton tissue nutrients, cattail expansion, and algal bloom events.

COP Objective or Constraint: COP Objectives 1a, 1b, 1c, 3.

Region(s): Northeast Shark River Slough (NESRS)

Associated Features: S-12s, S-333, S-334, S-356; timing, location, and volume of deliveries

Driver or uncertainty type: Operational driver. Water quality at S-333 tends to degrade when water levels at the structure are low, resulting in spikes of nutrient, specifically total phosphorus concentrations, when these waters are delivered to NESRS. This affect is also observed at the S-12 structures with declining impacts on total phosphorus from west (S-12D) to east (S-12C). Spikes in total phosphorus delivered to NESRS result in excess phosphorus loads (above levels protective of the marsh) and thus a potential for the cascade of nutrient impacts described in this uncertainty.

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? By observing ecosystem response for this uncertainty, impacts on downstream resources in the NESRS marsh will be illuminated. If the operational deliveries for S-333 are addressed through alternative management options/strategies that are protective of the ecological values of NESRS, then COP will benefit with higher potential for improved ecological conditions within NESRS.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each:

- Increased flow will not alter current periphyton system-wide indicator report status
- Additional flows will not result in an increase in algal bloom events (frequency, spatial extent, duration, and/or magnitude) in Florida Bay and Lower Southwest coast relative to current conditions
- No acceleration in cattail distribution expansion rate relative to current conditions
- No alteration of current spatial distribution of soil and vegetation nutrient pools relative current conditions
- Discharging through S-333 and S-12D at headwater conditions proposed by COP (stage below headwater trigger more often and for longer duration) will not result in degraded water quality and/or adverse ecological response in the marsh.

*Note. For practical operations, several stage triggers shall be established for conditions when stages are declining and separately for conditions when stages are rising. Continued data collection will be used to refine these triggers.

What is expected to be learned by measuring this attribute?

- Through monitoring flow and nutrients, COP will learn about nutrient response to structure configuration (i.e., S-333 and S-334 flowing or S-333 and S-334 closed; S-333N versus S-333 operations) and operations
- Monitoring of periphyton in the downstream marsh will allow COP to learn about changes in the periphyton nutrient content or algal blooms as demonstrated in the CERP RECOVER System Status Report (see CERP RECOVER 2014, 2019).
- Monitoring of macrophytes, such as cattail, will allow COP to learn about changes in rates of sensitive macrophyte expansion/retraction relative to current rates or presence/absence.
- Monitoring of the spatial nutrient front will allow COP to learn about movement of the spatial nutrient front or changes in nutrient rates of release from soils along soil and/or vegetation transect relative to existing conditions.

What is the time frame in which changes to this attribute are expected to be measurable?

- Flow and water quality monitoring at existing frequency. Discrete total phosphorus changes can be nearly immediately detected, but determination of any statistically significant change from historic levels could take 3 to 10 years, depending on the change magnitude.
- Periphyton (TP content, biomass, composition): 3 months to 1 year
- Cattail expansion: 3 to 5 years
- Soil nutrient front: 3 to 10 years

Is this attribute complimented by other monitoring programs within and/or outside of COP?

- COP should take advantage of existing monitoring which includes monitoring performed by the South Florida Water Management District, United States Geological Survey, Everglades National Park, and cooperators.

When during COP's life cycle should this monitoring begin and end?

- It has already begun and should continue 10 years after complete implementation of COP.

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: A baseline monitoring period of 3 years for soil nutrient content (1 every year) to measure long-term nutrient trends and 3 years of bi-annual (wet/dry season) periphyton tissue nutrients in areas of concern (e.g. downstream of S-12D, NESRS NCTransects) to measure early indication of nutrient changes is recommended to adequately establish existing conditions. Monitoring of soil nutrient content annually and bi-annual periphyton tissue nutrients beginning with implementation of S-356/G-3273 Relaxation Increment 1 test and carried through operation and management is necessary to document any changes in nutrient distribution resulting from incremental increases in deliveries past Tamiami Trail with each constructed feature.

Triggers/thresholds that indicate good performance or need for adaptive management action in response to COP:

Structure monitoring:

- Need for adaptive management action: increases in nutrients above existing conditions indicates potential for adverse impacts to downstream ecology;
- Good performance: maintaining or reducing nutrient levels represents good performance

Periphyton:

- TP content
  - Need for adaptive management action: if TP content in periphyton tissue increases above baseline;
  - Good performance: if TP content in periphyton tissue remains or declines below baseline
- Biomass
  - Need for adaptive management action: if biomass decreases below baseline;
  - Good performance: if biomass remains or increases above baseline
- Composition
  - Need for adaptive management action: if species composition shifts to more cyanobacteria relative to baseline;
  - Good performance: if species composition shifts to more desmids and diatoms relative to baseline

Cattail:

- Need for adaptive management action: if cattails expansion rate increases above rates observed during the base period;
- Good performance: if cattails expansion rate reduces or remains the same as baseline

Soil:

- Need for adaptive management action: if soil nutrient front expansion rate exceeds the baseline rate;
- Good performance: if soil nutrient front expansion rate remains or reduces below baseline rate

Management options that may be chosen based on test results: Adjust operations to change spatial and/or temporal distribution of water; model refinement and coupling to improve ability to forecast effects of operations and adaptive operational changes. Specific operational options include:

1. maintain discharges below 150 cfs through the combined S-12D and S-333 when S-333 headwater stage is below a level historically associated with elevated phosphorus concentrations; this action will cease when either a) or b) occur:
   a) S333_H stage increases to 9.2 ft. or higher or
   b) S333_H stage increases 1 ft. above the May 15th stage.

2. shift a fraction of the S-12D discharges to S-12C, and/or
3. reduce dry-season recession rates by reducing outflow volumes for WCA-3A through S-12s and S-333 between December and May in water years with December stage lower than 10 ft NGVD29 to maintain higher stages in L-29 coming out of the dry season and reduce frequency and/or duration of low stage conditions associated with elevated phosphorus.

Additional options that have not been tested and will require additional analysis and NEPA review for implementation include:

4. avoid first flush events through S-333 following low stage-low flow periods at the S-333 headwater,
5. avoid discharges greater than 150 cfs through S-333 for a period of one to two week to allow water levels at the S-333 headwater to increase above a stage historically associated with elevated phosphorus concentrations,
6. utilize the S-333N discharge structure in place of S-333 assuming the low stage impact on phosphorus concentrations has a lower magnitude of increase.

Table C.2-21 summarizes the monitoring recommendations and provides funding estimates.

Table C.2-21. COP AM Uncertainty ID#16b (Water Quality in NESRS) management option matrix.

Uncer-tainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Time-frame to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC #16b – Water Quality in NESRS	TP concentration at structures plus additional water quality measures	Flow, TP nutrient concentration, turbidity and other water quality measures in water flowing into park	3 to 10 years	ENP-Northeast Shark River Slough, at structures S-12D, S-333	• Need for adaptive management action: increases if nutri-ents above existing conditions indicates potential for ad-verse impacts to downstream ecol-ogy; • Good performance: maintaining or re-ducing nutrient lev-els represents good performance	Existing	Adjust operations to change spatial and/or temporal distribution of water; model refinement and coupling to improve ability to forecast effects of operations and adaptive operational changes. 1. Maintain discharges below 150 cfs through the combined S-12D and S-333 when S-333 headwater stage is below a level historically associated with elevated phosphor concentrations; this action will cease when either a) or b) occur: a) S333_H stage increases to 9.2 ft. or higher or b) S333_H stage increases 1 ft. above the May 15th stage. 2. Shift a fraction of the S-12D discharges to S-12C, and/or 3. Reduce dry-season recession rates by reducing outflow volumes for WCA-3A through S-12s and S-333 between December and May in water years with December stage lower than 10 ft NGVD29 to maintain higher stages in L-29 coming out of the dry season and reduce frequency and/or duration of

Uncer-tainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Time-frame to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
							low stage conditions associated with elevated phosphorus. Additional options that have not been tested and will require additional analysis and NEPA review for implementation include: 4. Avoid first flush events through S-333 following low stage-low flow periods at the S-333 headwater, 5. Avoid discharges greater than 150 cfs through S-333 for a period of one to two week periods to allow water levels at the S-333 headwater to increase above a stage historically associated with elevated phosphorus concentrations, 6. Utilize the S-333N discharge structure in place of S-333 assuming the low stage impact on phosphorus concentrations has a lower magnitude of increase.
Same as above	Periphyton • TP content • Biomass • Composition	Periphyton in downstream marsh, bi-annual	3 months to 1 year	ENP-Northeast Shark River Slough, downstream of S-12D, NESRS NCTransects	• TP content o Need for adaptive management action: if TP content in periphyton tissue increases above baseline; o Good performance: if TP content in periphyton	Existing	Same as above

Uncer-tainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Time-frame to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
					tissue remains or declines below baseline • Biomass o Need for adaptive management action: if biomass decreases below baseline; o Good performance: if biomass remains or increases above baseline • Composition o Need for adaptive management action: if species composition shifts to more cyanobacteria relative to baseline; o Good performance: if species composition shifts to more desmids and diatoms relative to baseline		
Same as above	Cattail expansion	Local mapping of cattail in	3-5 years	Same as above	• Need for adaptive management action: if cattails expansion	Existing	Same as above

Uncer-tainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Time-frame to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
		downstream marsh			rate increases above rates observed during the base period; • Good performance: if cattails expansion rate reduces or remains the same as baseline		
Same as above	Soil nutrient front	Soil nutrient content in downstream marsh, annual	3-10 years	Same as above	• Need for adaptive management action: if soil nutrient front expansion rate exceeds the baseline rate; • Good performance: if soil nutrient front expansion rate remains or reduces below baseline rate	Existing	Same as above

C.2.5 Uncertainties screened out of the COP AAMP

The uncertainties screened out as being of lower priority to COP are provided in **Table C.2-22**. Screening them out of COP does not mean that they are unimportant, but that they are do not create a high level of risk to COP meeting its objectives. Reasons for screening out each uncertainty are provided. In some cases the uncertainty was deemed more appropriate to the performance monitoring or constraint monitoring section.

Table C.2-22. Uncertainties screened out of the COP-AMMP.

Uncertainty ID#	Region	Category	Uncertainty	Meeting Notes and Discussion	Rationale for Screening
3	ENP-Taylor Slough	Hydrological Ecological	Flow adjustments & Fish: Adjusting water levels recession rates - which are better for fish in ENP?	This was originally brought in as a possible uncertainty in pre-workshop list but was not ranked highly as an uncertainty. (Risk=low to medium, Knowledge=medium, Relevance=low).	Ranked into Tier 3 group by Adaptive Management Workshop Attendees and not pursued further.
4	ENP	Ecological	Exotic Fish: What are most cost effective methods to remove exotic fish or restrict exotic fish from entering ENP?	This was originally brought in as a possible uncertainty in pre-workshop list but was not ranked highly as an uncertainty as workshop attendees felt was outside scope of COP. (Risk= medium, Knowledge=medium to high, Relevance=low).	Ranked into Tier 3 group by Adaptive Management Workshop Attendees and not pursued further.
5a	ENP	Hydrological	FDOT constraint on Tamiami Trail - 8.5 ft maximum constraint on canal stage: L-29 may need to go to 8.5 from October through March to accommodate El Nino events. Extending elevated canal levels between 8.3 and 8.5 for more than 90 days will depend on real-time monitoring of the US 41 roadway subbase	This was originally brought in as a possible uncertainty in pre-workshop list but was not ranked highly as it was felt this uncertainty was already mostly resolved and any monitoring would be compliance/constraint monitoring. (Risk=low, Knowledge=high, Relevance=high).	Ranked into Tier 3 group by Adaptive Management Workshop Attendees and not pursued further.
11b	ENP	Ecological	Resolve tradeoffs between COP and other local wetlands and Biscayne Bay: Will the constructed and operational features of COP reduce surface and/or groundwater base flows and wetland/groundwater recharge to the east of the L-30 and L-31-N in areas such as Biscayne Bay?	This was originally brought in as a possible adaptive management uncertainty in pre-workshop list from CEPP Uncertainty ID#62. Workshop attendees split impacts to Pennsuco Wetlands from impacts to Biscayne Bay and other local wetlands and ranked them separately. (Risk=low, Knowledge=medium, Relevance=low to high).	Ranked into Tier 3 group by Adaptive Management Workshop Attendees and not pursued further.
13	ENP	Hydrological Ecological	NESRS/TS Priority for FL Bay: Is it better to put more freshwater into Taylor Slough or Northeast Shark River Slough to avoid hypersalinity conditions in Florida Bay?	This was originally brought in as a possible adaptive management uncertainty in pre-workshop list. Workshop attendees decided to combine this with Uncertainty ID#10.	Redundant with Uncertainty #10.
14	ENP	Ecological	CSSS and COP: Effects of COP on CSSS subpopulations	This was originally brought in as a possible uncertainty in pre-workshop list. Workshop attendees felt the level of knowledge was high and this was better addressed as compliance/constraint monitoring rather than an adaptive management uncertainty.	Ranked into Tier 3 group by Adaptive Management Workshop Attendees. Identified as being important for compliance/constraint monitoring.

Uncertainty ID#	Region	Category	Uncertainty	Meeting Notes and Discussion	Rationale for Screening
15	ENP	Water Quality	Water Quality in Detention Areas: Water quality levels in detention areas. Can differing water management affect levels?	This was originally brought in as a possible uncertainty in pre-workshop list but was not ranked highly as an uncertainty. (Risk=low, Knowledge=high, Relevance=high).	Ranked into Tier 3 group by Adaptive Management Workshop Attendees and not pursued further.
17	ENP	Water Quality	Fire & Nutrients: Can fire management be used to effectively manage small excess nutrient loads?	This was originally brought in as a possible uncertainty in pre-workshop list but was not ranked highly as an uncertainty. (Risk=low, Knowledge=low, Relevance=low).	Ranked into Tier 3 group by Adaptive Management Workshop Attendees and not pursued further.
19	East of WCA-3A, WCA-3B and ENP	Hydrological	Water supply to wellfields east of WCA and and park	This was added as a possible uncertainty during the workshop but was not ranked highly as an uncertainty. (Risk=low to medium, Knowledge=medium, Relevance=high). May be better addressed as compliance monitoring.	Ranked into Tier 3 group by Adaptive Management Workshop Attendees and not pursued further.
21	ENP	Hydrological Ecological	Groundwater salinity, water quality and ecological consequences	This was added as a possible uncertainty during the workshop and ranked as Tier 1 / 2. However the ecological breakout group decided this was redundant to uncertainty #1 and combined the two uncertainties.	Redundant with Uncertainty ID #1.
22	WCA-3A	Ecological	Python increase in Northern WCA-3A	This was added as a possible uncertainty during the workshop but was not ranked highly as an uncertainty. (Risk=medium, Knowledge=medium, Relevance=low).	Ranked into Tier 3 group by Adaptive Management Workshop Attendees and not pursued further.
26	WCA-3A, WCA-3B, ENP	Ecological	Freshwater fish	Although ranked as Tier 1 during the workshop, the ecological breakout group decided this topic was better addressed as a performance measure.	Changed to ecological performance measure.
27	WCA-3A, WCA-3B, ENP	Ecological	Crocodilians	This was added as a possible uncertainty during the workshop. Attendees decided the time frame for response was too long to be relevant to COP. Fish and wading birds were felt to show responses in a shorter time span. (Risk=low to medium, Knowledge=medium to high, Relevance=low to medium).	Ranked into Tier 3 group by Adaptive Management Workshop Attendees and not pursued further.
28	ENP	Hydrological	Priority use of structures 332B, 332C, or 332D to send water to Taylor Slough	This was added as a possible uncertainty during the workshop. However only on person provided rankings during workshop with risk = low, Knowledge=medium and relevance=high.	Ranked into Tier 3 group by Adaptive Management Workshop Attendees and not pursued further.
29	East of ENP	Hydrological	Effect of operations on wetlands in 8.5 square mile area	This was added as a possible uncertainty during the workshop. However no attendees decided to provide rankings and the issue was dropped.	Ranked into Tier 3 group by Adaptive Management Workshop Attendees and not pursued further.

Uncer-tainty ID#	Region	Category	Uncertainty	Meeting Notes and Discussion	Rationale for Screening
30	WCA-3A, WCA-3B and ENP	Ecological	Snail Kites	This was added a possible uncertainty during the workshop. Workshop attendees felt this was better addressed as compliance/constraint monitoring rather than an adaptive management uncertainty.	Ranked into Tier 3 group by Adaptive Management Workshop Attendees. Identified as being important for compliance/constraint monitoring.

C.2.6 COP Adaptive Management and Monitoring Plan Implementation

Adaptive Management (AM) provides an interdisciplinary, integrated, structured process for lowering risk, increasing certainty and informing decisions. For AM to be successful in ensuring the delivery of intended benefits and avoiding unintended negative impacts of COP, mechanisms must be in place to collect, manage, analyze, synthesize, coordinate, and integrate new information into management decisions. Following the types of decisions, the institutional structure, and costs associated with adaptive management are described. Relevant costs and feedback into management of the COP Ecological Monitoring Plan and the COP Water Quality and Hydrology Monitoring Plan are also included as the adaptive management process involves the evaluation of program performance and compliance with constraints as well as resolving remaining critical uncertainties.

C.2.6.1 Types of Adaptive Management Options and Links to NEPA

The adaptive management options associated with each uncertainty may be classified into one or more of the following categories in Table **C.2-23** depending on whether additional NEPA permitting and review will be required.

(A) Adaptive Management Options Defined in Water Control Plan and supported by EIS: proposed management options in the COP-AMMP are defined within the COP Water Control Plan and supported in the environmental effects analysis contained in the EIS.

(B) Adaptive Management Options Not Defined in Water Control Plan and not supported by EIS: proposed management options in COP-AMMP are not defined within the COP Water Control Plan and are not supported in the environmental effects analysis contained in the EIS. Proposed management option may require supplemental NEPA permitting and review.

(C) Adaptive Management Options Not in COP Authority: management options in COP-AMMP are proposed as a subsequent planning effort and do not currently fall under the authority of COP (i.e. would require subsequent authorization/study). May require supplemental NEPA, permitting and review.

Table C.2-23. Adaptive management actions identified as requiring further NEPA or no further NEPA review. The table provides a link between adaptive management uncertainties, and their corresponding actions, and whether additional NEPA permitting and review would be required.

Uncertainty or Performance Measure ID#	Decision Criteria: Trigger(s) for Management Action	Management Action Options Suggestions	Additional NEPA permitting and review required
UNC #1 /#21 – (Flows, salinity & peat collapse)	• Salinities in brackish marsh ≥20 psu ≥2 months in 2 consecutive years • Median daily water level 0cm or below ground >2 months in brackishwater marsh (Nine Mile Pond station; ENP) • Change in soil P from the prior 2 years of the period of record • Decrease in below ground resistivity (i.e., increase in conductivity) from the prior 2 years of the period of record • Any loss of elevation from a previous measurement at a specific location • Change in accretion rate in low-flow continuously inundated SET <1.2 mm/yr (e.g., Highway Creek.) • Visual evidence of peat collapse along vegetation transects (e.g., exposed *Cladium* culms • Transition of vegetated marsh habitat to open water in 5-year aerial vegetation mapping • Decreased sawgrass density along annual vegetation transects • Retraction or decreasing density of Eleocharis (spike rush) in freshwater marsh and Taylor Slough	1. Spatial redistribution of water into less sensitive areas 2. Reduce point source discharges (e.g., S-12A, S-12B, S-12C, S-12D) and shift more water to the Blue-Shanty flowway 3. Redistribution of water to more closely match historic timing of flows to the coastal wetlands and estuaries 4. Refinement of existing hydrologic and hydrodynamic models in the southern coastal wetlands, Florida Bay, and the Lower Southwest Coast 5. Adjustments to operations along Tamiami Trail and the LECSA 2 & 3 SFWMD Canal System to improve water deliveries to Biscayne Bay, Florida Bay, and the Lower Southwest Coast	(B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to water management operating criteria.
UNC #8 Tree Islands.	• Change in tree island number, size, and boundary firmness that indicates ecological degradation of tree islands is occurring (tree island loss, area of tree islands reduction, boundary between tree islands and marsh firmness loss) and where the degradation is occurring. Specific thresholds for vegetation change to be developed as part of CEPP.	6. Landscape Assessment (LILA) Everglades ecological experiments. 7. Increase operational flexibility to maximize flow velocities in the key areas including: 1) hydrological pulsing, 2) Vegetation clearing or management.	#6,#7,#8, #9 = (B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to

Uncertainty or Performance Measure ID#	Decision Criteria: Trigger(s) for Management Action	Management Action Options Suggestions	Additional NEPA permitting and review required
		8. Incremental increases to WCA-3B hydroperiods to create more resilient tree islands with higher elevations in anticipation of a future increment of CERP. 9. Adjust operations along the northern boundary of WCA-3A by redistributing water into the S-8. 10. Create moat-like sloughs around tree islands using vegetation management options (e.g., fire, harvesting, herbicide, physical stress) as tested in the Loxahatchee Impounded	water management operating criteria. #10 = (C) AM Option not under authority of COP. May require supplemental NEPA.
UNC #20 –WCA-3B Vegetation	• Signs of significant slough loss from remote sensing or results from the multistate model could provide a trigger for more water to be allowed into WCA-3B.	11. More water could be provided to WCA-3B through the S-152. This water would reach the southwestern side of WCA-3B that has the most remnant sloughs.	(B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to water management operating criteria.
UNC #2 –S-197 / Manatee Bay Discharges	For S-197, discharges into Manatee Bay that: • cause rapid salinity changes sufficient to cause a faunal or seagrass mortality event; • water column stratification with development of hypoxic or anoxic bottom waters; • chlorophyll *a* concentrations with red stoplight indicator or exceeding Numerical Nutrient Criteria thresholds	12. Operate structures in ways less likely to damage the ecosystem, e.g., 13. Avoid discharges through S-197 in order to maintain sufficient flows in Taylor Slough and into northeastern Florida Bay and avoid eastward seepage of water from Taylor Slough. 14. If discharges through S-197 are unavoidable and when not otherwise constrained by safety and flood control requirements,	(B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to water management operating criteria.

Uncertainty or Performance Measure ID#	Decision Criteria: Trigger(s) for Management Action	Management Action Options Suggestions	Additional NEPA permitting and review required
		o Minimize discharge rates and durations, especially over 800 cfs and over a week duration. Several smaller releases (e.g., < 500 cfs) are preferred over large, pulsed releases. o Avoid two or more discharge events within six months that are magnitude 800 cfs or more for a week duration	
UNC #9 Hydrologic Transmissivity	• Difference in stage at canal to 10 km downstream is greater than expected or takes longer to achieve expected stages downstream than expected compared with historical datasets	15. Conduct a dye study to determine where water flow is being impeded. 16. Managing agency conducts controlled fire to remove impeding vegetation.	#15= (B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to water management operating criteria. #16 = (C) AM Option not under authority of COP. May require supplemental NEPA.
UNC #11 –Pennsuco Wetlands	• Deviation from historic conditions	Modify and/or adjust operations to include 17. Additional flows through S-151 to reduce potential negative effects on areas of decreased hydroperiod and water depths; 18. Reduction in flows to Taylor Slough through S-335	(B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to water management operating criteria.
UNC #23: Soil oxidation and peat fires	• Statistically significant decrease in soil moisture content • Organic soil content decrease	Modify and/or adjust operations to include 19. Additional flows through S-150 and/or S-11A, S-11B, S-11C to reduce potential	#19, #20, #21= (B) AM Option Not defined in Water Control Plan - additional NEPA

Uncertainty or Performance Measure ID#	Decision Criteria: Trigger(s) for Management Action	Management Action Options Suggestions	Additional NEPA permitting and review required
	• Sediment elevation decrease in ridges and tree islands • Statistically significant increase in frequency of peat soil consuming fires. • Monitor key indicator regions that act as sentinel sites to determine severity of drought. If groundwater drops one foot below ground during the spring dry season (January-June) in 2 out of 5 years then an AM option should be triggered	negative effects on areas of decreased hydroperiod and water depths; 20. Ateration in flows to NESRS through S-333N/S-333; 21. Adjustment in flows at S-335 22. Prioritize backfilling of Miami canal to reduce dryout of northern WCA3	dependent on degree of proposed change to water management operating criteria. #22 = (C) AM Option not under authority of COP. May require supplemental NEPA.
UNC #18 – Wading Birds in Alligator Alley North Colony	• Evaluation of foraging conditions, nesting effort, previous years foraging conditions	Modify and/or adjust operations to include 23. additional flows through S-150 and/or S-11A, S-11B, S-11C to reduce potential negative effects; 24. reduction in flows to NESRS through S-333N/S-333; 25. Adjustment in flows at S-335	(B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to water management operating criteria.
UNC ID #24: Water flow, salinity, algal blooms and ecological benefits in Florida Bay, Whitewater Bay and southwest coast estuaries.	• Flow criterion based on Florida Bay Minimum Flows and Levels (MFL) criterion, but with a higher discharge to minimize harm and promote restoration. • Salinity criterion based on Florida Bay MFL, combined with salinity-rainfall trend analysis. • Algal bloom criterion based on the southern coastal systems (SCS) bloom indicator and FDEP Numerical Nutrient Criteria • Segrass and faunal indicator trends, using system-wide indicators SCS and RECOVER juvenile seatrout performance measure.	26. Modify operations to increase flow to Florida Bay and/or southwest coast estuaries either via changing distribution or timing. This includes distribution of water from WCA-3A or -3B to ENP or distribution within ENP (inflow to Shark River Slough vs Taylor Slough). This entails potential modifications of operation of structures along Tamiami Trail and the ENP eastern boundary. 27. Additional actions could be taken to improve seepage management, especially on ENP eastern boundary, by raising L-31 and/or C-111 stages.	#26 = (B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to water management operating criteria. #27 = (C) AM Option not under authority of COP. May require supplemental NEPA.

Uncertainty or Performance Measure ID#	Decision Criteria: Trigger(s) for Management Action	Management Action Options Suggestions	Additional NEPA permitting and review required
UNC #25 –Wading Birds	• Decrease or no improvement in numbers of foraging birds based on evaluation of baseline data • Decrease or no improvement in nesting success (nest abandonment) based on evaluation of baseline data	28. Evaluate distribution of water between WCA 3, NESRS and Taylor Slough; modify regional operation of the system. Modify and/or adjust operations to include 29. additional flows through S-150 and/or S-11A, S-11B, S-11C to reduce potential negative effects; 30. reduction in flows to NESRS through S-333N/S-333; 31. adjustment in flows at S-335.	(B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to water management operating criteria.
UNC #6 – Seepage.	• Increased hydroperiod durations and/or peak stages in 8.5 SMA beyond historical observations and modeling results, which may necessitate operational changes in 8.5 SMA and/or S-331 Structure, or reductions in canal stages and flows into NESRS. • Decreased hydroperiod durations and/or peak stages in 8.5 SMA compared to historical observations and modeling results, which can allow further relaxation of L-29 operational constraints for flows into NESRS. • Performance evaluation of 2020 COP Biological Opinion RPA, potentially including dry nesting days, discontinuous hydroperiods, and water level reversal west of the C-111 detention areas (update following the ESA consultation).	32. Adjustments to operations in the L-29, L-30, L-31N, and C-111 to improve water deliveries to NESRS, Taylor Slough, the Biscayne Bay. 33. Adjustments to operations for 8.5 SMA. 34. Refinement/improvement of existing numerical models to improve ability to forecast effects of structures and operations, if needed. 35. Recommend additional targeted groundwater modeling to evaluate need for additional segments of barrier wall or increases in pump capacity to control seepage due to expected increased flows to NESRS.	#32, #33, #34 = (B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to water management operating criteria. #35 = (C) AM Option not under authority of COP. May require supplemental NEPA.
UNC #10 – Northeast Shark River Slough (NESRS) and Taylor Slough (TS)	• Under COP operations we expect less than 1 psu (practical salinity unit) annual average change in Florida Bay over a decadal period. Changes in flows at Taylor Slough Bridge (TSB) and coastal creeks are more likely to be sensitive to COP operations and reveal patterns of change after 1-5 years of COP implementation. Stage levels in Shark River Slough, Taylor	36. Adjustments to operations from WCA-3B at S-335 and WCA-3A at S-334 and then conveyed towards Taylor Slough by the S332's. Additional NEPA will be needed if varies from the operations already developed in Alt Q, evaluated in the COP EIS, and subsequently included in the WCP	(B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to water management operating criteria.

Uncertainty or Performance Measure ID#	Decision Criteria: Trigger(s) for Management Action	Management Action Options Suggestions	Additional NEPA permitting and review required
	Slough, and the C-111 basin are also likely to respond within the first few years of COP implementation. • A summary of flows and stage levels will be presented at the annual PDT plus workshop. The development of thresholds and triggers can be developed by a task team if/when the PDT+ observes that sufficient data is available to identify durable thresholds/triggers. Expectation is that this uncertainty will become more relevant once Tamiami trail is modified to support 9.7 ft NGVD stage, after 2023 (current estimate is construction begins in 2022).	37. Refinement of existing hydrologic and hydrodynamic models in Taylor Slough, the southern coastal wetlands, and Florida Bay	
UNC #12a – Tamiami Trail Flow Formula (TTFF) and Drought	• Alternative forms of the TTFF will be analyzed and presented periodically at COP meetings. If/when significant differences between the formulas emerge, then focused hydrologic modeling simulations will be pursued with the results used to discern the likely consequences of employing a different approach.	38. Option 1: Recommend an alternative form of the Tamiami Trail Flow Formula for making deliveries to ENP. Implementation of these refinements and/or modifications to the TTFF is likely to occur during a project-specific update to COP, including supplemental NEPA as required, or as part of other future Water Control Plan updates (e.g. CEPP). 39. Option 2: Maintain to existing intuitive regression approach for TTFF based deliveries, as advocated for initial implementation of the COP TTFF based on technical team evaluations.	(B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to water management operating criteria.
UNC #12b – Tamiami Trail Flow Formula (TTFF) and Drought	• If test is able to be successfully implemented without unexpected violation of constraints (e.g., causes water quality concerns), then the test operational strategy (with the drought intensity threshold constraints) will become part of the regular water control plan operational strategy.	40. Option 1: Adopt operational strategy that provides a moderate increase to TTFF inflows into Central and Southern Shark River Slough during seasonal transitions.	(A) AM Option Defined in Water Control Plan – evaluated in supporting EIS

Uncertainty or Performance Measure ID#	Decision Criteria: Trigger(s) for Management Action	Management Action Options Suggestions	Additional NEPA permitting and review required
	• If unexpected violation of constraints occur that appear unresolvable (e.g., water quality concerns or excessive drying of WCA-3A), then operations will return to using the Tamiami Trail Flow Formula as described in the Water Control Plan.	41. Option 2: Based on consideration of constraints and forecast conditions, maintain adherence to the COP TTFF based delivery strategies.	
UNC #5b – Florida Department of Transportation constraint on Tamiami Trail	• Criteria for damage to the roadway or its subbase, which will continue to be developed through review of the monitoring data collected during the Increment 2 field test (instrumentation was initially available for the 2019 wet season). • Criteria for seepage/flooding in 8.5 SMA greater than historical levels.	42. For the 8.5 SMA, observed seasonal rainfall and hydro-period events which fall below the lower limit of the "acceptable" performance threshold following the conclusion of the corresponding wet or dry season period provide an indication that further operational changes are needed to ensure achievement of the required 8.5 SMA flood mitigation performance. Operational changes may include additional utilization of S-331 to reduce the necessity for S-357 pump operations, increased pump operations at S-357, and/or consideration of additional operational constraints at G-3273 for inflows to NESRS. 43. If the 8.5 SMA flood mitigation criteria are determined as limiting the inflows to NESRS when the L-29 Canal is maintained up to 8.5 feet NGVD (the maximum operating limit for the COP Water Control Plan), following the earlier FDOT correspondence recommending removal of the FDOT constraint or completion of the TTNS roadway modifications, additional remedies for the 8.5 SMA flood mitigation will be explored through interagency coordination between	#42 = (B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to water management operating criteria. #43 = (C) AM Option not under authority of COP. May require supplemental NEPA.

Uncertainty or Performance Measure ID#	Decision Criteria: Trigger(s) for Management Action	Management Action Options Suggestions	Additional NEPA permitting and review required
		USACE, SFWMD, and DOI. Exploratory hydrologic modeling using MD-RSM and the ENP M3ENP MIKE-SHE model are planned during 2019-2020 prior to implementation of the COP.	
UNC #7 –Saltwater intrusion	• COP L-31 and C-111 Canal Reaches: Should persistent difficulty be reported by water managers in the attempt maintain the anticipated water levels in the primary canal reaches be observed due to backwater effects from tidal or surge conditions limiting discharges through coastal structures, the COP AM team will summarize and characterize the nature of these limitations. Persistent challenges are explicitly defined as limited capacity to use coastal outflow structures within any 24 hour period, or the inability to drain a canal reach due to surge conditions, or any clear shift in the spatial pattern of flood impacts. • Protection of Critical Resources: Should undesirable trends be observed due to saltwater impacts in the ENP marsh or the Biscayne aquifer, the COP AM team will form a task team to summarize and characterize the nature of these effects (e.g. episodic, exacerbated / accelerating trends, etc…).	44. Identify potential operational changes within the scope of the original COP effort for further consideration. 45. Identify complementary projects and programs than may help to mitigate the effects. These may include: a. CERP b. Federal initiatives such as the USACE Coastal Atlantic or Back-Bay studies c. State initiatives like the SFWMD's Level of Service program d. County or local initiatives 46. Identify potential infrastructure or regional operations that could be considered by complimentary efforts.	#44 = (B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to water management operating criteria. #45, #46 = (C) AM Option not under authority of COP. May require supplemental NEPA.
UNC #16a – Water Quality in Taylor Slough	• TP concentration at structures plus additional water quality measures o Need for adaptive management action: increases in nutrients above existing conditions indicates potential for adverse impacts to downstream ecology; o Good performance: maintaining or reducing nutrient levels represents good performance	47. Adjust operations to change spatial and/or temporal distribution of water; model refinement and coupling to improve ability to forecast effects of operations and adaptive operational changes	(B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to water management operating criteria

Uncertainty or Performance Measure ID#	Decision Criteria: Trigger(s) for Management Action	Management Action Options Suggestions	Additional NEPA permitting and review required
	• Periphyton TP content o Need for adaptive management action: if TP content in periphyton tissue increases above baseline; o Good performance: if TP content in periphyton tissue remains or declines below baseline • Periphyton Biomass o Need for adaptive management action: if biomass decreases below baseline; o Good performance: if biomass remains or increases above baseline • Periphyton Composition o Need for adaptive management action: if species composition shifts to more cyanobacteria relative to baseline; o Good performance: if species composition shifts to more desmids and diatoms relative to baseline • Cattail Expansion o Need for adaptive management action: if cattails expansion rate increases above rates observed during the base period; o Good performance: if cattails expansion rate reduces or remains the same as baseline		
UNC #16b – Water Quality in NESRS	• TP concentration at structures plus additional water quality measures o Need for adaptive management action: increases in nutrients above existing conditions indicates potential for adverse impacts to downstream ecology; o Good performance: maintaining or reducing nutrient levels represents good performance	Adjust operations to change spatial and/or temporal distribution of water; model refinement and coupling to improve ability to forecast effects of operations and adaptive operational changes. 48. Maintain discharges below 150 cfs through the combined S-12D and S-333 when S-333 headwater stage is below a level historically associated with elevated	#48, #49, #50 = (A) AM Option Defined in Water Control Plan – evaluated in supporting EIS. # 51, #52, #53 = (B) AM Option Not defined in Water Control Plan - additional NEPA

Uncertainty or Performance Measure ID#	Decision Criteria: Trigger(s) for Management Action	Management Action Options Suggestions	Additional NEPA permitting and review required
	• Periphyton TP content o Need for adaptive management action: if TP content in periphyton tissue increases above baseline; o Good performance: if TP content in periphyton tissue remains or declines below baseline • Periphyton Biomass o Need for adaptive management action: if biomass decreases below baseline; o Good performance: if biomass remains or increases above baseline • Periphyton Composition o Need for adaptive management action: if species composition shifts to more cyanobacteria relative to baseline; o Good performance: if species composition shifts to more desmids and diatoms relative to baseline • Cattail Expansion o Need for adaptive management action: if cattails expansion rate increases above rates observed during the base period; o Good performance: if cattails expansion rate reduces or remains the same as baseline	phosphorus concentrations; this action will cease when either a) or b) occur: a) S333_H stage increases to 9.2 ft. or higher or b) S333_H stage increases 1 ft. above the May 15th stage. 49. Shift a fraction of the S-12D discharges to S-12C, and/or 50. Reduce dry-season recession rates by reducing outflow volumes for WCA-3A through S-12s and S-333 between December and May in water years with December stage lower than 10 ft NGVD29 to maintain higher stages in L-29 coming out of the dry season and reduce frequency and/or duration of low stage conditions associated with elevated phosphorus. Additional options that have not been tested and will require additional analysis and NEPA review for implementation include: 51. Avoid first flush events through S-333 following low stage-low flow periods at the S-333 headwater, 52. Avoid discharges greater than 150 cfs through S-333 for a period of one to two week periods to allow water levels at the S-333 headwater to increase above a stage historically associated with elevated phosphorus concentrations, 53. Utilize the S-333N discharge structure in place of S-333 assuming the low stage impact on phosphorus concentrations has a lower magnitude of increase.	dependent on degree of proposed change to water management operating criteria.

C.2.6.2 Adaptive Management Institutional Structure and Feedback Loops

To facilitate implementation of the COP-AMMP, the implementing agencies will continue weekly operations meetings and assign staff, establish Periodic Science Calls every three to four weeks and a COP Project Delivery Team Plus with a minimum of an annual meeting, and publish a Biennial Combined Operations Plan Report: Operations, Monitoring, and Adaptive Management.

Weekly Operations Meetings: The operations managers at the SFWMD meet on a weekly basis to evaluate how to operate the water control structures using the Water Control Plan in light of the current status of the system (hydrological, water quality), expected weather (short term meteorological), constraints (water supply, flood control, environmental), and goals and objectives (water supply, environmental).

Periodic Science Calls (PSC): Monitoring results and forecasts will be discussed in a PSC forum held approximately every three to four weeks which includes all stake holders similar to current PSCs held in compliance with the 2016 ERTP BO. This meeting involves scientists from COP implementing agencies and participating agencies (USACE, SFWMD, NPS, USFWS, FDEP, FWC). The PSCs makes recommendations to the operations managers for changes in operations within the approved operations strategies framework. The COP implementing agencies and participating agencies shall identify representatives or persons they delegate to attend these meetings. Such meetings can be divided into multiple groups when the number and diversity of issues warrant (e.g., water quality, wildlife, wading birds).

Wildlife Coordination Calls: The COP-AMMP assumes the Wildlife Coordination Calls (USFWS, ACOE, SFWMD, NPS and others) will continue. These calls vary from weekly to monthly depending on the time of year and provide recommendations to both the operations managers and to the Periodic Science Calls.

COP Project Delivery Team Plus Meetings: A COP Project Delivery Team Plus (COP-PDT+) will succeed the COP Project Development Team and will consist of representatives of COP implementing agencies, oversight agencies, and stakeholder groups similar in composition to the pre-implementation COP Project Development Team. The COP PDT+ will meet at least once annually as part of assessing and reporting COP's performance to discuss results. Meetings may occur more frequently during the first 2-3 years of COP implementation, for example at the beginning of the wet season and beginning of the dry season. The meeting goal will be to understand status and trends and potential causes of performance issues and/or success, as well as discuss the reality of what options (COP and non-COP related) are available to improve performance if needed. The COP PDT+ will receive reports from scientists, hydrologists, engineers and water managers, summarizing operational activities during the previous period, the status of meeting COP goals and objectives and constraints, any problems that occurred during the year, results of adaptive management monitoring (targeted studies) and resolving of adaptive management uncertainties, the status and results of implementation of any adaptive management actions during the year, the need for any emergency deviations, and any recommendations for changes that go beyond the Water Control Plan and COP-AMMP. Monitoring results will be presented in the context of goals, thresholds, or triggers. The COP PDT+ will review the results and accompanying report and provide feedback on the effectiveness of the implementation of COP, changes that can be made within the constraints of the Water Control Plan, and make recommendations to the senior level implementing agency leads regarding implementing adaptive management options or dealing with new unanticipated uncertainties. Additional and/or

emergency meetings of the COP-PDT+ may be called to address complex, urgent, or emergency situations. Similar to the Project Development Team, the Project Delivery Team Plus can designate sub-teams to more effectively develop and report back on issues.

Types of adjustments to management actions: Suggested types of adaptive management options to adjust implementation with associated decision groups are provided in **Table C.2-24** and more specific links between the adaptive management uncertainties and the likely most relevant evaluation and decision level are included in **Table C.2-25**.

Table C.2-24. Management options included in the COP Adaptive Management Plan and implementing group.

Type of Decision	Deciding Level
Inform Operational Decisions– results inform changes to operations within the flexibility already allowed for within the Water Control Plan (WCP).	*Weekly Operations Meetings – agencies implement within boundaries of WCP.* *Periodic Science Call - reviews and makes recommendations for adjustments every three to four weeks within boundaries of WCP.*
NEPA Covered COP Adaptive Management Contingency Options - results may suggest a need to implement contingency options described within the adaptive management strategies or Management Options Matrix. Such contingency options that are described in sufficient detail and do not require construction modifications would not require additional permitting beyond this document.	*Periodic Science Call - reviews and makes recommendations to operators, PDT+ and senior agency officials.* *PDT+ reviews and makes recommendations to operators and senior agency officials.* *Senior agency officials can implement.*
Actions requiring additional NEPA permitting and review – Some actions not covered with sufficient specificity in the EIS/PIR will require additional environmental review and public comment and potentially additional modeling or analyses.	*Periodic Science Call - reviews and makes recommendations to operators, PDT+ and senior agency officials.* *PDT+ makes recommendations to senior agency officials.* *Senior agency officials can implement starting new NEPA permitting and review processes and seek funding.*
Informing CEPP or Other Project Implementation - results may inform CEPP or other agencies regarding the next phase of CEPP project sequencing or other advisable actions that are beyond the scope of COP, such as construction of additional seepage barriers	*PDT+ makes recommendation to CEPP or other project planning efforts and senior agency officials.*

Biennual Combined Operations Plan Report: Operations, Monitoring, and Adaptive Management: A biennual COP summary report will be submitted to the COP-PDT+ of the actions taken under the COP Water Control Plan and AMMP including justification and result of any deviations; monitoring of performance and constraints; status of plan in meeting its objectives; results of monitoring and status of resolving adaptive management uncertainties; implementation and results of any adaptive management actions; recommendations for future actions within the constraints of the Water Control Plan; and recommendations for actions that would require additional NEPA or other funding, permitting, and review outside of the COP-AMMP. When development of this report coincides with the CERP RECOVER System Status Report, this report may be included as part of that System Status Report, e.g, as an appendix.

COP AM core staff: The implementing agencies and partner agencies shall assign staff who will have sufficient time dedicated to PSC and PDT+ meetings, writing the Combined Operations Plan Annual Operations, Monitoring, and Adaptive Management Report, and organizing the annual COP-PDT+ meeting.

Table C.2-25. Linking adaptive management uncertainties, compliance, and performance monitoring evaluation and response to most relevant institutional groups. "X"= will typically be discussed in this group. "--" = typically will not be discussed in this group (but still could be).

Uncertainty or Type of Monitoring	Operations meetings (Weekly)	Periodic Science Call and Wildlife Coordination Call (Weekly to Monthly	PDT plus (1-2 times per year)	PDT plus task team (as assigned)
Ecological Uncertainties	--	--	--	--
UNC # 1 and #21 (Flows, salinity, peat collapse)	--	--	X	X
UNC #8 (Tree Islands)	--	--	X	X
UNC #20 (WCA-3B Vegetation)	--	--	X	X
UNC #2 (S197/Manatee Bay)	--	X	X	X
UNC #9 (Hydrologic Transmissivity)	--	--	X	X
UNC #11a (Pennsuco Wetlands)	X	--	X	--
UNC ID #23 (Soil oxidation and peat fires)	X	X	X	--
UNC ID#18 Wading Birds in Alligator Alley North Colony)	--	X	X	X
UNC ID #24 (Salinity, water flow, algal blooms in Whitewater Bay and Florida Bay)	--	X	X	X
UNC ID #25 (Wading Birds)	--	X	X	--
Hydrological Uncertainties	--	--	--	--
UNC ID #6 (Seepage / Flood Protection)	X	--	X	--
UNC ID #10 (Northeast Shark River Slough (NESRS) and Taylor Slough (TS))	--	--	X	X
UNC ID #12a (TTFF - General)	--	--	X	X
UNC ID #12b (TTFF and Drought)	--	--	X	X
UNC ID #5b (Florida Department of Transportation constraint on Tamiami Trail)	X	--	X	--
UNC ID #7 (Saltwater intrusion)	--	--	X	X
Water Quality Uncertainties	--	--	--	--
UNC #16a (Water Quality in Taylor Slough)	X	X	X	as needed
UNC #16b (Water Quality in Northeast Shark River Slough)	X	X	X	as needed
Performance and Compliance	--	--	--	--
Performance and compliance monitoring	X	X	X	--

C.2.6.3 COP Adaptive Management and Monitoring Plan Cost Estimate

Identification of the COP-AMMP contained in **Appendix C** was guided partly by two objectives. First, it must be complete from a COP perspective in that it must provide the monitoring required to address COP-specific needs. Second, it must be integrated with other Everglades monitoring to take advantage of existing monitoring efforts, knowledge, and information and thereby leverage dollars committed and spent elsewhere to avoid redundancies and insure cost-effectiveness. These two objectives guided development of the adaptive management plan, ecological monitoring plan, hydrometeorological monitoring plan, water quality monitoring plan, and cultural resources monitoring plan. Where possible, COP will rely on existing monitoring resources such as physical instrumentation, stations, locations, servicing, and analysis efforts funded by RECOVER, CERP sponsors, and partner agencies (see for example **Figure C.2-8**). Therefore the monitoring described in the COP-AMMP is limited to the additional, marginal increase in monitoring resources and analysis efforts needed to address COP-specific questions. It is assumed that the monitoring programs will continue for at least the time needed by COP. The additional cost estimate for the COP-AMMP can be found in **Table C.2-26** with a more complete linkage to existing monitoring programs provided in **Table C.2-27**. RECOVER monitoring currently being performed within WCA-3 and ENP is addressed within RECOVER's MAP and the Central Everglades Planning Project Integrated Project Implementation Report and Environmental Impact Statement Adaptive Management and Ecological Monitoring Plan (USACE 2014) and COP will draw heavily on this existing monitoring.

While most of the monitoring for the eighteen adaptive management uncertainties can be addressed with existing funding, five uncertainties identified the need for additional funding. The total estimated cost for new monitoring and modeling in the COP-AMMP (**Table C.2-26)** is approximately $280,000 per year for at least 5 years plus $50,000 for supplemental modeling costs. This does not include costs for meetings and staff time to write reports. Remaining funding for MOD Waters will be insufficient to cover these costs and COP will need to seek additional funding to cover all the uncertainties. However, no new additional ongoing performance or constraint monitoring are expected. Costs for some adaptive management actions that go beyond shifting of flows (e.g., modeling, new structures) will have to be determined. Costs are subject to change based on the actual management measures chosen. USFWS BO costs will be based on any monitoring requirements identified by the USFWS and will be reflected in the Final EIS. Costs will be updated by the Final EIS.

Table C.2-26. Estimated new COP monitoring costs and costs for optional adaptive management actions. TBD=To Be Determined.

COP ID#	COP AM Uncertainty	New COP monitoring costs	Adaptive Management Action costs
1 & 21	**Flows, Salinity and Peat Collapse:**	**$180,000/yr for 5-10 yrs**	Possible modeling costs
8	Tree Islands	$0, Existing	TBD but will be external to COP
20	WCA-3B Vegetation	$0, Existing	$0
2	**S-197 / Manatee Bay Discharges**	**$20,000/yr for 5-10 years**	$0
9	Hydrologic Connectivity	$0, Existing	TBD but will likely be external to COP.
11a	Pennsuco Wetlands	$0, Existing	$0
23	Soil Oxidation and Peat Fires	$0, Existing	TBD but will be external to COP
18	**Wading Birds in Alligator Alley North Colony**	**$50,000 / yr**	TBD but any costs will be external to COP: e.g., temporary pumps; Additional canal plug.
24	**Salinity, waterflows, algal blooms in Whitewater Bay & FL Bay**	**$30,000/yr for 5 years**	Possible modeling costs
25	Wading Birds	$0, Existing	TBD
6	Seepage/Flood Protection	$0, Existing	Possible modeling costs. Seepage barrier costs external to COP
10	NESRS & TS	$0, Existing	Possible modeling costs.
12a	**Tamiami Trail Flow Formula-General**	**$50,000 (modeling costs)**	$0
12b	Tamiami Trail Flow Formula and Drought	$0, Existing	$0
5b	FDOT constraint on Tamiami Trail	$0, Existing	Possible modeling costs.
7	Saltwater intrusion	$0, Existing	TBD but will be external to COP
16a	Water Quality in Taylor Slough	$0, Existing	TBD
16b	Water Quality in NESRS	$0, Existing	TBD

* USFWS Biological Opinion has not yet been received at the writing of this document could result in additional costs

Figure C.2-8. Map of Hydrology Stations grouped by region in Everglades National Park and nearby vicinity.

C.2.6.4 Addressing future unidentified uncertainties.

Because new information is continually becoming available, the COP-AMMP must be recognized as a living document that is improved upon through incorporation of new information. While every effort has been made to identify and address any remaining critical uncertainties regarding the implementation of COP, future unexpected problems will inevitably arise. Some problems may result in emergency deviations. For other situations the uncertainty should be raised to the PSCs and the PDT for recommendations on the best path forward to address the uncertainty. This could include, for example, the identification of the critical uncertainty, developing a modeling services request, evaluating the results, implementing field testing if necessary, and updating implementation in the water control plan. The implementing agencies (USACE, SFWMD) will determine if such novel uncertainties require an EA or EIS as appropriate.

Table C.2-27. Adaptive management uncertainties linked to existing monitoring programs and estimated new costs.

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Locaton
UNC #1 & 21 Flows, salinity & peat collapse	Inundation Duration and Salinity in Coastal Marsh	Water level and salinity measured continuously at permanent installed hydro gages NMP and NP62, others as identified	NESRS, ENP(TS)	$0, Existing	?	?	?	?
UNC #1/#21 Continued	Discharge and salinity from Taylor Slough	Discharge (flow rate) and salinity measured continuously at permanent installed Hydro gage NP-TSB (northern Taylor Slough), ENPTR (Taylor River) and TaylorS3 (downstream near Florida Bay)	ENP(TS)	$0, Existing	ENP maintains these stations	ENP	Perm	Damon Rondeau / DataForever and DBHydro
UNC #1/#21 Continued	Soil P pool relation to groundwater salt wedge	soil, surfacewater, and groundwater P, surface and groundwater conductivity, groundwater resistivity monitored with quarterly samples in "areas of concern (e.g., Model Lands, Lostman's River)"	NESRS, ENP(TS), ENP(SC)	$100,000	NEW	NEW	--	--
UNC #1/#21 Continued	Soil elevation and depth change	Soil elevation and depth at SETs established along the southern coast, NMP station in brackish marsh	ENP(TS), ENP(SC), Florida Bay	$0, Existing	USGS, SFWMD	USGS, SFWMD	Temp	Carlos Coronado (SFWMD)

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Locaton
UNC #1/#21 Continued	mangrove-white zone movement and marsh vegetation changes	Mangrove-white zone movement; marsh vegetation composition and density; open-water area in marsh at mangrove-white zone at Everglades-Florida Bay transition zone; monitored with 5 year aerial vegetation mapping surveys and annual vegetation transect surveys	ENP, ENP(TS), ENP(NESRS), ENP(SC), Florida Bay	$80,000	ENP	USACE and ENP	Temporary – as needed	David Rudnick, SFNRC servers
UNC #1/#21 Continued	Source of freshwater (Tentative/if necessary)	Normalized isotopic compositions (stable isotopes (18O and 2H)) in surfacewater and rainfall grab samples at "areas of concern (e.g., Model Lands, Lostman's River)".	NESRS, ENP(TS), ENP(SC)	Cost range depending on scale of investigation is between $50,000 and $100,000	NEW	NEW	--	--
UNC #8 Tree Islands.	Tree island size, Structural complexity, Species composition Boundary shifts	Mapping every 2-3 years of change in tree island boundaries and area maximum tree height/island, functional vegetation composition (e.g., presence of short hydroperiod, late	WCA-3A, WCA-3B, ENP-SRS	$0, Existing	FIU – Jay Sah	RECOVER	Perm	FIU, USACE, South Florida Environmental Report

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Locaton
		succession hardwood hammock species) locations of additional new or missing tree islands						
UNC #20 - WCA-3B Vegetation	Slough percent coverage (filling in of the sloughs); multistate transition probabilities for slough to ridge	WCA-3B sloughs mapped every year using remote sensing and compared with multi-state transition model run.	Within remnant ridge and slough section of WCA-3B (southwest)	$0, Existing	SFWMD	SFWMD	During period of CEPP imple-menta-tion	Christa Zweig / SFWMD
UNC #20 Continued	Hydroperiod	EDEN gages and surfaces within WCA-3B	WCA-3B	$0, Existing	EDEN (sofia.usgs.gov/eden)) by USGS	USGS, SFWMD	Perm	http://sofia.usgs.gov/eden; https://www.sfwmd.gov/science-data/dbhydro
UNC #2 –(S-197 / Manatee Bay Discharges)	C-111, S-197, and adjacent or downstream creek discharge	Discharge estimates (daily, monthly, and annual) from flow velocity or rating curve, with tracking of proportion of total discharge from S-197 and specified creeks.	S-18C, S-197, Manatee Bay Creek, West Highway Creek, Trout Creek	$0, Existing	SFWMD	SFWMD	Perm	https://www.sfwmd.gov/science-data/dbhydro

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Locaton
UNC #2 Continued	Continuous Salinity and Temperature Monitoring	Daily average: Temperature, Conductivity, salinity	Manatee Bay, Barnes Sound, Little Blackwater Sound, Trout Cove	$0, Existing	ENP	ENP	Perm	Damon Rondeau / DataForever and DBHydro https://www.sfwmd.gov/science-data/dbhydro;
UNC #2 Continued	Seagrass habitat, light	Seagrass cover, community compositon, light attenuation	Manatee Bay, Barnes Sound, Long Sound, Little Blackwater Sound, Joe Bay, Trout Cove	Existing plus $10,000 / year for seasonal sampling	SFWMD	SFWMD	Temp	Chris Madden
UNC #9 – Hydrologic Trans-missivity	Flow velocity at Tamiami Trail	Flow velocity through culverts; Difference in stage drop north to south of Tamiami trail versus expectations compared with historical datasets.	ENP - Vegetation "halos" immediately south of water control structures and culverts along Tamiami Trail.	$0, Existing	USGS S-12 B/C Gages & TT Culverts (USGS); NE-1,NE-2 (USGS) NP-201 (NPS)	USGS	Perm	http://sofia.usgs.gov/eden; https://www.sfwmd.gov/science-data/dbhydro; http://www-sfnrc.nps.gov/

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Locaton
UNC #11 – Pennsuco Wetlands	Hydroperiod; Water Depth	Hydroperiod (Surface and Ground water) observed across a water year as measure at an identified set of gages in the study area. Water depth (surface and ground water) observed across a water year as measured at an identified set of gages in the study area. Depth and duration of dry season below ground across a year, as measured at an identified set of gages in the study area.	Pennsuco wetlands	$0, Existing	S-356, S-141, S-337, S-335 (SFWMD) G-975, G-3818 (USGS)	SFWMD, USGS	Perm	http://sofia.usgs.gov/eden; https://www.sfwmd.gov/science-data/dbhydro
UNC #23 - Soil oxidation and peat fires	Hydroperiod, Water Depth, Soil Oxidation, Peat Accretion, Fire Frequency	Hydroperiod (Surface and Ground water) observed across a water year as measure at an identified set of gages in the study area. Depth Water depth (surface and ground water) observed across a water year as measured at an identified set of gages in the study area. Depth and duration of dry season below ground	Areas directly west of the Miami Canal and north of WCA-3B and northern WCA-3B are of particular concern due to observed model results	$0, Existing	NESRS-2, G-620, Site 62, Site 63, Site 64, Site 65, 3A-2, 3A-3, 3A-4, 3A-28 (USGS); G-3273 (SFWMD); NP-201, NP-33, NP-	CERP-RECOVER, ENP, SFWMD	Perm	http://sofia.usgs.gov/eden; https://www.sfwmd.gov/science-data/dbhydro; http://www-sfnrc.nps.gov/

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Locaton
		across a year, as measured at an identified set of gages in the study area. Soil moisture content Peat accretion Fire mapping Soil decomposition	Areas within NESRS and Taylor Slough in ENP are most likely to be affected; however monitoring within all of WCA 3 and ENP should be conducted		36, NP-38, NP-67 (NPS); 3A-NW, 3A-28, 3B-SE (SFWMD)			
UNC #18 – Wading Birds in Alligator Alley North Colony	Wading bird presence. Foraging conditions. Nest initiation.	Nesting numbers, nesting success, water depth/stage, recession rate.	WCA-3A – Alligator Alley North colony and surrounding marsh	9 X surface water wells and sondes. EDEN gages and SFWMD wading bird surveys are part of on-going monitoring .	SFWMD EDEN	SFWMD and RECOVER	Perm	http://sofia.usgs.gov/eden; https://www.sfwmd.gov/science-data/dbhydro;

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Locaton
				Added cost= $50,000/ yr				
UNC ID #24: Changes in water flow, salinity, algal blooms and ecological benefits in Florida Bay, Whitewater Bay and southwest coast estuaries.	Water inflow from creeks and rivers	Flow velocity, with estimates of discharge (approximately 20 minute intervals)	Network of 17 creek stations: Mangrove ecotone of Florida Bay, Whitewater Bay and southwest coast rivers (to Lostman's River)	$0, Existing (USGS, RECOVER)	USGS	USGS / RECOVER	Temp	https://waterdata.usgs.gov/fl/nwis/current/?type=flow http://sofia.usgs.gov/eden; https://www.sfwmd.gov/science-data/dbhydro;
UNC #24 Continued	Salinity regime	Specific conductivity and temperature to estimate salinity (hourly measurements)	Florida Bay, Whitewater Bay, southwest coastal rivers (to Lostman's River). 18 stations in Florida Bay, 15 stations in sw coast estuaries	$0, Existing (ENP)	ENP Marine Monitoring Network; SFWMD shipboard dataflow surveys	ENP, SFWMD	Temp	https://www.sfwmd.gov/science-data/dbhydro; http://www-sfnrc.nps.gov/

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Locaton
UNC #24 Continued	Algal blooms	Chlorophyll *a* (monthly for grab sample network; seasonal for spatial mapping)	Florida Bay, Whitewater Bay, southwest coastal rivers (to Lostman's River)	Existing (SFWMD); estimated $30,000 for monthly interval change	SFWMD stations, SFWMD shipboard Dataflow Surveys	SFWMD	Temp	https://www.sfwmd.gov/science-data/dbhydro
UNC #24 Continued	Seagrass community	Bran-Blanquet cover metric, species composition (annual)	Florida Bay, Whitewater Bay	$0, Existing (RECOVER)	FHAP project (RECOVER) Expand to cover Long Sound, Joe Bay, Little Madeira Bay;	RECOVER	Temp	?
UNC #24 Continued	Faunal indicators	Fish abundance, biomass, and species composition (monthly to seasona) Fish movement and location relative to salinity (monthly) Fish prey base concentration with recession (monthly to seasonal) Roseate spoonbill nesting success (dry season) Crocodile abundance, nesting success, growth	Florida Bay, Whitewater Bay, Shark River	$0, Existing (RECOVER)	Juvenile sport fish (RECOVER), Florida Bay Marsh-Mangrove Interface Project (RECOVER); Hydrology, Aquatic Vegetation and Fauna in SE (RECOVER)	RECOVER	Temp	?

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Locaton
		and survivorship (dry season?)						
UNC #25 – Wading Birds	Wading Birds	Hydroperiod Water Depth/Stage Recession Rates Numbers of foraging wading bird, wading bird nests, and nesting success (monitoring to include aerial and ground surveys conducted monthly during breeding season)	Wading bird colonies within WCA 3 and ENP	$0, Existing	SFWMD EDEN ENP	RECOVER	Perm	http://sofia.usgs.gov/eden; https://www.sfwmd.gov/science-data/dbhydro;
UNC ID#6 Seepage	Peak stage, hydroperiod duration Dry nesting days; Discontinous hydroperiods; Occurrence of water level reversals	Stage and structure flow rates	WCA-3B; Northeast Shark River Slough (NESRS); 8.5-Square-Mile Area (8.5 SMA); and areas along the L-31N, L-30, and C-111 Canals	$0, Existing	SFWMD, USACE, and ENP	RECOVER	Perm	https://www.sfwmd.gov/science-data/dbhydro;
UNC #10 – NESRS and TS	Volumes delivered to S-332s (i.e. how much water	Flow rates and stage measured continuously at structures.	S-332s	$0, Existing	SFWMD	SFWMD	Perm	http://sofia.usgs.gov/eden;

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Locaton
	focused on delivery to UTS actually reaches the marsh, measured each dry season).							https://www.sfwmd.gov/science-data/dbhydro;
UNC #12a – Tamiami Trail Flow Formula (TTFF) - General	Seasonal timing of delivery of flows to NESRS	Daily averages of stage	All COP features that are included in the Tamiami Trail flow formula: S-333, S-12 C and D (outflow of WCA3/inflow to Shark River Slough portion of ENP, Potentially also affects inflow structures to WCA3: S-11 A through C,	$50,000	SFWMD and USACE	RECOVER	Perm	https://www.sfwmd.gov/science-data/dbhydro;

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Locaton
			S-8, and S-140 .					
UNC #12b – Tamiami Trail Flow Formula (TTFF) and Drought	Seasonal timing of delivery of flows to NESRS	Daily averages of stage	S-333, S-12 C and D (outflow of WCA3/inflow to Shark River Slough portion of ENP), as well as S-11 A-C, S-8, and S-140 (inflows into WCA3).	Existing unless additional model runs are required	SFWMD	RECOVER	Perm	https://www.sfwmd.gov/science-data/dbhydro;
UNC #5b – FDOT Constraint on Tamiami Trail	Duration of stage above 8.3 ft and 8.5 ft in L-29; Roadway Stability measures	Stage in L-29; # cumulative or consecutive days in water year >8.3 ft; # days stage > 8.5 ft; Ground water, surface water and soil moisture levels taken at 4 transect locations; Monitoring is real time in 15 minute intervals.	WCA-3A; Northeast Shark River Slough (NESRS); 8.5-Square-Mile Area (8.5 SMA), and areas along the L-31N Canal 4 transect locations on	$0, Existing	ENP and USACE	ENP and USACE	Temp	https://respec.eagle.io/

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Locaton
			Tamiami Trail road and subway.					
UNC #5b Continued	8.5 SMA flood mitigation performance relative to stage in L-29 and stages in NESRS; Hydroperiod performance in NESRS given seasonal rainfall	Stage in L-29; Stage in NESRS gages near and outside 8.5 SMA; Volume, depth, duration of seepage in 8.5 SMA; seasonal rainfall	Northeast Shark River Slough (NESRS), 8.5-Square-Mile Area (8.5 SMA), and areas along the L-31N Canal.	$0, Existing	ENP and USACE	ENP and USACE	Temp	https://www.sfwmd.gov/science-data/dbhydro; and USACE servers?
UNC ID#7 – Saltwater Intrusion	"Keep in view" issue using existing monitoring, modeling, analyses, and reports by other entities involving: Coastal structure difficulties in maintaining target water levels or desired	"Keep in view" issue using existing monitoring, modeling, analyses, and reports.	L-31, C-111, southern Miami-Dade County and ENP	$0, Existing	NOAA, SFWMD, USACE plus various researchers	NOAA, SFWMD, USACE	Perm	https://www.sfwmd.gov/science-data/dbhydro; https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=8724580 SFWMD Operations managers

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Locaton
	discharge due to tide or surge; Sea level rise; Flood protection performance (groundwater monitoring); Flooding concern reports via telephone							RECOVER SSR and other agency and university reports and papers Interagency Modeling Center of CERP (SFWMD, USACE, DOI)
UNC #7 Continued	Agricultural Areas: Frequency and number of Days Groundwater < 24" from soil surface	Stage at interior structures; Groundwater wells: frequency of water levels above a set of belowground thresholds – 24", 18", 12", 6", and 0"; Reports from growers of flooding	S-176,S-177, S-18C, S-197, S-331, S-334, S-333 and S-335, plus For agricultural water level monitoring stations .	$0, Existing	SFWMD	SFWMD	Perm	https://www.sfwmd.gov/science-data/dbhydro; https://www.sfwmd.gov/science-data/modeling/wdat
UNC #16a – Nutrient Loading in Taylor Slough	TP concen-tration at structures	Flow, TP nutrient concentration in water flowing into park	ENP- Taylor Slough	$0, Existing	SFWMD	SFWMD	Perm	https://www.sfwmd.gov/science-data/dbhydro;

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Locaton
UNC #16a Continued	Periphyton TP content Biomass Composition	Periphyton in downstream marsh, biannual	ENP- Taylor Slough areas of concern (e.g. downstream of S-328, S-332 outflow for G-737, downstream of the southern stretch of L-31W canal)	$0, Existing	ENP	ENP	Temp	Dilip Shinde, https://www.sfwmd.gov/science-data/dbhydro; and SFNRC servers
UNC #16a Continued	Cattail expansion	Local mapping of cattail in downstream marsh	Same as above	$0, Existing	ENP	ENP	Temp	Jed Redwine, SFNRC servers
UNC #16a Continued	Soil nutrient front	Soil nutrient content in downstream marsh, twice per year	Same as above	$0, Existing	ENP	ENP	Temp	Dilip Shinde, https://www.sfwmd.gov/science-data/dbhydro; and SFNRC servers

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Locaton
UNC #16b – Water Quality in NESRS	TP concentration at structures plus additional water quality measures	Flow, TP nutrient concentration, turbidity and other water quality measures in water flowing into park	ENP-Northeast Shark River Slough, at structures S-12D, S-333	$0, Existing	SFWMD	SFWMD	Perm	????, https://www.sfwmd.gov/science-data/dbhydro;
UNC #16b Continued	Periphyton TP content Biomass Composition	Periphyton in downstream marsh, bi-annual	ENP-Northeast Shark River Slough, downstream of S-12D, NESRS NCTransects	$0, Existing	ENP	ENP	Temp	Dilip Shinde, https://www.sfwmd.gov/science-data/dbhydro; and SFNRC servers
UNC #16b Continued	Cattail expansion	Local mapping of cattail in downstream marsh	Same as above	$0, Existing	ENP	ENP	Temp	Jed Redwine, SFNRC servers
UNC #16b Continued	Soil nutrient front	Soil nutrient content in downstream marsh, annual	Same as above	$0, Existing	ENP	ENP	Temp	Dilip Shinde, https://www.sfwmd.gov/science-data/dbhydro; and SFNRC servers

C.3 Ecological Monitoring Plan

C.3.1 Ecological Performance Measure Monitoring and USFWS Biological Opinion Monitoring

The primary objectives of the COP Ecological Monitoring Plan (COP-EMP) are to identify the monitoring necessary to inform decision-makers, COP partner agencies, and the public on whether COP is achieving its environmental restoration related goals and objectives and whether it is meeting its regulatory compliance and legal constraints. The ecological monitoring and the monitoring identified in the COP Adaptive Management Plan (Section C.2) are not one-and-the-same, because the COP-EMP focuses on COP's success at meeting project objectives (per WRDA 2007 guidance) while the monitoring specified in the Adaptive Management Plan focuses on addressing project uncertainties (per WRDA 2007 guidance) whose resolution may improve the ability of COP to meet its objectives.

The COP - AMMP will contain the monitoring and associated costs required under the USFWS Biological Opinion (BO) and other agency permits that are needed to protect and conserve natural resources. Currently the monitoring recommended reflects the 2016 ETRP BO. This monitoring is considered a "placeholder" as monitoring required under the BO is not yet included in the Draft EIS. However this monitoring will be updated once a new BO is received. A BO will be received after submittal of a Biological Assessment by USACE to USFWS concurrent with release of the Draft EIS for public review.

Development of the computer models to assess alternatives for COP resulted in the identification of and agreement upon key indicators of the ecosystem that are closely tied and responsive to changes in water management by COP. These indicators were used as the basis for creating performance monitoring recommendations. Thus the indicators that were used to assess the success of different alternatives are the primary indicators that will inform the performance of COP when implemented in the real world. This will allow feedback not only on the performance of COP but also upon the strengths and weaknesses of the modeling process which in turn can inform future projects undertaken by CERP which are being assessed by the same or similar models. In addition to hydrological monitoring, two biological endpoints are included as performance measures including freshwater fish and wading bird colonies as these are key indicators of the overarching reasons for conducting restoration in the Everglades. However changes in such biological endpoints will take longer to detect than the more immediate hydrological parameters. Given uncertainty about how long COP is expected to last (likely 10 years or less) these two biological endpoint indicators were deemed sufficient when combined with the expected recommendations of the USFWS BO for the Cape Sable seaside sparrow, Everglades snail kite, wood stork, and tree islands.

Table C.3-1 identifies the ecological monitoring to be conducted for the plan. All the monitoring gages and necessary data collection are already in existence through existing agencies or funded via CERP RECOVER. No additional monitoring needs were identified for the COP ecological performance monitoring. The primary added cost will be generating reports plus staff time participating in meetings associated with adaptive management. COP assumes this monitoring will proceed.

As the monitoring described in this portion of the COP-AMMP is already existing, the data management and QA/QC will remain as specified by the implementing entities. Multi-agency hydrological data is stored in the SFWMD database DBHYDRO (https://www.sfwmd.gov/science-data/dbhydro). Data collected by Everglades National Park is stored within the National Park Service database DATAForEVER (http://www-sfnrc.nps.gov/).

C.3.2 Baseline for Ecological Monitoring

If monitoring data is available and unless otherwise specified, the baseline for comparison of ecological monitoring and determination whether change has occurred will be the ten year period prior to COP Implementation.

C.3.3 Management Options

The management options to be taken if a performance measure is not being met or a compliance or constraint threshold is approaching violation are generally the same across all indicators and include:

1. Determine what operational decision resulted in outcome and document.
2. Make changes in operations within the limited flexibility provided in the COP
3. Evaluate scope of issue such as:
    a. Whether a COP EIS covered or non-covered adaptive management uncertainty applies
    b. Whether adjustments in the Tamiami Trail Flow Formula or Water Control Plan are needed beyond those allowed for in COP and require additional NEPA permitting and review,
    c. Whether fixing the issue is beyond the scope of COP, i.e. an additional structure is needed such as a seepage barrier or additional water in the system is needed and speeding up implementation of CEPP projects would alleviate issue,
    d. Whether additional information is needed to assist effective operations such as an additional hydrologic gaging station in a critical location or a critical assumption must be tested using modeling.
    e. Whether an emergency deviation is needed together with a required EA or EIS.
4. Elevate issue to policy/principles of agencies who will decided if an EA or EIS is appropriate and whether action is necessary.

Table C.3-1. Ecological performance measures.

Performance Measure	COP Region or Area	COP Objec-tive	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
PM-1. Inundation Duration in the Ridge and Slough Landscape	NESRS Central SRS; North WCA-3A; South WCA-3A; WCA-3B; Taylor Slough	1a,b,c, 2, 3, 4	What is duration of hydroperiod (by region) relative to baseline?	hydroperiod	3-5 years	water stage elevation measured continuously, local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	EDEN daily water surfaces (sofia.usgs.gov/eden) or specific gages at NESRS: hydro gages NE-2, NE-1, G-3660, and J-47 Central SRS: hydro gages P-35, P-36 North WCA-3A: hydro gages 3A-NW, 3A-NE, 3A-11, 3A-2 South WCA-3A: hydro gages 3A-3, E4,3A-S, 3A-4, 3A-28 WCA-3B: Hydro gages 3B-71, Shark1, 3B-S1W1 Taylor Slough: P-37, CY-3, NP-46, NP-67, TSH, R-127, E-146

Performance Measure	COP Region or Area	COP Objec-tive	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
PM-2. Amount and distribution of Flows into Everglades National Park	NESRS, west SRS	1a,b,c, 2, 3	What is the volume, timing, duration, and proportion of flow into east versus west Shark River Slough across Tamiami Trail relative to baseline?	Volume, Timing, Duration, and Distribution of flow south from Tamiami Trail	3-5 years	water stage elevation measured continuously at structures, use rating curves to estimate daily flow rates	Permanent installed gages near structures; Continuous measurements	West SRS - Tamiami Trail: (S-12A/B/C/D + S-343A/B East SRS - S-333 + S-356 - S-334) EDEN daily water surfaces (sofia.usgs.gov/eden)
PM-2 Continued	Taylor Slough	1a,b,c, 2, 3	What is the volume, timing, duration of flow at Taylor Slough Bridge relative to baseline?	volume, timing of flow	3-5 years	water stage elevation measured continuously, local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	TSB (Taylor Slough Bridge gage) EDEN daily water surfaces (sofia.usgs.gov/eden)
PM-3. Frequency and Duration of Dry Events in Shark River Slough	NESRS	1a,b,c, 3	Is the area, duration, and frequency of dry events (below ground surface) in northeast Shark River Slough changing compared with baseline?	Occurrence, area and duration of dry events	3-5 years	water stage elevation measured continuously, local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	NESRS: gages NESRS-2 EDEN daily water surfaces (sofia.usgs.gov/eden)

Performance Measure	COP Region or Area	COP Objec-tive	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
PM-4. Soil Oxidation	NESRS Central SRS North WCA-3A Central WCA-3A South WCA-3A WCA-3B Taylor Slough	1a,b,c, 2, 3	What are the number of ft*days water level is below ground per year compared with baseline?	Drought Intensity	3-5 years	Daily average water stage elevation measured continuously, local marsh elevation measured in past decade	Permanent installed minimum level gages in marsh; Continuous measurements	NESRS: Minimum level gages NESRS-2, Marl Prairies: Minimum level gages G-3273, NP-201, G-620 Central SRS: Minimum level gages NP-33, NP-36, NP-38 North WCA-3A: Minimum level gages 3A-NW, 3A-NE, 3A-2,3A-3 Central WCA-3A: 3A-4 South WCA-3A: minimum level gages 3A-28 WCA-3B: minimum level gage 3B-SE Taylor Slough: NP-67

Performance Measure	COP Region or Area	COP Objec-tive	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
PM-5. Slough Vegetation Suitability	NESRS Central SRS North WCA-3A South WCA-3A WCA-3B Taylor Slough	1a,b,c, 2, 3	In sloughs is the average wet season (June-October) water depths between 2-3 ft and average dry season (November-May) water depths between approximately 1.5-2 ft? Are there limited dry down events where water is <0.7 ft above the ground surface? Are there near continuous 365 day calendar year hydroperiods with water above ground surface? The above measures are compared with baseline.	Wet season average depth (June-October); Dry season average depth (November - May); Hydroperio d; Drydown events	3-5 years	water stage elevation measured continuously, local marsh elevation measured in past decade	Vegetation mapping in NESRS, collected every 2-3 years. Vegetation monitoring in RECOVER using GRTS panels, each region visited each year, revisit evey 5 years. Also water level information from EDEN, continuously collected.	EDEN daily water surfaces (sofia.usgs.gov/eden) for Indicator Regions or specific gages in RECOVER indicator regions: 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, and 160 NESRS: NE-2, P-33 WCA-3A: 3A-NW, 3A-NE, 3A-11, 3A-3, EDEN-4 WCA-3A-South: 3A-SW, 3A-4, 3A-S, A-W2, 3A-28 WCA-3B: 3B-71 Taylor Slough: CP, TSH

Performance Measure	COP Region or Area	COP Objec-tive	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
PM-6. Florida Bay Salinity	Craighead Basin, Taylor Slough, Eastern Panhandle Manatee Bay North FL Bay Central FL Bay West FL Bay	1a,b,c, 2, 3, 4	What is the volume, timing, and distribution of flows into Florida Bay in total and by region compared with baseline?	Timing, volume of flow / discharge	3-5 years	water stage elevation measured continuously,	Permanent installed gages in marsh; Continuous measurements	Inland hydrology: TSB, P-37, CP, E-146, OL, TR, Coastal Discharge Station: ALC, MCC, TRE, ECR, MUD, TROUT, HCW
PM-6 Continued	Northeast FL Bay East FL Bay East-Central Florida Bay Central FL Bay South FL Bay West FL Bay	1a,b,c, 2, 3, 4	Are salinity regimes (25-75th percentiles) consistent with or show shifts to lower salinity regimes during dry season than baseline? Are high salinities reaching into the damaging salinity event range and what is the duration? Are low salinities reaching into	Dry Season Regime Overlap Wet Season Regime Overlap Dry Season High Salinity Wet Season High Salinity	3-5 years	June-Oct: Wet season salinity: Salinity Mean (June-Oct), Monthly mean, 25th percentile, 75th percentile, maximum, minimum Nov-May: Dry Season Salinity: Salinity Mean (June-Nov), Monthly mean, 25th percentile, 75th percentile, maximum, minimum	Permanent water quality monitoring stations	North FL Bay: LM, JB, TC, LS East FL Bay: BS, LB, MB, TP East-Central FL Bay: DK, BN Central FL Bay: BK, GB, TB, WB South FL Bay: BA, West FL Bay: MK, JK, LR, PK

Performance Measure	COP Region or Area	COP Objec-tive	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
			the damaging salinity event range in Manatee Bay and what is the duration?					
PM-7. Woodstork & Wading Birds	WCA-3A ENP	3	What is the status and trends in the number of wading bird colonies and distribution of wading bird colonies compared with baseline? What colonies are new? What colonies have disappeared?	Number and distribution of Wading Bird Colonies with any nests; with 50 or more nests	3-10 years	Number and Locations of wading bird colonies	Annual region wide survey to detect colonies, Monthly aerial surveys of nesting colonies during breeding season; summarized in annual Wading bird report	Suitable habitat in WCA-3 and ENP

Performance Measure	COP Region or Area	COP Objec-tive	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
PM-7 Continued	WCA-3A ENP	3	What are the status and trends in the number of nesting pairs detected by colony and across colonies for wood storks, ibis, great egrets, snowy egrets compared with baseline? What is the status and trend in the timing of wood stork nesting? What is the frequency of occurrence and location of White Ibis supercolonies?	3 year running average of number of nesting pairs of key wading bird species; timing of initiation of woodstork nesting; supercoloni es	3-10 years	Maximum number of active nests detected by species	Annual region wide survey to detect colonies, Monthly aerial surveys of nesting colonies during breeding season; summarized in annual Wading bird report	Wading bird colonies in WCA-3 and ENP

Performance Measure	COP Region or Area	COP Objec-tive	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
PM-8. Tree Islands	WCA-3A, WCA-3B, ENP	1a,b,c, 3, 5	What is the percent of mapped tree islands in each area that are innundated less than 10% period of record (POR) each year? What is the distribution of inundation of mapped tree islands?	Percent of tree islands innundated	5-10 years	Daily average water stage elevation measured continuously, local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	EDEN daily water surfaces (sofia.usgs.gov/eden)
PM-9. Flows to Eastern Panhandle and at S-197	Eastern Panhandle	1a,b,c, 2, 4	Are flows across the Eastern Panhandle increasing compared with the baseline?	C-111 spreader canal overland flow: volume and timing of overland flow as measured by the difference between flows at S-18C and S-197	3-5 years	Daily average water stage elevation measured continuously	Permanent installed gages at structures; Continuous measurements	S-18C, S-197

Performance Measure	COP Region or Area	COP Objec-tive	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
PM-9 Continued	S-197	1a,c, 2, 4	Are number of days with 0 flow increased and number of days with >0 to 400 cfs, >400 to 800 cfs, and > 800 cfs decreased compared with baseline?	S-197 Daily Flow Distribution in cfs	3-5 years	Daily average water stage elevation measured continuously	Permanent installed gages in marsh; Continuous measurements	S-197 Gage
PM-10. High-Low Closure Criteria for Everglades Wildlife Management Areas	WCA-3A	1a, 3, 5	Are the frequency of occurrence and the number of days closed due to low water per water year the same or less than expected compared with baseline?	Days closed due to low water	3-5 years	Days closed; Daily average water stage elevation measured continuously	Daily closure determination; Based upon water stage elevation measured continuously	WCA-3A
PM-10 Continued	WCA-3A	1a, 3, 5	Are the frequency of occurrence and the number of days closed due to high water per water year the same or less than expected under baseline?	Days closed due to high water	3-5 years	Days closed; Daily average water stage elevation measured continuously	Daily closure determination; Based upon water stage elevation measured continuously	WCA-3A

Performance Measure	COP Region or Area	COP Objec-tive	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
PM-10 Continued	WCA-3A	1a, 3, 5	Is the Number of High Water Closures the same or less than expected under baseline?	Number of High Water Closures	3-5 years	Days closed; Daily average water stage elevation measured continuously	Daily closure determination; Based upon water stage elevation measured continuously	WCA-3A
PM-10 Continued	WCA-3A	1a, 3, 5	Is the Number of Damaging High Water Closures (>60 days) the same or less than expected under baseline?	Number of Damaging High Water Closures (>60 days)	3-5 years	Days closed; Daily average water stage elevation measured continuously	Daily closure determination; Based upon water stage elevation measured continuously	WCA-3A
PM-10 Continued	WCA-3A	1a, 3, 5	Is the Number of Low Water Closures the same or less than expected under baseline?	Number of Low Water Closures	3-5 years	Days closed; Daily average water stage elevation measured continuously	Daily closure determination; Based upon water stage elevation measured continuously	WCA-3A
PM-11. Biscayne Bay Critical Flows	Biscayne Bay-North Central South	Constr aint	Is the flow volume, timing, and distribution maintained or changed compared with baseline?	Flows/Disch arge	3-5 years	total discharge	Based upon water stage elevaton measured continuously	North: S-25 + S-25B + S-27 + S-28 + S-29 Central: G-93 + S-22 + S-123 South: S-20F + S-20G + S-21 + S-21A

Performance Measure	COP Region or Area	COP Objec-tive	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
PM-12. Freshwater Fish	ENP	1a,b,c, 2, 3	Are fish communities showing changes in abundance of small sized freshwater fish (less than 8 cm adult standard length; primarily livebearers and killifishes) similar to predicted by simulations?	Freshwater fish community composition	3-10 years	Fish species counts and fish lengths. Monitored annually.	Annual, 1 m^3 throw traps	long term prey base fish stratified random monitoring stations located throughout NESRS marsh

Table C.3-2. Estimated monitoring required for USFWS Biological Opinion.

Compliance Measure	COP Region or Area	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
BO1. Woodstorks and Wading Birds	WCA-3A	Is the incidental take trigger met that water depths are not greater than 16 inches (41 cm) occur from March 1 through May 31 throughout WCA-3A as measured by the two gage average 3A-3 and 3A-4 (based upon a ground surface elevation of 8.4 feet NGVD) If not, has this trigger not been met for 2 consecutive years?	Number of days water depth exceeds 16 inches (March 1-May 31)	3-5 years	Daily average water stage elevation measured continuously, local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	Gages 3A-3 and 3A-4
BO2. Cape Sable Seaside Sparrow (CSSS)	Pop A, Ax	Is the hydrologic target met that the absolute area and percent of area within and adjacent to subpopulation A and Ax habitat with 90 consecutive dry nesting days between March 1 and July 15 is greater than 24,000 acres (40%) respectively?	Absolute area and percent of subpopulation A,Ax habitat (marl prairie) with 90 consecutive dry days between March 1 and July 15	3-5 years	Daily average water stage elevation measured continuously, local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	EDEN daily water surfaces (sofia.usgs.gov/eden). Also specific gages at: NP-205, NP-TMC, NP-34

Compliance Measure	COP Region or Area	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
BO2 Continued	Pop's B-F	Is the hydrologic target met that at least 40 percent of designated CSSS Critical Habitat has 90 consecutive dry nesting days between March 1 and July 15?	Absolute area and percent of habitat for each of population B-F habitat (marl prairie) with 90 consecutive dry days between March 1 and July 15	3-5 years	Daily average water stage elevation measured continuously water stage elevation measured continuously, local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	EDEN daily water surfaces (sofia.usgs.gov/eden). Also specific gages at: Pop B: NP-46 Pop C: NP-N10, NTS-1, R3110 Pop D: SWEVER4 POP E: NP-206, NP-A13, NP-CR3
BO2 Continued	Western Marl Prairie (Populations A, Ax)	Is the hydrologic target met that at least 24,000 acres of suitable habitat within and adjacent to CSSS subpopulation A must show a 4-year running average discontinuous hydroperiod range of 90-210 days, with no 2 consecutive years failing to meet this target?	Area of Discontinuous Hydroperiod	3-5 years	Daily average water stage elevation measured continuously, local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	EDEN daily water surfaces (sofia.usgs.gov/eden). or specific gages at: NP-205, NP-TMC, NP-34
BO2 Continued	Pops B-F	Is the hydrologic target met that at least 40 percent of each designated CSSS critical habitat unit must show	Area of Discontinuous Hydroperiod	3-5 years	Daily average water stage elevation measured continuously,	Permanent installed gages in marsh; Continuous measurements	EDEN daily water surfaces (sofia.usgs.gov/eden). or specific gages at:

Compliance Measure	COP Region or Area	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
		a 4-year running average discontinuous hydroperiod range of 90-210 days, with no 2 consecutive years failing to meet this target.			local marsh elevation measured in past decade		Pop B: NP-46 Pop C: NP-N10, NTS-1, R3110 Pop D: SWEVER4 POP E: NP-206, NP-A13, NP-CR3
BO2 Continued	Populations A-F	What are the status and trends in relative CSSS abundance detected per population and across populations compared baseline?	CSSS Abundance	4-10 years	Relative Abundance of Singing Males detected within each population	7 Minute Point Counts of Singing Males; Annual (April - May)	Sampling design is a systematic design of permanent locations, spaced 1 km apart in each CSSS population A-F habitat. Total number of point counts is approximately 500 / year.
BO3. Everglades Snail Kite	WCA-3A	Is the incidental take trigger met that water depths remain at or below 9.2 ft NGVD at gage 3AS3W1 April 15 - May 31? If not, has this trigger not been met for 2 consecutive years?	Dry season high water frequency	3-5 years	Gage 3AS3W1 High Water Peak Stage (feet, NGVD) ;Number of Days Gage 3AS3W1 > 9.2 feet, NGVD (April 15-May 31)	Permanent installed gages Continuous measurements	Gage 3AS3W1
BO3 Continued	WCA-3A	Is the constraint met that water depths >10.5 ft at gage 3AS3W1 are less than 60 days between June	Wet season high water frequency	3-5 years	Gage 3AS3W1 High Water Peak Stage (feet, NGVD); Number of Days Gage	Permanent installed gages Continuous measurements	Gage 3AS3W1

Compliance Measure	COP Region or Area	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
		1 - December 31? If not, has this trigger not been met for 2 consecutive years?			3AS3W1 > 10.5 feet, NGVD (June 1-December 31)		
BO3 Continued	WCA-3A	Is the incidental take trigger met that the stage difference should not recede by more than 1.7 ft between Jan 1 - May 31 (or onset of wet season) as measured at gage(s) closest to kite nesting, as determined by the Service?	Recession / Dry Season Amplitude	3-5 years	Daily average water stage elevation measured continuously at gage(s) closest to kite nesting, as determined by the Service.	Permanent installed gages Continuous measurements	Gages closest to kite nesting as determined by the USFWS (e.g., 3A-S, 3A-28, 3A-4)
BO3 Continued	WCA-3A	What are the status and trends in number of Everglades Snail Kite nests counted and the proportion of successful nests?	Snail Kite nest counts, proportion of successful nests	4-10 years	Count and locations of snail kite nests, Number successful and unsuccessful nests in fledging	Multiple consecutive surveys throughout designated wetands from March 1st to June 30, 2-3 week intervals, each year.	Initial nesting surveys throughout WCA-3A, 3B northern ENP

C.3.4 Ecological Monitoring Plan Additional Cost Estimate and Links to Existing Monitoring Programs

Monitoring identified for the COP-ENP is already existing prior to the beginning of COP and is assumed will continue. Thus no additional costs are assumed due to ecological performance monitoring. The USFWS BO will be provided subsequent to the Draft COP-AMMP. Any costs that are in addition to the existing monitoring will be identified in that document. Links to existing monitoring programs are provided in **Table C.3-3.**

Table C.3-3. Ecological Performance Measure (PM) and estimated USFWS Biological Opinion (BO) linked to existing monitoring.

Performance Measure or Biological Opinion Number	Attribute or Indicator of interest	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (temp/ perm)	Project Manager / Data Storage Location
PM-1. Inundation Duration in the Ridge and Slough Landscape	Hydro-period	Water stage elevation measured continuously, local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	EDEN daily water surfaces (sofia.usgs.gov/eden) or specific gages at NESRS: hydro gages NE2, NE1, G3660, and J47 Central SRS: hydro gages P35, P36 North WCA-3A: hydro gages 3A-NW, 3A-NE, 3A-11, 3A-2 South WCA-3A: hydro gages 3A-3, E4,3A-S, 3A-4, 3A-28 WCA-3B: Hydro gages 3B-71, Shark1, 3B-S1W1 Taylor Slough: P37, CY3, NP 46, NP-67, TSH, R127, E146	USGS, ENP, SFWMD	RECOVER, SFWMD, and ENP	Perm	DataForever and DBHYDRO https://www.sfwmd.gov/science-data/dbhydro;

Performance Measure or Biological Opinion Number	Attribute or Indicator of interest	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (temp/ perm)	Project Manager / Data Storage Location
PM-2. Amount and distribution of Flows into Everglades National Park	Volume, Timing, Duration, and Distribution of flow south from Tamiami Trail	Water stage elevation measured continuously at structures, use rating curves to estimate daily flow rates	Permanent installed gages near structures; Continuous measurements	West SRS - Tamiami Trail: (S-12A/B/C/D + S-343A/B East SRS - S-333 + S-356 - S-334) EDEN daily water surfaces (sofia.usgs.gov/eden)	USGS, ENP, SFWMD	RECOVER, SFWMD, and ENP	Perm	DataForever and DBHYDRO https://www.sfwmd.gov/science-data/dbhydro;
PM-2 Continued	Volume, timing of flow	Water stage elevation measured continuously, local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	TSB (Taylor Slough Bridge gage) EDEN daily water surfaces (sofia.usgs.gov/eden)	USGS, ENP, SFWMD	RECOVER, and ENP	Perm	DataForever and DBHYDRO https://www.sfwmd.gov/science-data/dbhydro;
PM-3. Frequency and Duration of Dry Events in Shark River Slough	Occurrence, area and duration of dry events	Water stage elevation measured continuously, local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	NESRS: gages NESRS-2 EDEN daily water surfaces (sofia.usgs.gov/eden)	USGS, ENP,	RECOVER, and ENP	Perm	DataForever and DBHYDRO https://www.sfwmd.gov/science-data/dbhydro;

Performance Measure or Biological Opinion Number	Attribute or Indicator of interest	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (temp/ perm)	Project Manager / Data Storage Location
PM-4. Soil Oxidation	Drought Intensity	Daily average water stage elevation measured continuously, local marsh elevation measured in past decade	Permanent installed minimum level gages in marsh; Continuous measurements	NESRS: Minimum level gages NESRS-2, Marl Prairies: Minimum level gages G-3273, NP-201, G-620 Central SRS: Minimum level gagues NP-33, NP-36, NP-38 North WCA-3A: Minimum level gages 3A-NW, 3A-NE, 3A-2,3A-3 Central WCA-3A: 3A-4 South WCA-3A: minimum level gages 3A-28 WCA-3B: minimum level gage 3B-SE Taylor Slough: NP-67	USGS, ENP, SFWMD	RECOVER, and ENP	Perm	DataForever and DBHYDRO https://www.sfwmd.gov/science-data/dbhydro;

Performance Measure or Biological Opinion Number	Attribute or Indicator of interest	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (temp/ perm)	Project Manager / Data Storage Location
PM-5. Slough Vegetation Suitability	Wet season average depth (June-October); Dry season average depth (November - May); Hydroperio d; Drydown events	Water stage elevation measured continuously, local marsh elevation measured in past decade	Vegetation mapping in NESRS, collected every 2-3 years. Vegetation monitoring in RECOVER using GRTS panels, each region visited each year, revisit evey 5 years. Also water level information from EDEN, continuously collected.	EDEN daily water surfaces (sofia.usgs.gov/eden) for Indicator Regions or specific gages in RECOVER indicator regions: 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, and 160 NESRS: NE-2, P-33 WCA-3A: 3A-NW, 3A-NE, 3A-11, 3A-3, EDEN-4 WCA-3A-South: 3A-SW, 3A-4, 3A-S, A-W2, 3A-28 WCA-3B: 3B-71 Taylor Slough: CP, TSH	USGS, ENP, SFWMD	RECOVER, and ENP	Perm	DataForever and DBHYDRO https://www.sfwmd.gov/science-data/dbhydro;
PM-6. Florida Bay Salinity	Timing, volume of flow / discharge	Water stage elevation measured continuously	Permanent installed gages in marsh; Continuous measurements	Inland hydrology: TSB, P37, CP, E146, OL, TR, Coastal Discharge Station: ALC, MCC, TRE, ECR, MUD, TROUT, HCW	USGS, ENP, SFWMD	RECOVER, SFWMD, and ENP	Perm	DataForever and DBHYDRO https://www.sfwmd.gov/science-data/dbhydro;

Performance Measure or Biological Opinion Number	Attribute or Indicator of interest	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (temp/ perm)	Project Manager / Data Storage Location
PM-6 Continued	Dry Season Regime Overlap Wet Season Regime Overlap Dry Season High Salinity Wet Season High Salinity	June-Oct: Wet season salinity: Salinity Mean (June-Oct), Monthly mean, 25th percentile, 75th percentile, maximum, minimum Nov-May: Dry Season Salinity: Salinity Mean (June-Nov), Monthly mean, 25th percentile, 75th percentile, maximum, minimum	Permanent water quality monitoring stations	North FL Bay: LM, JB, TC, LS East FL Bay: BS, LB, MB, TP East-Central FL Bay: DK, BN Central FL Bay: BK, GB, TB, WB South FL Bay: BA, West FL Bay: MK, JK, LR, PK	USGS, ENP, SFWMD	RECOVER, and ENP	Perm	DataForever and DBHYDRO https://www.sfwmd.gov/science-data/dbhydro;
PM-7. Woodstork & Wading Birds	Number and distribution of Wading Bird Colonies with any nests; with 50 or more nests	Number and Locations of wading bird colonies	Annual region wide survey to detect colonies, Monthly aerial surveys of nesting colonies during breeding season; summarized in annual Wading bird report	Suitable habitat in WCA 3 and ENP	ENP, SFWMD, and FAU	RECOVER, and ENP	Perm	SFWMD server, published in Wading bird report;

Performance Measure or Biological Opinion Number	Attribute or Indicator of interest	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (temp/ perm)	Project Manager / Data Storage Location
PM-7 Continued	3 year running average of number of nesting pairs of key wading bird species; timing of initiation of woodstork nesting; super-colonies	Maximum number of active nests detected by species	Annual region wide survey to detect colonies, Monthly aerial surveys of nesting colonies during breeding season; summarized in annual Wading bird report	Wading bird colonies in WCA3 and ENP	ENP, SFWMD, and FAU	RECOVER, and ENP	Perm	SFWMD server, published in Wading bird report;
PM-8. Tree Islands	Percent of tree islands inundated	Daily average water stage elevation measured continuously, local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	EDEN daily water surfaces (sofia.usgs.gov/eden)	USGS, ENP, SFWMD	RECOVER, and ENP	Perm	DataForever and DBHYDRO https://www.sfwmd.gov/science-data/dbhydro, and sofia.usgs.gov/eden
PM-9. Flows to Eastern Panhandle and at S-197	C-111 spreader canal overland flow: volume and timing of overland	Daily average water stage elevation measured continuously	Permanent installed gages at structures; Continuous measurements	S-18C, S-197	ENP and SFWMD	ENP, SFWMD, and RECOVER	Perm	DataForever and DBHYDRO https://www.sfwmd.gov/science-data/dbhydro,

Performance Measure or Biological Opinion Number	Attribute or Indicator of interest	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (temp/ perm)	Project Manager / Data Storage Location
	flow as measured by the difference between flows at S-18C and S-197							
PM-9 Continued	S-197 Daily Flow Distribution in cfs	Daily average water stage elevation measured continuously	Permanent installed gages in marsh; Continuous measurements	S-197 Gage	SFWMD	SFWMD	Perm	https://www.sfwmd.gov/science-data/dbhydro,
PM-10. High-Low Closure Criteria for Everglades Wildlife Management Areas	Days closed due to low water	Days closed; Daily average water stage elevation measured continuously	Daily closure determination; Based upon water stage elevation measured continuously	WCA-3A	FFWCC	FFWCC	Perm	Announced publicly, summary provided by FFWCC
PM-10 Continued	Days closed due to high water	Days closed; Daily average water stage elevation measured continuously	Daily closure determination; Based upon water stage elevation measured continuously	WCA-3A	FFWCC	FFWCC	Perm	Announced publicly, summary provided by FFWCC

Performance Measure or Biological Opinion Number	Attribute or Indicator of interest	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (temp/ perm)	Project Manager / Data Storage Location
PM-10 Continued	Number of High Water Closures	Days closed; Daily average water stage elevation measured continuously	Daily closure determination; Based upon water stage elevation measured continuously	WCA-3A	FFWCC	FFWCC	Perm	Announced publicly, summary provided by FFWCC
PM-10 Continued	Number of Damaging High Water Closures (>60 days)	Days closed; Daily average water stage elevation measured continuously	Daily closure determination; Based upon water stage elevation measured continuously	WCA-3A	FFWCC	FFWCC	Perm	Announced publicly, summary provided by FFWCC
PM-10 Continued	Number of Low Water Closures	Days closed; Daily average water stage elevation measured continuously	Daily closure determination; Based upon water stage elevation measured continuously	WCA-3A	FFWCC	FFWCC	Perm	Announced publicly, summary provided by FFWCC
PM-11. Biscayne Bay Critical Flows	Flows/Discharge	Total discharge	Based upon water stage elevaton measured continuously	North: S-25 + S-25B + S-27 + S-28 + S-29 Central: G-93 + S-22 + S-123 South: S-20F + S-20G + S-21 + S-21A	SFWMD	SFWMD	Perm	https://www.sfwmd.gov/science-data/dbhydro,

Performance Measure or Biological Opinion Number	Attribute or Indicator of interest	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (temp/ perm)	Project Manager / Data Storage Location
PM-12. Freshwater Fish	Freshwater fish community composition	Fish species counts and fish lengths. Monitored annually.	Annual, 1 m^3 throw traps	Long term prey base fish stratified random monitoring stations located throughout NESRS marsh	FIU	ENP, CERP-RECOVER	Temp	Joel Trexler
BO1. Woodstorks and Wading Birds	Number of days water depth exceeds 16 inches (March 1-May 31)	Daily average water stage elevation measured continuously, local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	Gages 3A-3 and 3A-4	SFWMD	SFWMD	Perm	https://www.sfwmd.gov/science-data/dbhydro,
BO2. Cape Sable Seaside Sparrow (CSSS)	Absolute area and percent of subpopulation A,Ax habitat (marl prairie) with 90 consecutive dry days between March 1 and July 15	Daily average water stage elevation measured continuously, local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	EDEN daily water surfaces (sofia.usgs.gov/eden). Also specific gages at: NP-205, NP-TMC, NP-34	ENP	ENP	Perm	https://www.sfwmd.gov/science-data/dbhydro, Sparrow Viewer: https://sofia.usgs.gov/eden/csss/

Performance Measure or Biological Opinion Number	Attribute or Indicator of interest	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (temp/ perm)	Project Manager / Data Storage Location
BO2 Continued	Absolute area and percent of habitat for each of population B-F habitat (marl prairie) with 90 consecutive dry days between March 1 and July 15	Daily average water stage elevation measured continuously water stage elevation measured continuously, local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	EDEN daily water surfaces (sofia.usgs.gov/eden). Also specific gages at: Pop B: NP-46 Pop C: NP-N10, NTS-1, R3110 Pop D: SWEVER4 POP E: NP-206, NP-A13, NP-CR3	SFWMD, ENP, USACE, and USGS	SFWMD	Perm	https://www.sfwmd.gov/science-data/dbhydro, Sparrow Viewer: https://sofia.usgs.gov/eden/csss/
BO2 Continued	Area of Discon-tinuous Hydro-period	Daily average water stage elevation measured continuously, local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	EDEN daily water surfaces (sofia.usgs.gov/eden). or specific gages at: NP-205, NP-TMC, NP-34	ENP	ENP	Perm	https://www.sfwmd.gov/science-data/dbhydro, Sparrow Viewer: https://sofia.usgs.gov/eden/csss/
BO2 Continued	Area of Discon-tinuous Hydro-period	Daily average water stage elevation measured continuously, local marsh elevation	Permanent installed gages in marsh; Continuous measurements	EDEN daily water surfaces (sofia.usgs.gov/eden). or specific gages at: Pop B: NP-46 Pop C: NP-N10, NTS-1, R3110	ENP	ENP	Perm	https://www.sfwmd.gov/science-data/dbhydro, Sparrow Viewer: https://sofia.u

Performance Measure or Biological Opinion Number	Attribute or Indicator of interest	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (temp/ perm)	Project Manager / Data Storage Location
		measured in past decade		Pop D: SWEVER4 POP E: NP-206, NP-A13, NP-CR3				sgs.gov/eden/csss/
BO2 Continued	CSSS Abundance	Relative Abundance of Singing Males detected within each population	7 Minute Point Counts of Singing Males; Annual (April - May)	Sampling design is a systematic design of permanent locations, spaced 1 km apart in each CSSS population A-F habitat. Total number of point counts is approximately 500 / year.	ENP	ENP	Temp	Tylan Dean. Data stored at SFNRC server Sparrow Viewer: https://sofia.usgs.gov/eden/csss/
BO3. Everglades Snail Kite	Dry season high water frequency	Gage 3AS3W1 High Water Peak Stage (feet, NGVD) ;Number of Days Gage 3AS3W1 > 9.2 feet, NGVD (April 15-May 31)	Permanent installed gages Continuous measurements	Gage 3AS3W1	SFWMD	SFWMD	Perm	https://www.sfwmd.gov/science-data/dbhydro,
BO3 Continued	Wet season high water frequency	Gage 3AS3W1 High Water Peak Stage (feet, NGVD); Number of Days Gage 3AS3W1 > 10.5 feet, NGVD (June 1-December 31)	Permanent installed gages Continuous measurements	Gage 3AS3W1	SFWMD	SFWMD	Perm	https://www.sfwmd.gov/science-data/dbhydro,

Performance Measure or Biological Opinion Number	Attribute or Indicator of interest	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (temp/ perm)	Project Manager / Data Storage Location
BO3 Continued	Recession / Dry Season Amplitude	Daily average water stage elevation measured continuously at gage(s) closest to kite nesting, as determined by the Service.	Permanent installed gages Continuous measurements	Gages closest to kite nesting as determined by the USFWS (e.g., 3A-S, 3A-28, 3A-4)	SFWMD	SFWMD	Perm	https://www.sfwmd.gov/science-data/dbhydro,
BO3 Continued	Snail Kite nest counts, proportion of successful nests	Count and locations of snail kite nests, Number successful and unsuccessful nests in fledging	Multiple consecutive surveys throughout designated wetands from March 1st to June 30, 2-3 week intervals, each year.	Initial nesting surveys throughout WCA-3A, 3B northern ENP	SFWMD	SFWMD	Perm	https://www.sfwmd.gov/science-data/dbhydro,

C.4 Water Quality and Hydrology Monitoring Plan

C.4.1 Summary

The water quality and hydrology monitoring plan presented here for Combined Operational Plan (COP) was developed by an interagency team from SFWMD, USACE, DOI, and FDEP In support of the MWD Incremental field tests from 2015 through 2020. The COP water quality and hydrology monitoring plan is principally a continuation of the plan that was put forward in the latest Increment 2 field test, including continuation of monitoring requirements along the Tamiami Trail Roadway, the 8.5 SMA interior flood mitigation area, and within the C-111 South Dade Northern and Southern Detention Areas. The operation of the system according to the requirements of the COP Water Control Plan will depend on the future hydro-meteorological conditions and water availability in the project area. Due to the several temporary water management deviations coincident with the field test increments, there have not been long enough time periods to operate the system in accordance with the prescribed field test operational criteria to observe the long term effects of the project components. Hydrologic response uncertainties which were unable to be comprehensively analyzed during the field tests will be carried forward through the continuation of the monitoring plan and/or through the COP Adaptive Management Plan.

The proposed water quality monitoring plan will provide data to: 1) Track compliance with Settlement Agreement monitoring requirements. 2) Monitor potential impacts to the NESRS and ENP SRS 3) Track S-356 discharges to ensure WQ continues to be representative of seepage from WCA-3A and ENP 4) Perform WQ monitoring required by C-111 SD EO 9.

Source attribution and characterization are needed to guide water quality management efforts in the future. The proposed monitoring plans for surface water and groundwater hydrology will provide data to: (1) assess the zone of influence of the S-356 pump station under a range of pumping scenarios; (2) develop water budgets of the L-31N Canal (north and south of the S-331 pump station) and the C-111 Canal (between S 176 and S-177) under representative operational scenarios; (3) assess performance of the 8.5 SMA project components, including S-357 and S-357N (construction completed in February 2018), to maintain the surface water and groundwater levels within the project areas of the 8.5 SMA, between the L 357W Levee and the L-31N Levee at the same levels as existed prior to the implementation of any MWD Project components; (4) demonstrate S-356's ability to manage additional seepage caused by increased MWD flows into NESRS under a range of hydrologic conditions; (5) quantify the net effects within the L-31N Basin (south of S-331 and north of S-176) and the C-111 Basin (south of S-176) from the of reduced WCA 3A regulatory discharges to NESRS combined with increased flood control releases from S-331/S-173 and increased seepage to the L-31N Canal south of S-331, including the capability of the S-332B/C/D pump stations and the C-111 South Detention Area to manage potential additional flows into the L-31N Canal under certain operational conditions; and (6) incorporate the ongoing SFWMD operations, monitoring, and performance assessments conducted as part of the CERP C-111 Spreader Canal Western Project. Items (5) and (6) are addressed within Section C.5 of the monitoring plan. The analysis of the collected data and their interpretation is contingent upon the existence of hydro-meteorological conditions that are relevant to the intended flow levels and flow rates in the project site. Since the inception of the incremental tests, the unusually wet conditions in South Florida did not allow the S-356 stations to be operated for extended periods of time until completion of the C-111 South Dade project

features in August-September 2018; S-356 operations continued until the onset of the dry season in late October 2018, and then re-started with the start of the 2019 wet season in mid-June 2019. In developing the original Increment 1 field test monitoring plan (Appendix C of the May 2015 EA), which provided the monitoring plan foundation throughout the incremental field test period from 2015-2020, the interagency teams reviewed the ongoing monitoring efforts within the study area as of October 2014 to determine what existing and additional monitoring would likely be required to fully evaluate the hydrologic and water quality impacts associated with relaxing the G-3273 operations constraint and raising the L-29 Canal maximum operating limit. Additional monitoring requirements were incorporated based on the operational strategies for Increment 1.1 and 1.2 and Increment 2, which included consideration of new information and an expanded monitoring network.

Six additional monitoring wells were identified in the revised monitoring plan with Increment 2: 2 additional wells within the expanded C-111 South Dade Northern Detention Area, 2 additional wells in the Southern Detention Area, and 2 additional wells within the 8.5 SMA interior. While raising the maximum operating limit for the L-29 Canal, the L-29 Canal will be operated to ensure the stability and safety of the Tamiami Trail (U.S. 41) Highway between S-333 and S-334, in accordance with the September 25, 2008 Relocation Agreement, the Tamiami Trail Modifications Contract between the Government and the Florida Department of Transportation (FDOT) and any subsequent amendments executed to support implementation of the Proposed Action. To address FDOT concerns with raising L-29 operating stages and potential effects on the road base, the Increment 2 monitoring plan was expanded to include six additional locations along Tamiami Trail between S-333 and S-334 with real-time monitoring of groundwater levels and soil moisture conditions. Since the L-29 Canal maximum operating stage limit was raised up to 8.5 feet NGVD in September 2018, the Increment 2 hydrologic monitoring plan components have demonstrated suitability to meet the monitoring needs of Increment 2 and the future COP. As such, this plan incorporates the best information available; however, as the COP operations are implemented, this plan may require revision.

Late in the development of the original Increment 1 monitoring plan, the formulation efforts recommended consideration of a change to the operational criteria of the S-197 structure. This change precipitated the need to amend the water quality and hydrology monitoring plan to incorporate additional monitoring south of the S-331 structure. Rather than re-write the monitoring plan, the additional monitoring required due to changed operations at S-197 are detailed in Section C.5 of this plan. Since this monitoring plan construct has supported nearly 5 years of monitoring during the incremental field test, a similar monitoring plan is proposed for the COP.

While the near record-high WCA-3A stages during February-March 2016 and the wet season following June 2017 created many water management challenges, temporary emergency deviations executed in response to these conditions provided valuable information on the responses within ENP and the SDCS system to raising of the L-29 Canal, including evaluation of operational limitations of the 8.5 Square Mile Area (SMA) flood mitigation project prior to completion of the MWD and C-111 South Dade projects. Based on information gained during implementation of the 2016 Emergency Deviation and the subsequent expanded recovery period, in addition to the inclusion of additional operational flexibility within the Operational Strategy for Increment 1.2 allowing operation of the L-29 Canal to a maximum operating limit of 7.8 feet NGVD, an expanded hydrologic monitoring plan for the 8.5 SMA was previously

established to complement the revised objectives of the Increment 1.1 and 1.2 Operational Strategy. The supplemental monitoring requirements for the 8.5 SMA are detailed in Section C.6.

C.4.2 Glossary/Acronyms

ADaPT – Automated Data Processing Tool software, for quality control analysis of analytical data

Assessment – to interpret responses in natural and/or human systems based on data acquired though monitoring activities.

ADVM – Acoustic Doppler Velocity Meter, for measurement of surface water flow velocity.

BWRF – Biweekly if Recorded Flow – Sampling frequency to collect sample on bi-weekly basis if flow has occurred in the past week.

Constraint – a condition that is to be minimized or avoided in the plan formulation and selection process to ensure that the project component does not result in undesirable changes in the project area or downstream waters. Example: The component shall not cause or contribute to a violation of state water quality standards.

DOI – Department of Interior

Data Qualifiers: a code that is added to data to serve as an indication of the quality of the data.

Data Quality Objectives (DQO) – a process that identifies the intended use of the data including the types of decisions that will be made based on the results. The analytes of interest, corresponding action levels, sampling design and quality control measures are also identified as well as data repositories into which the data will be entered, the mechanisms used to ensure that the data are accurately entered into a database and to verify that the data in the database are correct, and the level of data quality acceptable for this project.

EB – Equipment Blank, collected to monitor on-site sampling environment, sampling equipment decontamination, sample container cleaning, the suitability of sample preservatives and analyte-free water, sample transport and storage conditions and laboratory processes.

EM – Engineering Manual: USACE documents that provide guidance on various aspects of project design and implementation.

ENP – Everglades National Park

FB - Field Blank, collected to monitor on-site sampling environment, sample container cleaning, the suitability of sample preservatives and analyte-free water, sample transport and storage conditions and laboratory processes.

FCEB – Field Cleaned Equipment Blank, collected to monitor on-site sampling environment, sampling equipment decontamination in the field, sample container cleaning, the suitability of sample preservatives and analyte-free water, sample transport and storage conditions and laboratory processes.

FDACS – Florida Department of Agriculture and Consumer Services.

FDEP – Florida Department of Environmental Protection.

FWM – Flow Weighted Mean: Average concentration computed by multiplying individual concentration data points by corresponding flow data and dividing by the total flow.

Local Sponsor – the agency responsible for matching the Federal funding available for a project. The South Florida Water Management District (SFWMD) is the local sponsor for the majority of CERP projects.

LTL – Long Term Limit: 1991 Settlement Agreement compliance concentration limit for flows into Everglades National Park at Northeast Shark River Slough.

Matrix – refers to the material from which the sample is taken, such as surface water, groundwater, pore water, sediment, soil or air.

MWD – Modified Waters Delivery project, also known as the Project.

Monitoring – all of the activities required to acquire, process, store, retrieve and analyze data used to assess the status of water resources. It includes data collection, data analysis, data validation, and data management.

Monitoring Data – data that are collected for the purpose of determining the effects of CERP projects at a given location.

Monitoring Plan – the plan to acquire additional meteorological, hydrologic, hydraulic, water quality or ecological data. It includes considerations of sampling location, frequency, method, parameters and duration. It is based on the elements identified in the development of data quality objectives for the project.

NESRS – Northeast Shark River Slough, in Everglades National Park.

Objective – a measurable element of the goal(s) of a project or plan. Project objectives and constraints are identified in the Project Management Plan (PMP).

Permit Requirement – certain analytes are sampled, tested and results reported to state and/or federal agencies as a condition of a permit to build or operate a project.

PLMP – Project-Level Monitoring Plan.

Project-level – A project has a defined scope, quality objectives, schedule, and cost. Project-level activities refer to those that are within the scope of a specific project.

QA – Quality Assurance: the system of management activities and quality control procedures implemented to produce and evaluate data according to pre-established data quality objectives.

QAOT – Quality Assurance Oversight Team, comprised of representatives from USACE, SFWMD, FDEP, and USEPA, ultimately responsible oversight of the implementation of the quality system for CERP.

QASR – Quality Assurance System Requirements, the CERP Quality manual that establishes minimum criteria for environmental data quality.

QC – Quality Control: The system of measurement activities used to document and control the quality of data so that it meets the needs of data users as specified by pre-established data quality objectives.

RACU – Remote Acquisition and Command Unit. A device used for data acquisition and remote system control.

RECOVER – REstoration COordination and VERification (RECOVER) is a process that evaluates and assesses CERP performance by linking scientific and technical information throughout the planning and implementation period to ensure that a system-wide perspective is maintained throughout the restoration program.

RECOVER AT - The RECOVER Assessment Team is a standing, interagency, interdisciplinary team of scientists and resource specialists who are responsible for achieving the five primary tasks of RECOVER: 1) create, refine and provide documentation for a set of conceptual ecological models for the total system and a set of attribute-based biological performance measures for the Comprehensive Plan; 3) design and review the system-wide monitoring and data management program needed to support the Comprehensive Plan; 4) use the information coming from the system-wide monitoring program to assess actual system responses as components of the Comprehensive Plan are implemented and produce an annual assessment report describing and interpreting these responses; and 5) coordinate all scientific peer reviews of

RECOVER documents.

RS – Replicate samples defined as two additional samples collected in addition to the routine sample.

Sampling Frequency – how often samples are collected.

Sampling Methods – the methods used to collect samples in the field. The methods should be standard methods, methods based on a standard operating procedure, or a method that has been approved by the participating agencies.

SDCS – South Dade Conveyance System.

SFWMD – South Florida Water Management District

TOC – Technical Oversight Committee: Coordinates the administration of compliance verification of the 1991 Settlement Agreement.

TP – Total Phosphorus

USACE – United States Army Corps of Engineers

USEPA – United States Environmental Protection Agency

USGS – United States Geological Survey

WBS – Work Breakdown Structure: The WBS specifies a hierarchy of tasks and activities necessary to fulfill the objectives of the project. The WBS is structured in levels of work detail, beginning with the deliverable itself, and is then separated into identifiable work elements.

WCA – Water Conservation Area

WRF – Weekly if Recorded Flow: Sampling frequency to collect a sample if flow has occurred in the past week.

Zone of Influence – the area over which a project alters or impacts the environment.

Additional terms and definitions for CERP can be found in CGM 13 – Acronyms and Glossary of Terms (http://www.cerpzone.org/documents/cgm/cgm_013.03.pdf)

C.4.3 Introduction

This document serves as a reference for monitoring water quality and hydrology during the COP. Monitoring will be conducted to evaluate the long-term COP performance with regard to operational constraints, restoration goals and regulatory requirements. Specifically, the COP Water Control Plan makes permanent the previous field test operations which incrementally redistributed flows from WCA-3A into Everglades National Park (ENP) as construction activities progressed and culminated in raising of the L-29 Canal up to the 8.5 feet NGVD maximum operating limit envisioned following completion of the MWD Tamiami Trail roadway modifications. The redistribution of flows into ENP and higher stages should contribute to the restoration of the original hydrologic patterns within the Everglades freshwater wetlands, particularly in Northeast Shark River Slough (NESRS). The COP area of influence is primarily in the area of WCA-3A, ENP, and the L-29 and L-31N Canals.

The incremental approach to the development of the COP was projected to 1) allow interim benefits towards restoration of the natural systems, 2) reduce uncertainty of operating the components of the MWD and C-111 South Dade Projects, and 3) provide information to complete the COP efficiently. The increments included conducting field tests for existing structures, developing operating criteria for existing and planned structures, and ultimately updating the 2012 Water Conservation Areas, ENP, and ENP to South Dade Conveyance System (SDCS) Water Control Plan (hereafter referred to as the 2012 Water Control Plan) (USACE 2012c). Previous regional operational planning efforts—Interim Operational Plan (IOP), Combined Structural and Operational Plan (CSOP) and Everglades Restoration Transition Plan (ERTP)—have also recommended field testing S-356 to aid in determining real-time operational protocols, despite significant hydrologic modeling efforts conducted under each of these projects.

The proposed water quality monitoring plan will provide data to: (1) assess achievement of phosphorus target for S-356 discharges, (2) distinguish water sources for S-356 if possible, (3) quantify water quality interactions associated with the test through detailed analysis of chemical and physical parameters, (4) characterize water quality of the S-328 discharges and perform WQ monitoring required by C-111 SD EO #9 and Permits for the S328. Source attribution and characterization is needed to guide water quality management efforts in the future. Investigation of historic data collected for Na: Ca ratios at S-335, S-356, and G-211 with limited data showed that there can be distinctions in ratios at these structures. Monitoring Na, Ca and other ions, as well as specific conductance at the boundaries of the test area (S-335, S-336 [replaced with L30MILE0 as surrogate], G-211 [replaced with L-31NMILE5 as surrogate], and S-356) should provide additional data for source assessments. Determining sources could prove essential for developing management strategies should achievement of phosphorus targets prove problematic. However, the ability to determine various sources can be very difficult via either ratios or various forms of mass balances. The monitoring plan is designed to provide enough data and supporting information to allow a reasonable chance for successful estimates and future planning.

Quantifying seepage from ENP requires the development of a water budget and chemical mass balance. For chemical mass balance to be successful in quantification of seepage, noticeable differences in the concentration from various sources are needed in the observed values. Concentrations for a full suite of ions (Na, Ca, Mg, K, Cl, SO4, and Total Alkalinity) along with nutrients and specific conductance at selected surface water and groundwater monitoring locations will be used for these purposes. For water budgets

and chemical mass balances, the first 5-miles of L-31N will be divided into five sections with mile markers serving as boundaries. Each section will be treated as an individual mixing cell with inflow and outflow for the north and south boundaries represented by the flows measured at the mile markers. Surface water flow rates will be used to estimate inputs and outputs to each cell for water and chemical budgets if possible. Groundwater volumes will be estimated indirectly from the budget. The water budget will be refined by using the water quality data and chemical mass balances. A similar approach to water budget development will be applied to the L-29 canal, between the S-356 pump station westward to the eastern terminus of the Tamiami Trail Bridge, and in the L-30 Canal between the S-335 and S-356 structures. After the initial testing period, detailed data evaluation will attempt to fulfill the three basic objectives (water budget, mass balance, seepage quantification) and also provide information to modify the monitoring plan for future, longer-term operational periods.

C.4.4 Project Description

The MWD project and the associated COP is primarily intended to increase water deliveries from WCA-3A to ENP through NESRS for the benefit of natural resources. The Increment 2 field test, which started in February 2017 and extends through COP implementation, continued the process of small incremental steps toward achieving that goal by reducing the number of times S-333 discharges are limited by the existing G-3273 stage constraint of 6.8 feet NGVD. G-3273 lies within eastern ENP, directly west of the 8.5 Square Mile Area (8.5 SMA). The G-3273 constraint of 6.8 feet NGVD was originally established as a flood protection measure. Prior to the MWD incremental field tests, a stage of 6.8 feet NGVD at this gage had been used since 1985 as a trigger to cease S-333 discharges from flowing south into NESRS as a protective measure for residential areas to the east, particularly the 8.5 SMA. During the incremental field tests, additional seepage was expected to augment flows in the L-31N canal. To ensure that the existing level of flood protection is maintained in the L-31N basin, the S-356 pump station is operated to return seepage to the L-29 canal where it can flow south into NESRS. To ensure that the existing level of flood mitigation is maintained in the 8.5 SMA, S-357, S-331, and S-357N (pending construction completion) are operated to maintain water control levels as specified within the field test Operational Strategy.

Water deliveries to ENP and NESRS are subject to the water quality limit for total phosphorus (TP) defined in Appendix A of the 1991 Settlement Agreement. Appendix A compliance is currently assessed by comparing the Long Term Limit (LTL) against the 12-month flow-weighted mean (FWM) TP concentration in parts-per-billion (ppb), calculated using the measured total annual flows from the S-12A, S-12B, S-12C, S-12D, and S-333 (S-333 flows expressed as S-333 minus S-334) structures that distribute flows from WCA-3A into Shark River Slough. The LTL equation from Appendix A has an inverse relationship with flow: as flow into Shark River Slough increases, the LTL gradually falls until reaching 7.6 ppb for flow volumes equal or greater than 1,061,000 acre-feet per year. Although the effect of the increment tests is largely to redistribute existing flows, with respect to the Appendix A LTL, Increment 2 operations are expected to continue to result in higher flow volumes through the S-333 structure, lower flow volumes through the S-334 structure, and moderately lower flow volumes through the S-12D structure. In view of known patterns of TP concentrations across inflow structures, it is anticipated that these flow changes are likely to cause some increase in the FWM TP concentration and a decrease in the associated LTL due to increased flow volumes. Given that the FWM TP concentration has been at or just below the LTL for four

of the past seven years prior to the initiation of Increment 1, it is possible that COP operations will increase the risk of exceeding the LTL limit. However the WQ sensitivity runs developed and analyzed for the preferred alternative indicated the risk of exceeding the LTL could be mitigated for using adaptive management. Rainfall patterns are a significant factor in the nutrient concentration of the water deliveries to the SRS. If there is a gradual transition from dry season conditions to wet season condition, upstream marsh areas have more time to recover nutrient uptake capability. If the rainfall pattern similar to WY 2017 occurs (drought conditions followed by record high rainfall early in the wet season), higher concentrations of phosphorus will be routed to the SRS due to the lack of marsh nutrient uptake recovery time.

At present, TP concentrations measured at the S-356 pump station are not included in the Appendix A calculation. However, in light of this, the Technical Oversight Committee (TOC) is evaluating how this structure will be incorporated in future Appendix A calculations. The TOC will also continue to evaluate Appendix A compliance during Increment 2 and after COP is implemented. The SFWMD proposed and FDEP will require a water quality assessment methodology to assess Outstanding Florida Waters compliance as part of the FDEP test authorization requirements. The proposed methodology is expected to require that the S-356 flow-weighted mean total phosphorus (FWM TP) concentration not exceed 11 ppb on an annual basis and the annual FWM TP concentration not exceed 9 ppb on a three-year average basis. For S-356, it is anticipated that the Increment 1.1 and 1.2 testing is likely to show that the FWM TP concentrations through the structure meet the proposed compliance evaluation as part of FDEP test authorization since this flow is largely expected to be composed of seepage water from NESRS and WCA3B. The concentration of seepage water in this portion of the Everglades is generally expected to be less than 9 ppb. Hydrologic and water quality data collected under the Increment 1 and 2 testing will be assessed to discern sources of water pumped by S-356. Water quality results during the first year of testing (Oct 2015 - Oct 2016) indicated a FWM of ~ 6ppb for the S-356 flows.

It is important to note that the ecological monitoring discussed later in this appendix is designed specifically to address the challenges of managing the ecological response of the wetland landscape as it transitions back to a wetter condition with occasional pulses of elevated phosphorus.

Water quality monitoring and analyses during Increment 2 testing was used to help identify potential changes to the operating rules that could increase the probability of water quality compliance for additional flows entering NESRS that would be implemented in the Combined Operations Plan. No concerns with the S-356 flows have been identified at this time from the incremental testing that would indicate any changes to the S-356 operations related to water quality concerns. A water quality assessment has been evaluated at the S-356 pump station in accordance with the FDEP authorization to conduct Increment 2 testing. Concurrently, compliance with the LTL will be determined in accordance with the Settlement Agreement Appendix A requirements on an annual basis during Increment 2 testing. This will continue after the implementation of COP. Per the Settlement Agreement, new sources, such as the S-356, to the SRS must be included in the compliance calculation. The TOC is evaluating how to include the S-356 flows into the compliance calculations and in the interim, SFWMD is reporting compliance with and without S-356 flows. Thus far, no significant difference has been noted between the two methods. Both the water quality assessment of S-356 and the Appendix A compliance calculations are based on the same annual period of October 1st through September 30th. Given that the Increment 2 testing is

currently scheduled to begin in March 2018, the first year of the water quality assessment for Increment 2 test will likely also include nearly 5 months of test conditions collectively under previous operations (October 1, 2017 through February 2018). Because of this, operating plan changes resulting from the S-356 water quality assessment, if needed, would be implemented only after the conclusion of the Increment 2 test period (up to two years). During Increment 2 test operations, the Corps does not plan to impose operational constraints for water quality that could restrict or otherwise limit inflows to NESRS. Indications thus far does not support the need for the Corps to impose operational constraints on the S-346 related for WQ once COP is implemented.

C.4.5 Primary Objectives of Water Quality and Hydrology Monitoring Plan

The objectives of the COP water quality and hydrology monitoring plan were carried forward from the previous field test increments. The first six objectives listed below were originally identified in the Increment 1 monitoring plan, and the seventh objective for S-328 was added for Increment 1.1 and 1.2; the objectives were unchanged for Increment 2. Additional objectives are included in Section C.5 of this monitoring plan for the hydrologic monitoring plan components south of S-331.

1. Characterize surface water quality and volume discharged from the S-356 pump station into Northeast Shark River Slough (NESRS). Evaluate how pumping affects water quality of the surface water flowing into the ENP Shark River Slough.
2. Identify sources of the S-356 pump intake water. Define, to the maximum extent practical, the percentage of groundwater from WCA-3B seepage versus ENP seepage and how these percentages vary with different operations and different stage conditions experienced during the field test.
3. Support water quality compliance determination for Settlement Agreement and OFW compliance at S-356.
4. To determine, to the maximum extent practical, the area of influence of S-356 pump station operations in the Biscayne Aquifer.
5. Ensure existing levels of flood protection are maintained within the northern L-31N Basin (between S-335 and S-331).
6. Ensure existing levels of flood mitigation are maintained within the protected portion of the 8.5 SMA.
7. Evaluate water quality at the S-328 to determine if this structure needs to be included as new inflow point into the Taylor Slough for Settlement Agreement compliance.

Regarding objective #7, the monitoring regime has been developed by ENP/SFWMD/FDEP in support of the SFWMD initiative to increase flows to Taylor Slough and Florida Bay. Concurrence with the monitoring regime has been obtained with these agencies and the Corps, the S-328 operational criteria identified in the Operational Strategy (Appendix A of the draft Supplemental EA) was included within Increment 2. Pending completion of all required reviews, the final monitoring requirements will be detailed in the final EA report. Monitoring and reporting requirements for S-328 are the responsibility of SFWMD.

C.4.6 Active Mandates and Permits

Monitoring of inflows to ENP and park marsh stations is generally governed by the 1992 Consent Decree, the TP Rule (by way of Appendix A), and the 2012 Consent Order. The Increment 2 testing included the establishment of six new monitoring locations; however, in most instances, the pre-existing network of monitoring stations was able to be utilized to demonstrate the effects of Increment 2 on hydrology and water quality as well as compliance with water quality standards. Authorization to implement the COP will be obtained from the FDEP prior to implementation and this monitoring plan is likely to be included in that authorization by reference. The Corps intends to seek this authorization in form of a Coastal Zone Management Consistency (CZM) determination by the State of Florida. If the State of Florida does not provide CZM, the Corps will confirm that the CZM consistency has been met to the maximum extent practical. The individual structures (e.g., S-333 and S-356 etc.) authorizations will be reviewed and changes to each operational authorization will be reviewed and modified through coordination with FDEP if necessary.

C.4.7 Monitoring Components

C.4.7.1 Project Baseline Monitoring

Existing water quality and hydrology data that have been collected by the SFWMD in the L-29, L-30 and L-31N basins over the last 10-15 years (including the three increments of the MWD field test) will serve as the baseline data COP, similar to the approach used during the field tests.

C.4.7.2 Construction Monitoring

Construction of the S-356 structure was completed in 2002. No construction phase monitoring is anticipated for COP.

C.4.7.3 Post-Construction Monitoring (Effectiveness Monitoring)

Based on the water management and data evaluations conducted during Increment 2, the water quality and hydrologic monitoring plan has been reviewed to match the needs of the COP update to the Water Conservation Areas - Everglades National Park - Everglades National Park to South Dade Conveyance System Water Control Plan.

C.4.7.4 Inventory of Existing Monitoring Networks

C.4.7.4.1 Surface Water Hydrology

At flow control structures, surface water hydrology measurements include headwater stage, and tailwater stage, and flow rate. At non-structure monitoring locations, surface water hydrology measurements include stage. Table C.4-1 shows a list of the existing, established hydrologic monitoring locations within the COP area of interest. Real-time monitoring data for these hydrologic monitoring locations will be relied on by USACE, SFWMD, and ENP water managers and the COP Adaptive Management team to evaluate implementation of COP operations relative to the goals, objectives, and constraints, as described

in the COP Water Control Plan; reference maps which show these hydrologic monitoring locations are included in Appendix C (Figure C.4-1 through Figure C.4-5).

Table C.4-1. Gages and sensors for surface water hydrologic monitoring during COP.

Feature	Parameter	Purpose
S-12A	HW, TW, Q	Flow Volume (Tamiami Trail Flow Formula, TTFF)
S-12B	HW, TW, Q	Flow Volume (TTFF)
S-12C	HW, TW, Q	Flow Volume (TTFF)
S-12D	HW, TW, Q, Precipitation	Flow Volume (TTFF)
S-343A	HW, TW, Q	Flow Volume
S-343B	HW, TW, Q	Flow Volume
S-344	HW, TW, Q	Flow Volume
SRS1	Stage	Depth, Duration, Recession
3B-71	Stage	Depth, duration, recession
S-151	HW, TW, Q	Flow Volume (to L-31N/S-356 or Taylor Slough)
S-337	HW, TW, Q	Flow Volume (to L-31N/S-356 or Taylor Slough)
S-335	HW, TW, Q	Flow Volume (to L-31N/S-356 or Taylor Slough)
S-333	HW, TW, Q	Canal Level, Flow Volume (TTFF)
S-334	HW, TW, Q	Canal Level, Flow Volume
S-336	HW, TW, Q	Canal Level, Flow Volume
S-355A	HW, TW, Q	Canal Level, Flow Volume
S-355B	HW, TW, Q	Canal Level, Flow Volume
S-356	HW, TW, Q	Canal Level, Flow Volume
G-3273	Stage	Depth, Duration, Recession
S-357N	HW, Q	Canal Level, Flow Volume
S-357	HW, TW, Q	Canal Level, Flow Volume
S-331	HW, TW, Q, Precipitation	Canal Level, Flow Volume
S-338	HW, TW, Q	Canal Level, Flow Volume
S-332B	HW, TW, Q	Canal Level, Flow Volume
S-332C	HW, TW, Q	Canal Level, Flow Volume
S-194	HW, TW, Q	Canal Level, Flow Volume
S-196	HW, TW, Q	Canal Level, Flow Volume
S-332D	HW, TW, Q	Canal Level, Flow Volume
S-328	HW, TW, Q	Flow Volume
RG4	Stage	Depth, Duration, Recession
NTS18	Stage	Depth, Duration, Recession
S-332DX1	HW, TW, Q	Depth, Duration, Recession, Flow Volume
G-3574	Stage	Depth, Duration, Recession

Feature	Parameter	Purpose
G-3576	Stage	Depth, Duration, Recession
G-3577	Stage	Depth, Duration, Recession
G-3578	Stage	Depth, Duration, Recession
G-3272	Stage	Depth, Duration, Recession
G-596	Stage	Depth, Duration, Recession
G-3626	Stage	Depth, Duration, Recession
G-3627	Stage	Depth, Duration, Recession
G-3628	Stage	Depth, Duration, Recession
G-3437	Stage	Depth, Duration, Recession
Angel's Well	Stage	Depth, Duration, Recession
LPG1	Stage	Depth, Duration, Recession
LPG2	Stage	Depth, Duration, Recession
LPG3	Stage	Depth, Duration, Recession
LPG5	Stage	Depth, Duration, Recession
LPG7	Stage	Depth, Duration, Recession
LPG8	Stage	Depth, Duration, Recession
LPG11	Stage	Depth, Duration, Recession
LPG12	Stage	Depth, Duration, Recession
LPG13	Stage	Depth, Duration, Recession
LPG14	Stage	Depth, Duration, Recession
LPG15	Stage	Depth, Duration, Recession
LPG16	Stage	Depth, Duration, Recession
LPG17	Stage	Depth, Duration, Recession
NE1	Stage	Depth, Duration, Recession
NE2	Stage	Depth, Duration, Recession
NE4	Stage	Depth, Duration, Recession
G-3557	Stage	Depth, Duration, Recession
G-3558	Stage	Determine Duration, Recession Rates
S-177	HW, TW, Q	Canal Level, Flow Volume
S-178	TW, Q	Canal Level, Flow Volume
S-18C	HW, TW, Q, Precipitation	Canal Level, Flow Volume
S-197	Q	Flow Volume
S-357N	Q	Flow Volume
G-613	Stage	Depth, Duration, Recession
G-864A	Stage	Depth, Duration, Recession
G-3336	Stage	Depth, Duration, Recession

Feature	Parameter	Purpose
G-3338	Stage	Depth, Duration, Recession
G-3350	Stage	Depth, Duration, Recession
G-3355	Stage	Depth, Duration, Recession
G-3620	Stage	Depth, Duration, Recession
G-3901	Stage	Depth, Duration, Recession
G-789	Stage	Depth, Duration, Recession
ENP-TSB	Stage	Depth, Duration, Recession
C-358	Stage	Canal Level
G-211	HW, TW, Q	Canal Level, Flow Volume
S-199	HW, TW, Q	Canal Level, Flow Volume
S-200	HW, TW, Q	Canal Level, Flow Volume
NDA1W	Stage	Depth
NDA1E	Stage	Depth
SDA1	Stage	Depth
SDA2	Stage	Depth

Notes: HW– headwater stage; TW– tailwater stage; Q– flow rate

Sensors that measure surface water stage and flow rate usually are located at or near existing structures. Additional flow data at non-structure locations is considered to be critical to preparing a mass balance assessment that will characterize from where the flows at S-356 are sourced along the L-30 and L-31N canals. Surface water flow is measured continuously with acoustic Doppler Velocity Meters (ADVMs) by the USGS at five locations along the L-31N canal (south of L-29 at miles 1, 3, 4, 5, 7). USGS ADVM data are transmitted by telemetry to their National Water Information System (NWIS) where they can be accessed through their web portal at http://waterdata.usgs.gov/fl/nwis/current/?type=flow. Two other existing ADVM stations are located at mile 0 and mile 2 along the L-31N canal. These stations are maintained by the Miami-Dade Limestone Products Association (MDLPA), and data are available on request. The MDLPA ADVM stations may be removed at their discretion.

The USGS has installed two ADVM stations on L-29, at the eastern and western ends of the 1-mile bridge between structures S-333 and S-334.

C.4.7.4.2 Surface Water Quality

Water quality monitoring efforts identified for the L-29 canal, L-30 canal, L-31N canal, and Northeastern Shark River Slough as part of previous increments are retained for the COP. Figure C.4-1 through Figure C.4-5 show the existing surface water monitoring network for WCA-3 and ENP. The monitoring stations shown in these figures are required to demonstrate compliance with the non-Everglades Construction Project Permit (Non-ECP permit), the 1992 Consent Decree (commonly referred to as the "Settlement Agreement"), Emergency Order 9 for C-111 features (intended to be replaced by a ERP or CERPRA permit once COP is completed) and/or the Everglades Forever Act (TP-rule). Figure C.4-1 shows the existing structure monitoring locations in WCA-3A, which is north of the study area. Monitoring at these structure

locations is generally required by the Non-ECP permit. Figure C.4-2 shows the existing structure monitoring locations on the north and eastern boundaries of the ENP, along the L-29 levee (S-12s, S-333, S-334, S-355A/B, S-356) and along the L-31N/C-111 levee canal (S-332s, S-176, S-18C, S-197). Figure C.4-3 shows the existing marsh monitoring locations within WCA-3, and Figure C.4-4 shows the existing marsh monitoring locations within ENP. On these two figures (Figure C.4-3, Figure C.4-4), the monitoring stations identified with a circle are monitored as required in the Total Phosphorus Rule (FAC 62-302.540) and those identified with diamonds are required as part of the Settlement Agreement. Monitoring at TP-Rule sites is limited to Total phosphorus collected on a monthly basis. Monitoring at the Settlement Agreement marsh sites includes temperature, specific conductance, dissolved oxygen (DO), pH, total phosphorus (TP), total dissolved phosphorus (TDP), ortho-phosphorus (OPO4), alkalinity (Alk), calcium (Ca), chloride (Cl), potassium (K), magnesium (Mg), sodium (Na), sulfate (SO4), dissolved silica (SiO2), color, total suspended solids (TSS), total dissolved solids (TDS), dissolved organic carbon (DOC), and turbidity. This monitoring is done on either a monthly or bi-weekly basis. Figure C.4-5 shows existing locations for surface water flow velocity measurements using ADVMs along L-31N canal.

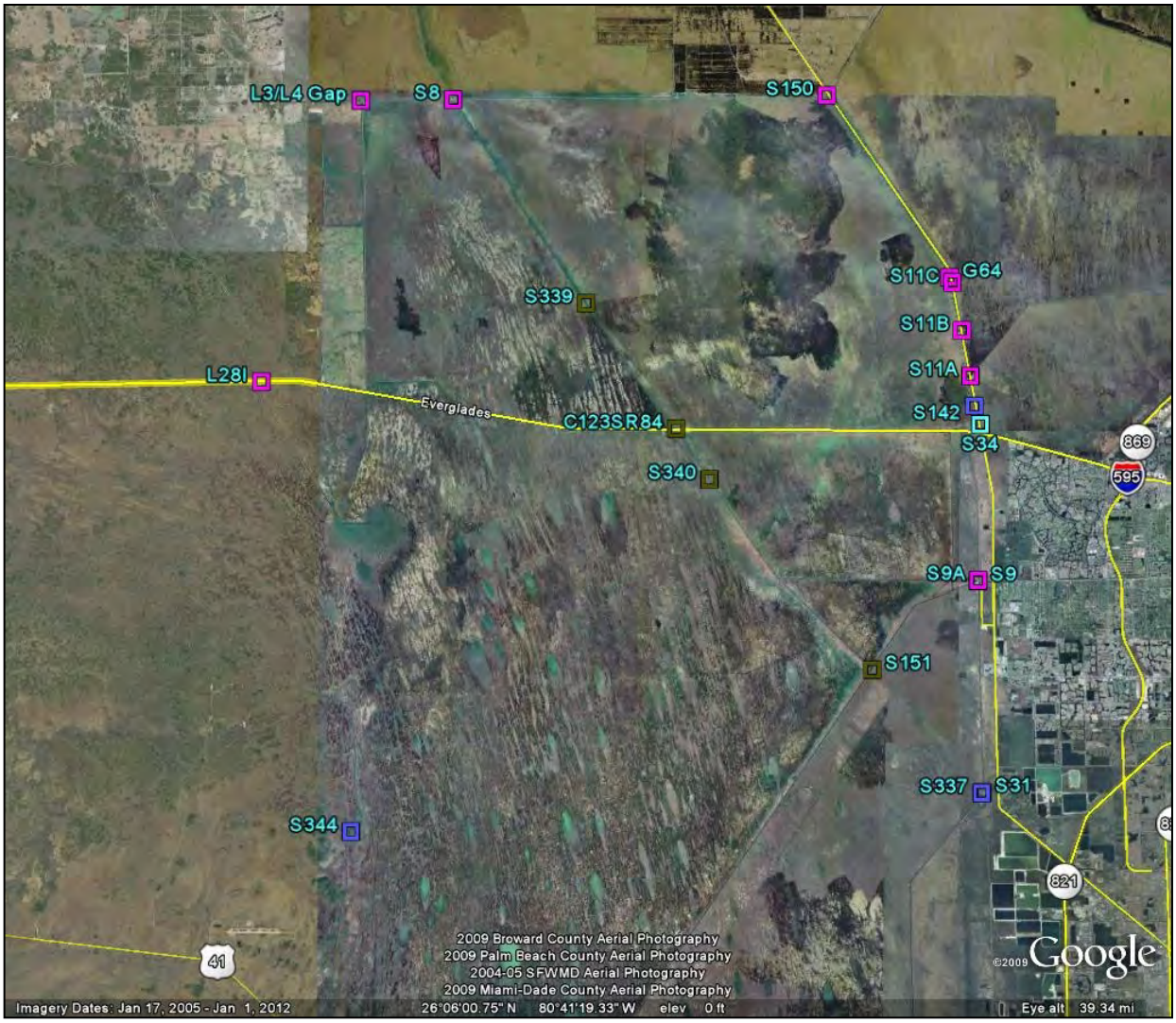


Figure C.4-1. Existing surface water stage and flow monitoring locations at structures in WCA-3A/3B.

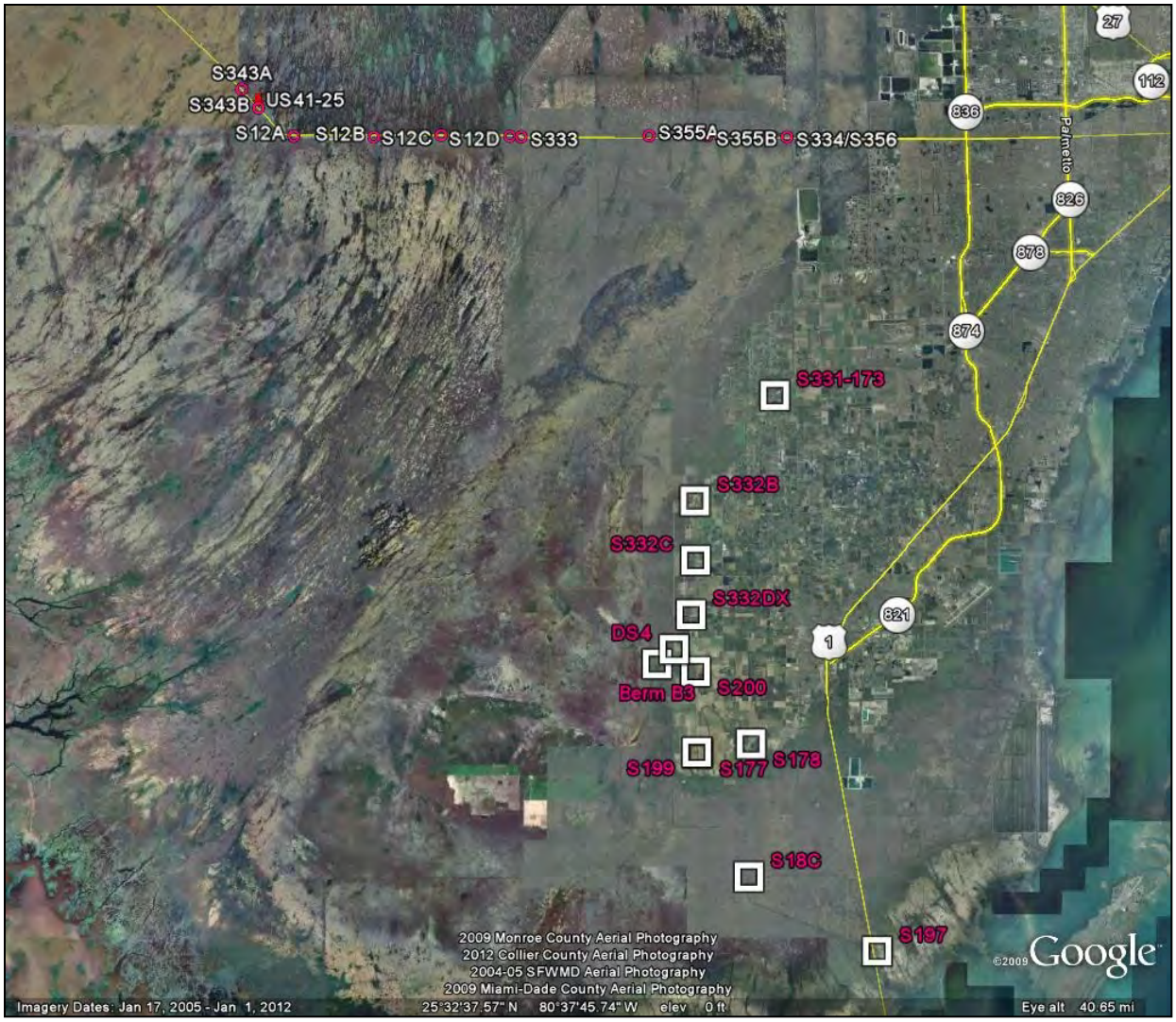


Figure C.4-2. Existing surface water stage and flow monitoring locations at structures along the northern and eastern boundary of ENP.

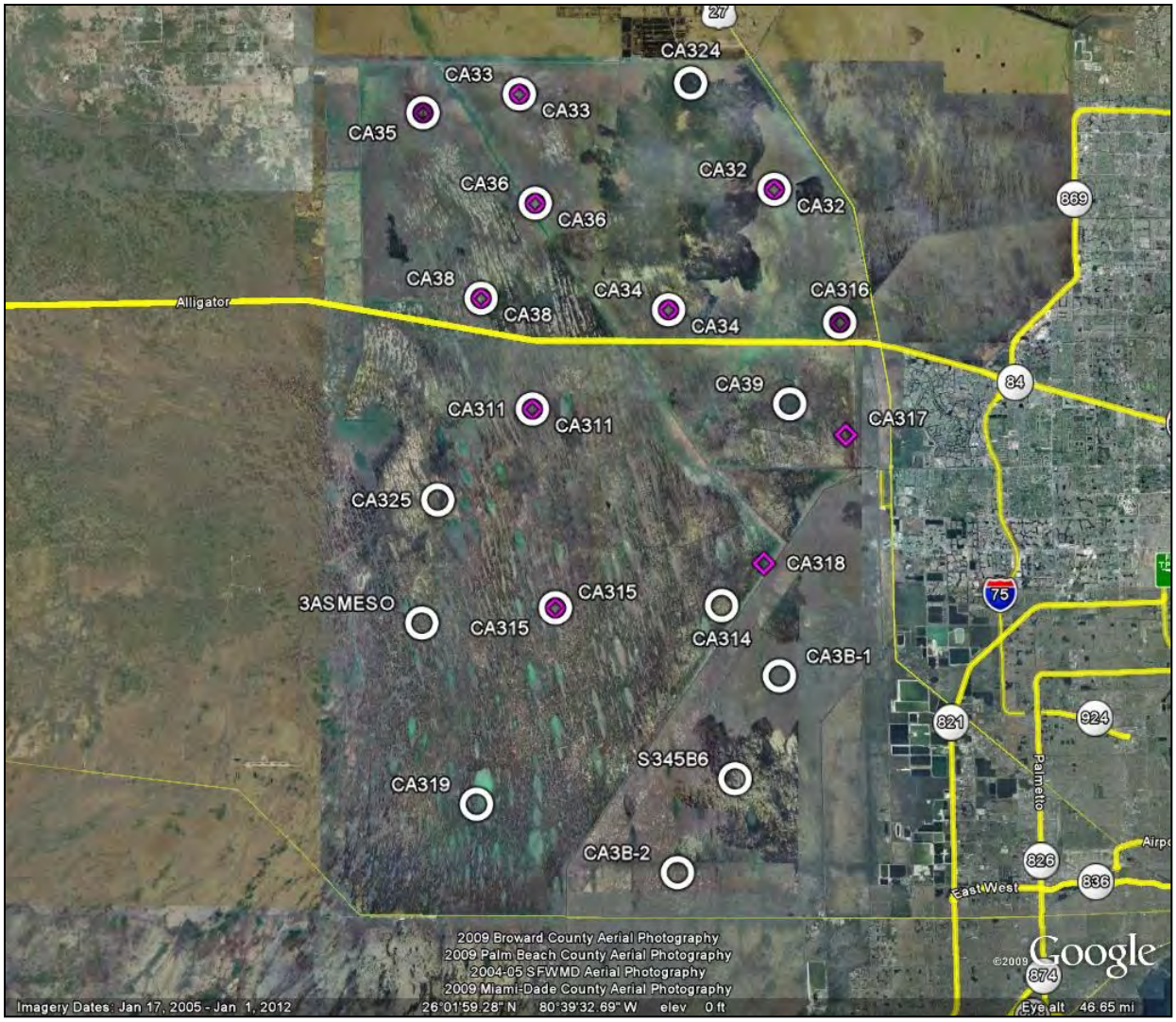


Figure C.4-3. Existing surface water stage monitoring at marsh locations in WCA-3A and WCA-3B. Monitoring stations identified with a circle are monitored as required in the Total Phosphorus Rule (FAC 62-302.540) and those identified with diamonds are required as part of the Settlement Agreement. Monitoring at TP-Rule sites is limited to Total phosphorus collected on a monthly basis. Monitoring at the Settlement Agreement marsh sites includes temperature, specific conductance, dissolved oxygen (DO), pH, total phosphorus (TP), total dissolved phosphorus (TDP), ortho-phosphorus (OPO4), alkalinity (Alk), calcium (Ca), chloride (Cl), potassium (K), magnesium (Mg), sodium (Na), sulfate (SO4), dissolved silica (SiO2), color, total suspended solids (TSS), total dissolved solids (TDS), dissolved organic carbon (DOC), and turbidity. This monitoring is done on either a monthly or bi-weekly basis.

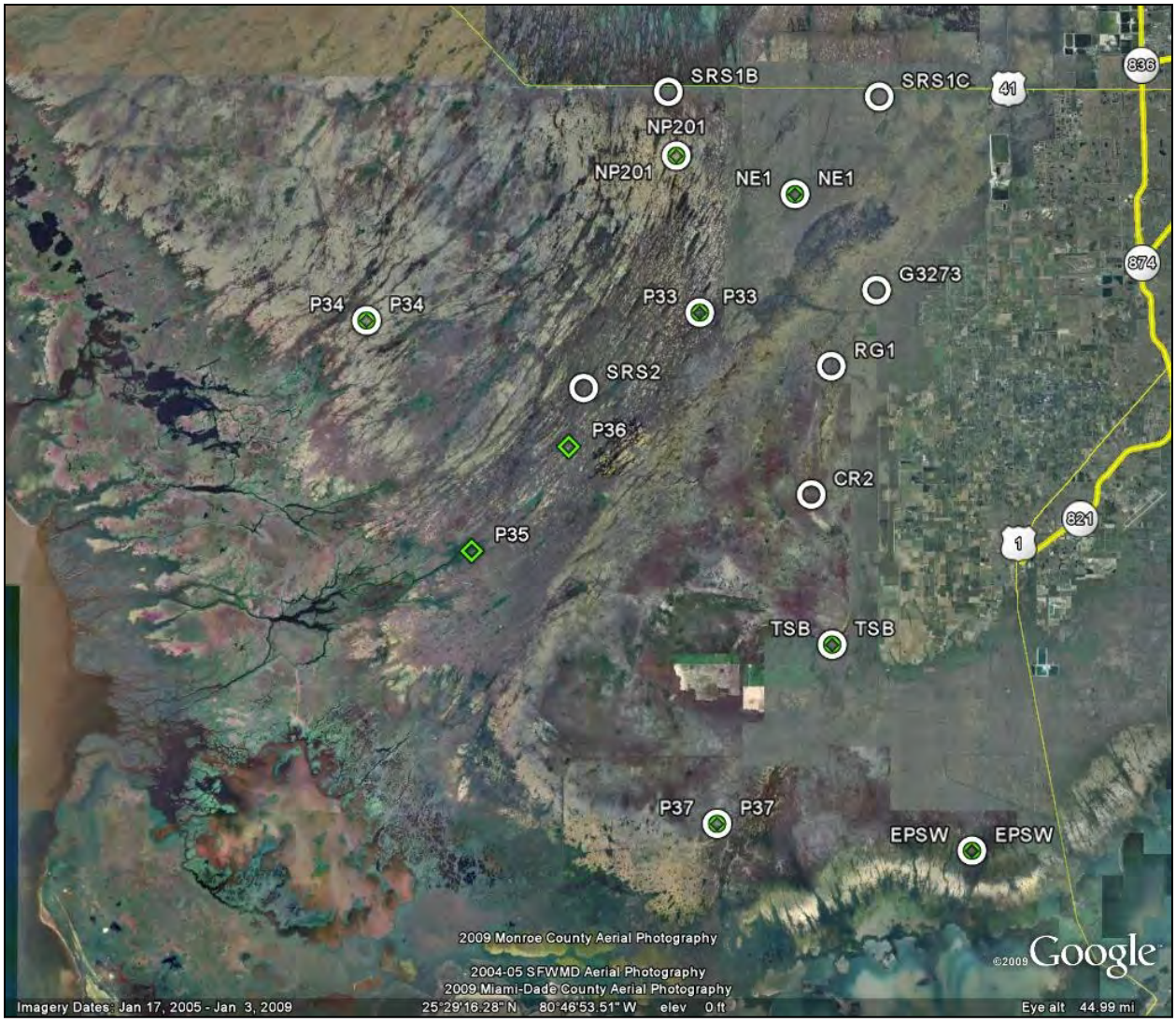


Figure C.4-4. Existing surface water stage monitoring at marsh locations in ENP. Monitoring stations identified with a circle are monitored as required in the Total Phosphorus Rule (FAC 62-302.540) and those identified with diamonds are required as part of the Settlement Agreement. Monitoring at TP-Rule sites is limited to Total phosphorus collected on a monthly basis. Monitoring at the Settlement Agreement marsh sites includes temperature, specific conductance, dissolved oxygen (DO), pH, total phosphorus (TP), total dissolved phosphorus (TDP), ortho-phosphorus (OPO4), alkalinity (Alk), calcium (Ca), chloride (Cl), potassium (K), magnesium (Mg), sodium (Na), sulfate (SO4), dissolved silica (SiO2), color, total suspended solids (TSS), total dissolved solids (TDS), dissolved organic carbon (DOC), and turbidity. This monitoring is done on either a monthly or bi-weekly basis.

Figure C.4-5. Existing surface water flow velocity monitoring along L-29 and L-31N with ADVMS.

C.4.7.4.3 Groundwater Hydrology

Several State and Federal agencies have constructed groundwater monitoring wells along Tamiami Trail in WCA-3B and adjacent to ENP. Monitoring wells were constructed for different projects during the last two decades. This proposed groundwater monitoring plan will coordinate data acquisition from all wells shown in Figure C.4-6. The result is a comprehensive groundwater monitoring network that will provide detailed data to evaluate effects of S-356 pump station operation. Table C.4-2 lists monitoring wells and clusters by location, and the types of data that are measured at each well. All wells listed in Table C.4-2 were evaluated during the first few months of the Increment 1 test. Hydrologic responses to S-356 pumping stresses in surrounding monitoring wells will be reviewed in context of seasonal water level changes and other distal pumping stresses (mining operations or MDWSD northwest wellfield) before deletion from the monitoring program. Those wells that show no response to S-356 operation will be deleted from the groundwater monitoring program. It is likely that the only monitoring wells to be deleted will be those located several miles away from the S-356 (for example, in Pennsuco wetlands or the Miami-Dade northwest wellfield). Monitoring wells located along L-29, L-30, L-31N, WCA-3B and NESRS will be retained throughout the study.

Hydrologic conditions in WCA-3B and the NESRS are controlled by interactions between surface water and groundwater of the Biscayne Aquifer. To evaluate these interactions and their effects on regional flows between WCA-3B and NESRS, a groundwater monitoring program is proposed using existing instrumented wells. Instrumented monitoring wells are located mostly north and south of Tamiami Trail near or on the L-30 and L-31N levees, and on tree islands in southeast WCA-3B (Figure C.4-6[1]). The L-30 and L-31N monitoring wells are instrumented with vented pressure transducers that measure groundwater levels. Groundwater levels are measured every 15 minutes, and data are transmitted through a SCADA system to an off-site receiver or are downloaded manually at monthly frequency. Groundwater level data are evaluated by a Contractor for quality control, then packaged and delivered monthly in spreadsheets. Groundwater monitoring locations can be grouped according to sampling objective, and these groups are shown on Figure C.4-6.

Groundwater level data at monitoring locations in WCA-3B and along L-30 (Figure C.4-6[1]) will characterize seepage in upgradient and background positions, and also will define the S-356 zone of influence north of the pump station. Groundwater level data obtained in northern NESRS and along the northern and southern portions of L-31N (Figure C.4-6[2] and Figure C.4-6[4], respectively) will characterize seepage in downgradient positions, and also will define the S-356 zone of influence south of the pump station. Hydrologic effects of the MDLPA seepage barrier along L-31N also will be evaluated from these data. Groundwater level data obtained near the Miami-Dade Water and Sewer Department (MDWSD) northwest wellfield (Figure C.4-6[3]) will characterize water level responses to pumping stresses at that facility.

Local to sub-regional pumping stresses are known to perturb groundwater flow direction and level in the study area. Examples of pumping stresses include the MDWSD northwest wellfield (Sonenshein and Hofstetter, 1990; Krupa et al., 2001), Lake Belt mining operations (Figure C.4-6[3]), and S-7 Pump Station operations (Krupa and Hill, 2002). Groundwater level, and flow rate and direction changes were observed at the onset of pumping at the MDWSD northwest wellfield, currently permitted at 90 million gallons per day (MGD; equal to 139 cfs). However, these effects were limited to regions east of the Dade-Broward levee, and drawdown of groundwater did not impinge on the L-30 Canal or ENP (Sonenshein and Hofstetter, 1990; Krupa et al., 2001). Operation of pump station S-7 (2,490 cfs; Broward and Palm Beach Counties) showed perturbations to groundwater flow and also surface water quality. Operational testing at the S-7 pumping station showed significant mixing of ground and surface water in the headwater side of the pump station, and significant seepage when head and tailwater elevations differed more than 3 feet. High head differences between head and tailwater can drive seepage of anoxic, higher specific conductance groundwater into the tailwater pool. The hydrogeologic setting of the S-7 pumping station differs from that of S-356 and has five times its pumping capacity. Water-quality changes observed at S-7 are not directly applicable to the field test proposed in this document. The existing 2015-2019 groundwater quality dataset will be interpreted in the context of concurrent S-356 pump station operation in order to detect any groundwater quality changes.

Figure C.4-6. Existing groundwater monitoring wells in the project area. Left, base map showing all well locations. Right, four inset maps: 1) instrumented monitoring wells along L30 and WCA-3B (Tree Island wells); 2) Approximately 1 mile south of Tamiami Trail, along L-31N between ENP and the L-31N Canal; 3) East of L30 proximal to the Miami-Dade Water and Sewer Department Northwest Well Field; 4) Approximately 4 miles south of Tamiami Trail, along L-31N between ENP and the L-31N canal.

Table C.4-2. Hydrologic characteristics measured in existing monitoring wells.

Well	Location	Open Interval (feet NGVD29) from land-surface elevation	Casing Con-struc-tion	Real-time GW Level	Specific Conduc-tance	Tem-pera-ture	Access Data (real-time or near-time) and comments
G-3778	L-31NN cluster (L-31NN-GW1) 1 mi S of TT	-85.7 to -87.7	PVC	Yes	No	No	dbhydro search for site name "L-31NN"
G-3779	L-31NN cluster (L-31NN-GW2) 1 mi S of TT	-36.5 to -38.5	PVC	Yes	No	No	dbhydro search for site name "L-31NN"
G-3780	L-31NN cluster (L-31NN-GW3) 1 mi S of TT	-15.7 to -17.7	PVC	Yes	No	No	dbhydro search for site name "L-31NN"
G-3781	L-31NN cluster (L-31NN-GW4) 1 mi S of TT	-0.6 to -2.6	PVC	Yes	No	No	dbhydro search for site name "L-31NN"
G-3784	L-31NS cluster (L-31NSGW1) 4 mi S of TT	-83.1 to -85.1	PVC	Yes	No	No	dbhydro search for sitename "L-31NS"
G-3785	L-31NS cluster (L-31NSGW2) 4 mi S of TT	-27.2 to -29.2	PVC	Yes	No	No	dbhydro search for sitename "L-31NS"
G-3786	L-31NS cluster (L-31NSGW3) 4 mi S of TT	-11.1 to -13.1	PVC	Yes	No	No	dbhydro search for sitename "L-31NS"
S-356-GW1	Well cluster at S-356 pump station	-40.24 to -42.24	PVC	Yes	No	No	Dbhydro search for sitename “S-356%”
S-356-GW2	Well cluster at S-356 pump station	-33.75 to -35.75	PVC	Yes	No	No	Dbhydro search for sitename “S-356%”
S-356-GW3	Well cluster at S-356 pump station	-9.75 to -11.75	PVC	Yes	No	No	Dbhydro search for sitename “S-356%”
S-356-GW4	Well cluster at S-356 pump station	+2.25 to +4.25	PVC	Yes	No	No	Dbhydro search for sitename “S-356%”

Well	Location	Open Interval (feet NGVD29) from land-surface elevation	Casing Con-struc-tion	Real-time GW Level	Specific Conduc-tance	Tem-pera-ture	Access Data (real-time or near-time) and comments
G-3787	L-31NS cluster (L-31NSGW4) 4 mi S of TT	-1.5 to -3.5	PVC	Yes	No	No	dbhydro search for sitename "L-31NS"
3BS1-GW1	Dual zone monitor well in WCA-3B tree island north of TT	upper: -8.77 to -9.77 lower: -27.00 to -29.00	PVC	Yes in both interv als	No	Yes in both interv als	dbhydro search for site name "3BS%"
3BS1-GW2	Dual zone monitor well in WCA-3B tree island north of TT	upper: -7.14 to -8.14 lower: -22.76 to -24.76	PVC	Yes in both interv als	No	Yes in both interv als	dbhydro search for site name "3BS%"
3BS1-GW3	Dual zone monitor well in WCA-3B tree island north of TT	upper: -8.35 to -9.35 lower: -20.72 to -22.72	PVC	Yes in both interv als	No	Yes in both interv als	dbhydro search for site name "3BS%"
3BS1-GW4	Dual zone monitor well in WCA-3B tree island north of TT	upper: -3.18 to -4.18 lower: -22.56 to -24.56	PVC	Yes in both interv als	No	Yes in both interv als	dbhydro search for site name "3BS%"
G-1488	Krome Ave. 3.9 mi. north of TT Latitude 25°49'06.7", Longitude 80°28'56.4"	Maximum depth -12.57	PVC	Yes	No	No	http://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=254830080284201 and Dbhydro
G-3253	At MDWASD North Wellfield Latitude 25°50'29.0", Longitude 80°24'58.4"	Maximum depth -29.21	PVC	Yes	No	No	http://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=255027080245501 and DBHydro
G-3273	ENP: latitude 25°37'49.381", longitude -80°34'33.21"	Maximum depth -8.23	PVC	Yes	No	No	http://www.sfwmd.gov/dbhydroplsql/show_wilma_info.report_process?v_output_format=sum

Well	Location	Open Interval (feet NGVD29) from land-surface elevation	Casing Con-struc-tion	Real-time GW Level	Specific Conduc-tance	Tem-pera-ture	Access Data (real-time or near-time) and comments
							mary&v_os_code=win&v_station=G-3273
G-3259A	At MDWASD North Wellfield Latitude 25°50'27.0", Longitude 80°24'09.6"	Maximum depth -54.9	PVC	Yes	No	No	http://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=255027080245501 and DBHydro
G-3551	4.2 miles S of TT and 100-ft west of L-31N canal	-6.7 to -11.7	PVC	Yes	No	No	http://waterdata.usgs.gov/fl/nwis/uv/?site_no=254158080294501&PARAmeter_cd=72020,62611 and Dbhydro
G-3553	0.38 mi. E of Krome Ave., 0.11 mi. S SW 72nd St. Latitude 25°41'53.3", Longitude 80°28'21.6"	Maximum depth -13.7	PVC	Yes	No	No	http://waterdata.usgs.gov/fl/nwis/nwismap/?site_no=254152080282101&agency_cd=USGS and DBHydro
G-3557	ENP: 5.2 miles S of TT, and 100-ft west of L-31N Canal	-7.9 to -12.9	PVC	Yes	No	No	http://waterdata.usgs.gov/fl/nwis/uv/?site_no=254112080294201&PARAmeter_cd=72020,62611 and DBHydro
G-3558	NE corner of FP&L service road next to Bird Dr. extension canal and SW 177th Ave/Krome Ave	-5.67 to -10.67	PVC	Yes	No	No	http://waterdata.usgs.gov/fl/nwis/uv/?site_no=254334080284401&PARAmeter_cd=72020,62611 and DBHydro
G-3559	ENP: 1 mile S of TT and 100-ft west of L-31N Canal	-5.9 to -10.9	PVC	Yes	No	No	http://waterdata.usgs.gov/fl/nwis/uv/?site_no=254445080295001&PARAmeter_cd=72020,62611 and DBHydro

Well	Location	Open Interval (feet NGVD29) from land-surface elevation	Casing Con-struc-tion	Real-time GW Level	Specific Conduc-tance	Tem-pera-ture	Access Data (real-time or near-time) and comments
G-3575	ENP: 4.07 mi S of TT on the S side of levee at L-31N Canal	-3.8 to -3.8 ft open end well	PVC	Yes	No	No	http://waterdata.usgs.gov/fl/nwis/uv/?site_no=254207080300201&PARAmeter_cd=72020,62611 and DBHydro
G-3576	ENP: 1.1 mi south of TT and 1.03 mi west of levee on west side of L-31N Canal.	-3.6 to -3.6 ft open-end well	PVC	Yes	No	No	http://waterdata.usgs.gov/fl/nwis/uv/?site_no=254442080305201&PARAmeter_cd=72020,62611 and DBHydro
G-3574	ENP: 1.06 mi. S of TT on L-31N levee	Stilling well - 0.6 ft	PVC	Yes	No	No	http://waterdata.usgs.gov/fl/nwis/uv/?site_no=254446080295501&PARAmeter_cd=72020,62611 and DBHydro
G-3575	ENP: 4.07 mi S of TT on the S side of levee at L-31N Canal	-3.8 to -3.8 ft open end well/piezometer	PVC	Yes	No	No	http://waterdata.usgs.gov/fl/nwis/uv/?site_no=254207080300201&PARAmeter_cd=72020,62611 and DBHydro
G-3576	ENP: 1.1 mi south of TT and 1.03 mi west of levee on west side of L-31N Canal.	-3.6 to -3.6 ft (possibly an open-end well/piezometer)	PVC	Yes	No	No	http://waterdata.usgs.gov/fl/nwis/uv/?site_no=254442080305201&PARAmeter_cd=72020,62611 and DBHydro
G-3577	ENP: 4.08 mi S of TT and 0.24 mi. W of levee on the W side of L-31N canal.	-2.0 to -2.0 ft (possibly an open-end well/piezometer)	PVC	Yes	No	No	http://waterdata.usgs.gov/fl/nwis/uv/?site_no=254207080300201&PARAmeter_cd=72020,62611 and DBHydro
G-3578	ENP: 4.02 mi south of TT and 1.01 mi. W of levee on west side of L-31N Canal	0 to 0 ft (possibly an open-end well/piezometer)	PVC	Yes	No	No	http://waterdata.usgs.gov/fl/nwis/uv/?site_no=254210080304801&PARAmeter_cd=72020,62611 and DBHydro

Well	Location	Open Interval (feet NGVD29) from land-surface elevation	Casing Con-struc-tion	Real-time GW Level	Specific Conduc-tance	Tem-pera-ture	Access Data (real-time or near-time) and comments
G-3676	At Rinker Materials Mine, approx. 2 mi N of TT, 3.7 mi E of Krome Ave.	Maximum depth -22.4	PVC	Yes	No	No	http://sofia.usgs.gov/eden/station.php?stn_name=G-3676
G-3761	1 mi. W of MDWASD NW Wellfield at NW 74th St. Latitude 25°50'30.1", Longitude 80°26'00.7"	Maximum depth -11.3	PVC	Yes	No	No	http://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=255035080255402
G-3818	Latitude 25°50'36.8", Longitude 80°27'04.3" 2.25 mi. due W of G3253/MDWASD NW well field, 5.3 mi N of TT in Pennsuco wetlands	Maximum depth -14.9	PVC	Yes	No	No	http://waterdata.usgs.gov/fl/nwis/nwismap/?site_no=255036080270501&agency_cd=USGS
G-3898	Latitude 25°41'52.82", Longitude 80°28'25.68" 0.17 mi. W of intersection of SW 72nd St. & SW 172nd Ave.	Maximum depth -15.8	PVC	Yes	No	No	http://waterdata.usgs.gov/nwis/nwismap/?site_no=254152080282601&agency_cd=USGS
G-618	Latitude 25°45'39.2", Longitude 80°34'37.8", south side of TT next to Coopertown Airboat Ride, 6.3	Maximum depth -12.6	PVC	Yes	No	No	http://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=254500080360001

Well	Location	Open Interval (feet NGVD29) from land-surface elevation	Casing Con-struc-tion	Real-time GW Level	Specific Conduc-tance	Tem-pera-ture	Access Data (real-time or near-time) and comments
	mi W of Krome Ave.						
G-3576	ENP: 1.1 mi south of TT and 1.03 mi west of levee on west side of L-31N Canal.	-3.6 to -3.6 ft open-end well	PVC	Yes	No	No	http://waterdata.usgs.gov/fl/nwis/uv/?site_no=254442080305201&PARAmeter_cd=72020,62611 and DBHydro

In July 2012, the MDLPA completed construction of a 2-mile long seepage barrier along the northern terminus of the L-31N levee, south of Tamiami Trail. In April 2016, the MDLPA completed construction of a 3-mile long extension (5-mile total length) to the seepage barrier along the northern portion of the L-31N levee, south of Tamiami Trail. The seepage barrier is composed of cement-bentonite slurry that is pumped into a pre-excavated trench. The dimensions of the seepage barrier are: 5-miles long, 32-inches wide, and 35-feet deep below land surface (to approximately -30 feet NGVD29). The primary objective of this seepage barrier is to reduce groundwater flow rate eastward out of NESRS. This objective is currently under evaluation by the USACE in support of implementation of the Central Everglades Planning Project (CEPP) under the Comprehensive Everglades Restoration Plan (CERP).

C.4.7.4.4 Groundwater Quality

Biscayne Aquifer water quality has moderate carbonate alkalinity, low chloride, sulfate and total phosphorus concentrations, and low specific conductance values (Figure C.4-7). Precipitation percolates through the peats and limestones in the recharge areas of western Miami-Dade County, dissolving mineral constituents as groundwater flows to the east and southeast toward the coast. Monthly and quarterly groundwater quality data were obtained from July 2015 through September 2017 as part of the Increment 1 monitoring effort. Commencing in November 2017, the groundwater monitoring program was revised under Increment 2. Revisions to the groundwater monitoring program are listed in subsection C.4.8.4.1.

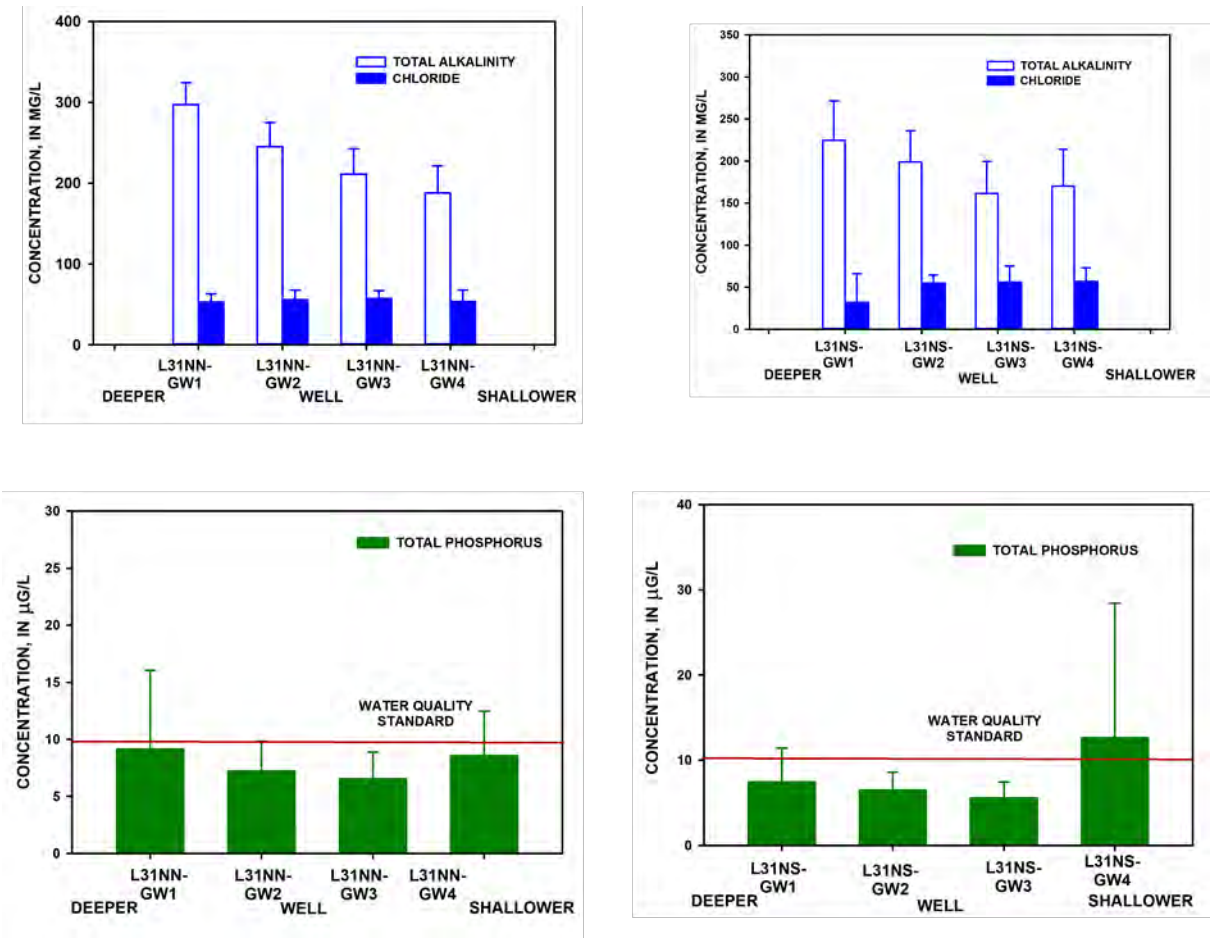


Figure C.4-7. Bar diagrams showing selected groundwater quality data at different depths from Biscayne Aquifer monitoring well clusters L-31NN and L-31NS.

C.4.7.5 Integration of Monitoring Components

New monitoring stations (refer to Section C.4.7) proposed as part of this project were selected based upon a review of the ongoing monitoring and the expected compliance requirements associated with the planned project features. Staff from SFWMD, USACE, DOI, and FDEP worked together to ensure that the new monitoring stations were consistent with the permit requirements and not duplicative of ongoing monitoring at existing stations.

C.4.8 Duration

This monitoring program is expected to be conducted during the Increment 2 testing period, which commenced in February 2018 and was completed in May 2019. At the completion of Increment 2 testing, a portion of the additional monitoring proposed in this plan may be carried forward to COP or other operating conditions that may follow.

C.4.8.1 Modification or Termination Conditions

Modification of the water quality monitoring plan will be determined annually by the needs of the project, and the water quality monitoring plan will be completely reassessed after the Increment 2 test is complete. At this time the WQ subteam anticipates no changes are necessary to the existing surface WQ monitoring in the project area. This plan will be changed to reflect any future design changes (new discharge structures into the L-29 canal, etc.) or permit requirements. It also may be terminated according to permit expiration dates. Decisions to adjust the monitoring plan will be coordinated through the project partners as well as the FDEP.

Monitoring plans for previous increments were developed assuming that major, ongoing monitoring programs that were not previously funded directly by the Project would continue to collect data relevant to the Project. Should any of these programs be discontinued or significantly curtailed, then the Federal and local sponsors of the COP Project will reevaluate monitoring priorities.

C.4.9 Monitoring/Sampling Locations and Naming Convention

A description of new monitoring or modifications to existing monitoring is provided below. Costs associated with the proposed monitoring are not provided in this document.

C.4.9.1 Surface Water Hydrology

C.4.9.1.1 Flow Measurements along L-29 and L-31N

Flow velocity measurements are critical to quantify westward flows that result from pump station operation. Currently, flow velocity measurements are made periodically along the reach of L-29 between structures S-333 and S-334. The bi-weekly USGS flow data collection effort will be coordinated with the water quality sampling schedule.

C.4.9.1.2 L-29 Canal Morphology

Following the prolonged use of S-356 Pump Station, stream channel morphology will be monitored in the L-29 Canal immediately downstream of the structure during the test for possible scouring. Monitoring for potential scour effects is an appropriate precaution since the structure discharge pipes are not submerged. Channel condition will be documented by photographs and field measurements before test initiation. If channel morphology changes during the field test, these features will be documented as appropriate. Stream channel morphology is defined at five surveyed cross-sections located downstream (west) of the S-356 pump station, between the outflow and the 1-mile Tamiami Trail Bridge (Figure C.4-8).

The USGS measured four transects at increasing distance from the tailwater of the S-356 pump station test in October 2015, prior to the initiation of Increment 1. These cross-sections will define baseline channel morphology. A second series of cross-sections was measured in July 2019 after prolonged operation of the S-356 pump station. A USGS report comparing the two sets of cross-sections will be delivered in early 2020.

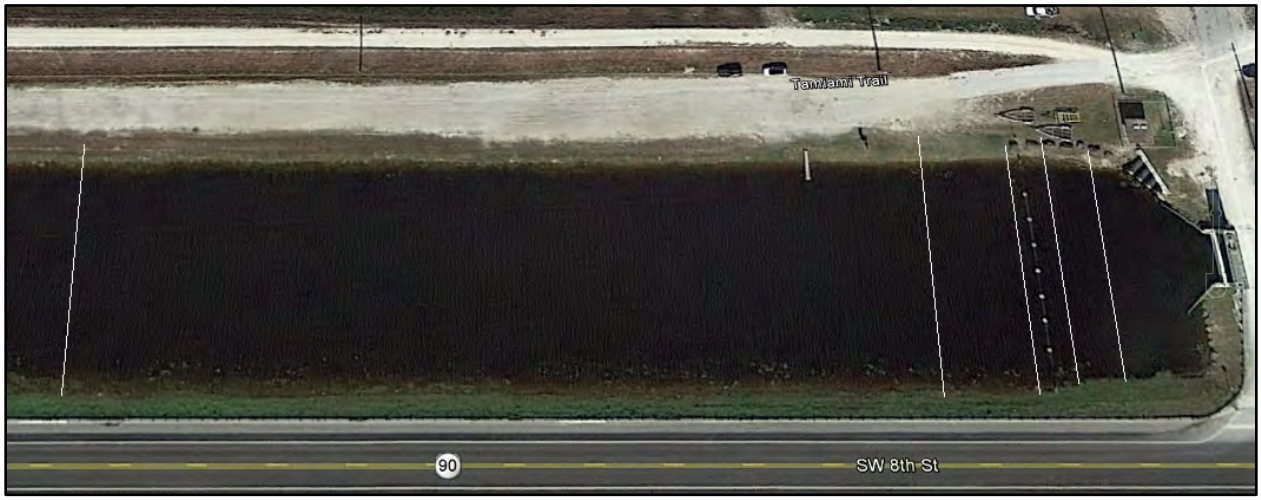


Figure C.4-8. Cross-section locations in the L-29 canal tailwater of the S-356 pump station.

Increment 2 allowed for temporary raising the maximum operating limit for the L-29 Canal, which runs parallel to the Tamiami Trail, up to 8.5 feet NGVD. In order to ensure no road damage is caused due to extended periods of high water stages, based on coordination with the Florida Department of Transportation (FDOT) concurrent with the development of the Increment 2 Operational Strategy, USACE coordinated with the Department of the Interior (DOI) to install six pressure transducers in four transects along the Tamiami Trail to monitor the effects of the increased L-29 water levels on the roadway (Figure C.4-9). Piezometers, soil moisture sensors, and surface water stage recorders were installed at specified locations along Tamiami Trail between S-333 and S-334 Spillways. The piezometers and soil moisture sensors were installed along FDOT right-of-way along the Tamiami Trail. Installation of the additional roadway monitoring was completed in November 2018. Phase 2 of the DOI Tamiami Trail Next Steps' (TTNS) project recommended 5.5 miles of additional bridging and roadway reconstruction for the remaining un-bridged portions of the eastern Tamiami Trail roadway between S-333 and S-334. DOI is currently proceeding with the engineering design efforts, with a construction contract award planned for late in 2020. The TTNS Phase 2 roadway modifications will adhere to FDOT roadway design standards for a design high water condition of 9.7 feet NGVD in the L-29 Canal. After completion of the TTNS Phase 2 roadway modifications, the piezometer and soil moisture information is no longer needed, and the USACE will continue to coordinate with FDOT through the Increment 2 field test and COP to ensure roadway concerns are effectively managed leading up to the roadway reconstruction, or the FDOT roadway constraints for COP may be removed earlier if demonstrated through the evaluation of the monitoring information.

Figure C.4-9. Transect locations for piezometer installation along the Tamiami Trail.

C.4.9.2 Surface Water Quality Monitoring Plan

There is an extensive and robust surface water quality monitoring program currently in place with sampling routinely conducted for all relevant parameters at all key structures in the C&SF water management system. No additional surface water quality monitoring was added for the MWD incremental field test. Current surface water quality monitoring is focused toward meeting permit and other mandate requirements, as well as providing information for water management, infrastructure management and environmental restoration. Monitoring mandates include the Everglades Settlement Agreement/Consent Decree (1995), the Total Phosphorus Rule, the Non-Everglades Construction Project (NECP) Permit, and the Canal-111 Emergency Order #9 (Exhibit B of Executive Order (E.O.) 9). Monitoring required by the aforementioned mandates is described in the South Florida Water Management District's (SFWMD) monitoring projects: Conservation Area Materials Budget, Park Inflows North, Park Inflows East, Everglades Protection Area, Phosphorus Source Control Project, and NECP. Figure C.4-10 shows physical locations of these stations. Table C.4-3 lists the sample monitoring locations in the vicinity of L-29 and L-31N. The table includes information on the parameters of interest, frequency of sampling, and entity conducting the efforts. The color coding in this table indicates whether the station is a currently active monitoring station, if it is a new station, new parameters added to existing stations, and responsible parties. For several of the existing monitoring stations, the parameter list was amended to include additional analytes necessary to meet the plan objectives.

C.4.9.2.1 Surface Water Quality Monitoring Stations

The justifications for the new monitoring stations are described in terms of how they contribute to the three monitoring plan objectives.

Objective 1: S-356 Surface Water Flow and Quality

<u>S-356:</u> To characterize the quality and volume of flow discharged at the S-356 pump station, weekly surface water quality grab sampling combined with an ADT autosampler for time-dependent TP monitoring will be conducted at the S-356 structure. The weekly TP grab sample data will be used to evaluate compliance with the DEP permit conditions and the autosampler TP data will be used in

evaluating the daily variability in water quality which will be useful in determining if factors such as pumping rate or headwater stage affect TP concentrations.

L29C1 (formerly TAMBR1), L29C4 (formerly TAMBR4), NE0: Water in the L-29 canal between the S-334 structure and S-333 is characterized by existing monitoring conducted at the Safari, Glader, Coopertown, and S-355A/B stations shown in Figure C.4-10. All of these existing stations are located at least 3 miles west of the S-356 pump. To characterize the quality of water that enters NESRS in close proximity to the S-356 pump, two new L-29 monitoring locations are proposed (TAMBR1 and TAMBR4). The proposed TAMBR1 station is at the US Highway 41 culvert located 500 meters west of the S-334 structure. This location will be used to characterize flows entering NESRS at this culvert.

The newly proposed NE0 monitoring station, located 500 meters south of L-29 in ENP, will be used to characterize the impact of flows through the TAMBR1 culvert as this water enters ENP. The TAMBR4 monitoring station will be located at the western end of the 1-mile bridge and will fill the gap between TAMBR1 and S-355B monitoring locations.

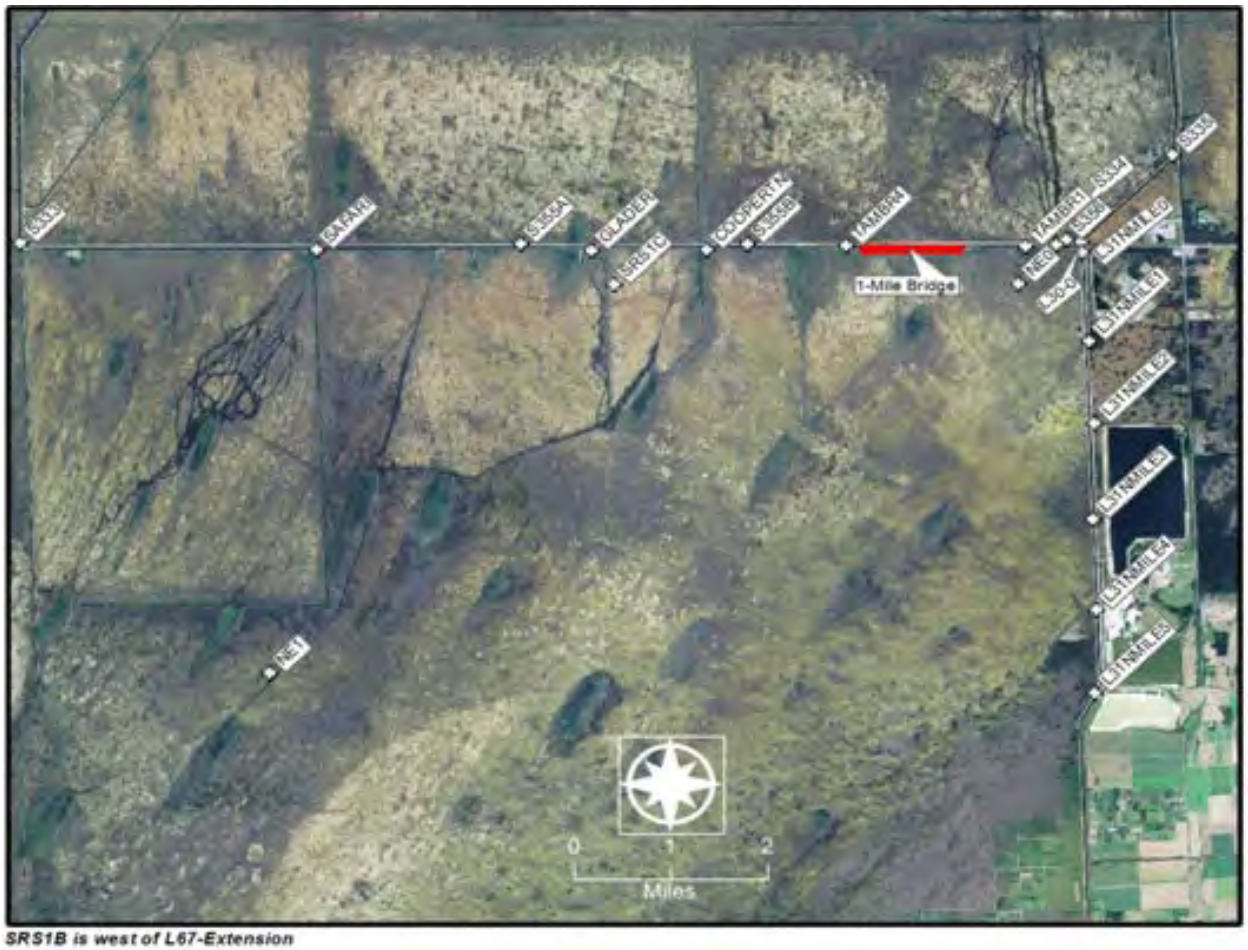
Objective 2: Sources of S-356 Flows

L-31NMile0, L-31NMile1, L-31NMile2, L-31NMile3, L-31NMile4, and L-31NMile5: Water pumped at S-356 will potentially be sourced from L-30 flows, groundwater in the vicinity of the pump, seepage from WCA-3B into L-30 canal, and seepage from ENP into the L-31N canal. The existing surface water quality monitoring network will be augmented to include two new stations (L-31NMile0 and L-30Mile0 (surrogate for S-336)) at the confluence of the C4, with the L-31N and L-30 canals, respectively and along the L-31N canal (L-31NMile1, L-31NMile2, L-31NMile3, L-31NMile4, and L-31NMile5). The five new monitoring sites along the L-31N canal are located at existing acoustic velocity meter stations that are used to estimate canal flow. The combined water quality and flow data at each of these stations will be used in the proposed mass balance analysis to determine the extent to which the sources of canal flow vary as a result of changing hydrologic and operating conditions that will occur over the course of the testing period. The first draft of this monitoring plan included additional new surface water quality monitoring sites such as S-336, S-21A, L-31NMile7, G-211, and S-338. The water quality monitoring team replaced with surrogates or removed these stations from the final plan after determining that these stations were not essential to meeting the monitoring plan objectives. (Details on groundwater flow quantification are provided in the groundwater monitoring plan below.)

Objective 3: Water Quality Compliance

Most of the existing surface water quality monitoring efforts at structures discharging into NESRS support the 1991 Settlement Agreement Appendix A compliance calculation. The mandated monitoring includes bi-weekly sampling when flowing at the S-12X, S-333, S-334, and S-355A/B structures. New sources to the SRS must also be included in the mandated monitoring. The SFWMD has been supplementing the required TP monitoring at these structures by collecting weekly samples at the S-12 structures and at the S-333 structure. While this additional monitoring is not mandated, the weekly resolution of this dataset may prove useful in evaluating the effect of shifting flows from the S-12s to S-333.

The collection of flow and TP concentration data at the S-356 structure will be used to demonstrate compliance with OFW requirements for discharges from this structure. The OFW compliance assessment requires that the flow-weighted mean TP concentration at the S-356 be less than 11 ppb on an annual basis and less than 9 ppb on a three year average annual basis. The calculation will be performed for the Federal Water Year (October through September) by the Corps and the results will be available in March of the following year.



SRS1B is west of L67-Extension

Figure C.4-10. Surface water quality monitoring station locations along Tamiami Trail.

Table C.4-3. Proposed surface water quality monitoring for G-3273/S-356 Increment 2 test.

Station	Status	Location	Water Quality Parameters	Frequency and Sample Type – Flowing	Frequency and Sample Type – Non-Flowing
L29C1 (TAMBR1)	Existing	L-29 north bank, directly across from culvert under US 41; 0.3 mi. west of S-334; a.k.a. FDOT Culvert 59	TPO4 , OPO4, Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Monthly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
L29C4 (TAMBR4)	Existing	L-29 north bank, directly across from culvert under US 41; 2.2 mi, west of S334; a.k.a. Culvert 56	TPO4 , Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Monthly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
NE0	Existing	NESS marsh site 0.5 km south of FDOT Culvert 59 (TAMBR1)	TPO4 , Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Monthly; grab; collection by ENP and analyses by SFWMD	Monthly; grab; collection by ENP and analyses by SFWMD
L30 Mile0	Existing	L-30 canal/L-29 juncture NW corner; 25° 45’ 41.93” N, 80° 29’ 53.70” W	TPO4 , OPO4, Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Monthly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
S355A	Existing	Approximately 5.5 mi. west of S-356. Tail Water	TPO4 , Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Biweekly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
S355B	Existing	Approximately 3.25 mi. west of S-356. Tail Water	TPO4 , Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Biweekly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
SAFARI	Existing	Downstream of culvert south of L-29, approximately 8 mi. west of L-31N.	TPO4 , Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Biweekly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
GLADER	Existing	Downstream of culvert south of L-29, approximately 5-1/4 mi. west of L-31N.	TPO4 , Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Biweekly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
COOPERTN	Existing	Downstream of culvert south of L-29,	TPO4 , Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Biweekly; grab; collection and	Monthly grab; collection and

Station	Status	Location	Water Quality Parameters	Frequency and Sample Type – Flowing	Frequency and Sample Type – Non-Flowing
		approximately 4 mi. west of L-31N.		analyses by SFWMD	analyses by SFWMD
S-333	Existing	SE Corner of WCA-3A at L-29.	DO, SC, pH, Turb, TSS, NOx, TKN, OPO4, TPO4, Na, K, Ca, Mg, Cl, SO4,, Alk	Weekly when flowing; otherwise monthly; grab	Monthly grab; collection and analyses by SFWMD
S-333	Existing	SE Corner of WCA-3A at L-29.	TPO4, TKN, NOx	Time-proportional autosampler: weekly	Monthly grab; collection and analyses by SFWMD
S334	Existing	On L-29 approximately 1/4 mile west of L-31N. Head Water.	TPO4 , Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Biweekly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
S-335	Existing	On L-30 north of L-29. Tail Water (and Head Water).	TPO4 , OPO4, Na, Ca, Mg, K, Cl, SO4, Alk, SC, DO, pH, SC, T	Biweekly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
S-356	Existing	On L-29 approximately 1/4 mi. west of L-31N.	DO, SC, pH, Turb, TSS, NOx, TKN, OPO4, TPO4, Na, K, Ca, Mg, Cl, SO4,, Alk	Weekly when flowing; otherwise monthly; grab	Monthly grab; collection and analyses by SFWMD
S-356	Existing	NOTE: Autosampler on site.	TPO4, TKN, NOx	Time-proportional autosampler: weekly	Monthly grab; collection and analyses by SFWMD
S-197	Existing	On C-111 approx .15mile east of US 1/C-111 juncture: 25° 17’ 13.46” N, 80° 26’ 29.94” W	DO, SC, pH, TSS, NOx, TKN, OPO4, TPO4, Na, K, Ca, Mg, Cl, SO4, TURB, SO4,	Biweekly if flowing	Quarterly
L-31NMile0	Existing	0.06 miles south of the intersection of L-29 and L-31N – Stage gage; 25° 45’ 36.25” N, 80° 29’ 53.32” W	TPO4 , Na, Ca, Mg, K, Cl, SO4, Alk, SC, DO, pH, SC, T	Monthly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
L-31NMile1	Existing	One mile south of the intersection of L-29 and L-31N - miles south of the	TPO4 , Na, Ca, Mg, K, Cl, SO4, Alk, SC, DO, pH, SC, T	Monthly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD

Station	Status	Location	Water Quality Parameters	Frequency and Sample Type – Flowing	Frequency and Sample Type – Non-Flowing
		intersection of L-29 and L-31N – Stage gage; 25° 44’ 46.75” N, 80° 29’ 51.46” W			
L-31NMile2	Existing	Two miles south of the intersection of L-29 and L-31N - miles south of the intersection of L-29 and L-31N – Stage gage; 25° 43’ 54.75” N, 80° 29’ 48.72” W	TPO4 , Na, Ca, Mg, K, Cl, SO4, Alk, SC, DO, pH, SC, T	Monthly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
L-31NMile3	Existing	Three miles south of the intersection of L-29 and L-31N - miles south of the intersection of L-29 and L-31N – Stage gage; 25° 43’ 03.32” N, 80° 29’ 47.57” W	TPO4 , Na, Ca, Mg, K, Cl, SO4, Alk, SC, DO, pH, SC, T	Monthly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
L-31NMile4	Existing	Four miles south of the intersection of L-29 and L-31N - miles south of the intersection of L-29 and L-31N – Stage gage; 25° 42’ 06.82” N, 80° 29’ 45.23” W	TPO4 , Na, Ca, Mg, K, Cl, SO4, Alk, SC, DO, pH, SC, T	Monthly collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
L-31NMile5	Existing	Five miles south of the intersection of L-29 and L-31N – Stage gage; 25° 41’ 09.81” N, 80° 29’ 50.10” W	TPO4 , Na, Ca, Mg, K, Cl, SO4, Alk, SC, DO, pH, SC, T	Monthly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
NE1	ENP Collects SFWMD Analysis	In the Park marsh, 4.67 miles south of the L-29 canal	Turb, TSS, NOX, NO2, NH4, TKN, OPO4, TPO4, Na, K, Ca, Mg, Cl, SO4, (Hard), Alk, (NO3), T, DO, SC, pH	Monthly; grab; collection by ENP, and analysis by SFWMD	Monthly; grab; collection by ENP, and analysis by SFWMD

Station	Status	Location	Water Quality Parameters	Frequency and Sample Type – Flowing	Frequency and Sample Type – Non-Flowing
SRS1C	ENP Collects SFWMD Analysis	In the Park marsh, 0.42 miles south of L-29 canal	TPO4, DO, pH, SC, T	Monthly; grab; collection by ENP, and analysis by SFWMD	Monthly; grab; collection by ENP, and analysis by SFWMD
SRS1B	ENP Collects SFWMD Analysis	In the Park marsh, 0.31 miles south of L-29 canal	TPO4, DO, pH, SC, T	Monthly; grab; collection by ENP, and analysis by SFWMD	Monthly; grab; collection by ENP, and analysis by SFWMD
S-328	Existing	Gated Culvert Structure(8x60") w/inS-332D detention area , discharges to L-31W	Monitoring regime being developed by ENP/SFWMD/FDEP concurrent with draft EA (final monitoring requirements will be detailed in the final EA)	Autosampler proposed for composite timed sample along with. Biweekly grab	N/A

C.4.9.3 Groundwater Hydrology

All existing groundwater monitoring stations described in Section C.4.5.4.3 were included during the initial months of Increment 1 of the S-356 pump station field test. Distal well locations may be eliminated (as included in Table C.4-2) if no response is shown to S-356 operation.

C.4.9.4 Groundwater Quality

Groundwater quality was monitored on a monthly or quarterly basis between July 2015 and May 2019, and these data currently are under review. ForCOP AMMP, the existing surface water quality monitoring program established under increment 2 is expected to continue on an as needed basis. The intent of the final product increment 2 testing was to provide a mass balance model that defines relative volumes of surface water and groundwater seepage as these waters flow through the canals and into ENP, before and during the S-356 pump station operation. Due to the lack of water quality problems caused by the operational testing of the S356, the necessity for this mass balance may no longer exist. If future water quality problems are linked to the S356 pumping, the requirement for a mass balance may need to be revisited.

C.4.9.5 Access and Authority

New monitoring stations located at water control structures will be accessed via existing levees or public roadways. To perform environmental sampling within ENP, a sampling and access permit will first be obtained from the National Park Service.

C.4.10 Project Reporting

Technical reporting and evaluations were reported by USACE during the MWD Incremental field tests in accordance with FDEP permit requirements, and the monitoring results were updated to the COP interagency PDT through regular quarterly meetings for the duration of the field tests. Information gained through the field test monitoring has been incorporated into the COP alternative formulation and hydrologic modeling process, culminating in the COP Recommended Plan detailed in the EIS and the supporting COP Water Control Plan. No further hydrologic data reporting will be conducted under COP based on the hydrometeorologic monitoring plan; rather, further reporting will be conducted in accordance with the commitments identified in the COP Adaptive Management Plan.

Reporting for project monitoring conducted to comply with the Settlement Agreement, C-111 SD EO 9 (until replace with an ERP or CERPRA issued to the SFWMD) Non-ECP permit, or EFA will be performed in accordance with the applicable requirements. Project monitoring that is not tied to those requirements will be reported on in accordance with the applicable Comprehensive Everglades Restoration Plan Regulation Act (CERPRA) permit requirement.

The Settlement Agreement, Non-ECP or EFA reports would be prepared and provided to FDEP by SFWMD on an annual basis with a target delivery date of April of each year. The S-356 monitoring will continue to be included into the annual SFWMD Settlement Agreement report in the future. The reporting period would be the federal water year for Appendix A and S-356 compliance assessments.

C.4.10.1 Frequency

Monitoring results will be reported no less frequently than annually and informal updates may be provided quarterly, in accordance with the commitments identified in the COP Adaptive Management and Monitoring Plan. Hydrometeorological monitoring information routinely tracked for assessment by USACE, SFWMD, and ENP water managers (refer to Section C.4.8.2.1) will be updated on a daily basis and available for review on the Jacksonville District Water Management web pages:

http://www.saj.usace.army.mil/Missions/Environmental/EcosystemRestoration/G3273andS356PumpStationFieldTest.aspx

http://www.saj.usace.army.mil/Missions/CivilWorks/WaterManagement.aspx

C.4.10.2 Content and Format

C.4.10.2.1 Hydrometeorological Analysis and Reporting

The Monitoring Plan contains a list of gages in Table C.4-1 to be used to evaluate COP water management operations. During the development of the original Increment 1 field test Operational Strategy (refer to Appendix A of the Increment 1.0 Environmental Assessment), the operations sub-team identified a preliminary list of analyses to be conducted to inform future water management actions within the Increment 1, Increment 1.1 and 1.2 test, and Increment 2.0 field test operations, as described below as analysis items A through J. The analyses were developed to complement the overall monitoring plan and evaluate implementation of field test water management operations relative to its goals, objective and constraints.

COP water management operations updates and action items will be discussed on a weekly basis between water managers from USACE and SFWMD, as well as ENP when needed, to provide collective interpretation of results and evaluate implementation of operations relative to the goals, objectives, and constraints identified in the COP Water Control Plan. USACE, SFWMD, and ENP water managers will participate in technical team meetings and periodic interagency meetings, in accordance with the commitments identified in the COP Adaptive Management and Monitoring Plan. Established meetings (e.g., WCA-3 Periodic Scientists Calls) may also support evaluation of the COP implementation and/or provide additional forums for periodic updates on the monitoring and assessment results.

Preliminary methodologies developed to analyze the Incremental field test and evaluate implementation of operations relative to the field test goals, objectives, and constraints are listed below as tasks labeled (A) through (J). These tasks are not intended to be further pursued under COP at this time. The water quality concerns of the S356 pump station mobilizing higher phosphorus content water from the deeper strata in the aquifer and from the eastern uban areas were not found to occur during the incremental testing. As a failsafe, WQ monitoring at the S356 will continue and the data will be evaluated to confirm nothing unexpected is occurring with the S356 WQ. Thus far the water quality delivered by the S356 has been reflective of relatively clean seepage water characteristic of ENP SRS and WCA 3B water quality. If there are unexpected water quality results (higher than expected and what has been measured during the incremental testing, the analyses and investigations described below and conducted during the incremental testing may need to be restarted.

These analyses conducted during the incremental testing were developed to complement the overall monitoring plan and were used to assess and evaluate the achievement of several of the stated water management objectives from the field test monitoring plan, including to: (1) ensure existing levels of flood protection are maintained within the northern L-31N Basin (between S-335 and S-331); (2) ensure existing levels of flood mitigation are maintained within the protected portion of the 8.5 SMA; (3) determine whether the field test contributes to flooding within the C-111 basin; and (4) determine whether the field test operational changes at S-197 ensure existing levels of flood protection are maintained within the C-111 Basin (south of S-176); the evaluation will include assessment of the trigger criteria used for S-197 gate openings and their beneficial effects on Manatee Bay. Modifications to the methodologies for the analyses listed here may be necessary due to data limitations or inconclusive results realized during

implementation of field tests. The analyses will account for average monthly historic rainfall as measured at available rainfall gages (S-12D, S-331, S-18C, and basin-wide NEXRAD rainfall datasets), compared to the average monthly rainfall observed at available rainfall gages during this Field Test. The following analysis items were tracked on a real-time basis during the field test: C, D, E, F, G, and H. The remaining analysis items (A, B, I, and J), which require extended periods of data collection and analysis, were assessed at periodic intervals during the field test. With the emphasis real-time incorporation of monitoring information during the COP plan formulation and hydrologic modeling effort, and the priority of USACE, SFWMD, and ENP technical staff given to preparation of the COP Draft EIS, Water Control Plan, and Adaptive Management and Monitoring Plan, further documentation on the Increment 2 field test hydrologic analysis items below has been deferred for inclusion as a compendium to the Final COP EIS.

A. TASK 1: Develop an accurate water budget for the period of the Field Test from surface water and groundwater monitoring flow and water-quality data. The water budget will quantify contributions of surface and groundwater flow at important reaches surrounding the S-356. Water budget calculations will be developed at the following reaches: 1) along L-31N between S-335 and G-211/S-331; and 2) along L-29 from S-334 to S-333, and 3) along L-30 canal between S-335 and S-356 pump stations.

   METHODOLOGY: Surface water data will be provided by USACE Water Management Section for all structures in the three indicated reaches mentioned on a quarterly basis. The USACE Engineering sub-team will develop a surface-groundwater budget through coordination with the USACE/ENP water quality sub-team monitoring efforts. Daily flow data along L-29 culverts and the bridge is not available. USACE Water Management Section reviewed results to support ongoing adaptive management operational adjustments, as needed, during the test.

   TASK 2: Identify the zone of influence of the S-356 pump station. Seepage direction and seepage flow rates from proximal and distal groundwater monitoring wells will be assessed during S-356 pump operation and compared to pre-test baseline data.

   METHODOLOGY: Spatial extent of zone of influence due to variable operations of S-356 and regional hydrologic conditions will be analyzed by USACE Engineering sub-team. USACE will review this information to support ongoing adaptive management operational adjustments, as needed, during the test, including influence of S-356 on hydro-period conditions within southeastern WCA-3B.

B. Identify the area of influence for hydrologic effects resulting from increased water deliveries from WCA-3A to NESRS following changes to the G-3273 constraint. Hydrologic effects within the South Dade Basin from reduced deliveries from WCA-3A to the SDCS and use of S-331 to provide flood mitigation for the 8.5 SMA will also be assessed.

   METHODOLOGY: Prior to the start of Increment 1.0, USACE completed the following analyses to establish Increment 1.0 pre-project base conditions for the project area: (1) Tabulate data from all regional surface water and groundwater gages (as identified in monitoring plan Appendix C) which include at least 5 years of record for the period July 2002 through May or June 2015; (2) Develop intra-annual stage frequency exceedance curves to demonstrate long-term hydrologic statistics during IOP and ERTP operations (Increment 1 pre-project base conditions); (3) Provide tabular summary of monthly rainfall amounts for the IOP/ERTP period at regional rainfall

monitoring locations to establish pre-project rainfall record; and (4) Estimate intra-annual frequency for 2002-2015 rainfall, based on 30-day moving average. During the field test implementation, USACE will provide plots of regional water levels (for all surface water and groundwater gage locations identified in the monitoring plan) and rainfall (30-day moving average and monthly totals) for comparison against the corresponding stage in intra-annual stage frequency curves developed for the pre-project base conditions (stage and rainfall). Water levels observed during the Increment 2 field test will be evaluated using the rainfall frequency data and comparison with the corresponding stage level in the intra-annual stage frequency curves developed for the pre-project base conditions. The zone of influence will be interpreted by water managers from USACE, SFWMD, and ENP, with assistance from the USACE Engineering sub-team.

C. Compare the volume of water sent to NESRS (S-333, S-355A, S-355B, S-356) during this Field Test (G-3273 above 6.8 feet) to the historical volume (G-3273 operationally maintained below the 2012 WCP constraint of 6.8 feet, except under Column 2 operations) of water that was sent to NESRS (S-333, S-355A, S-355B).

   METHODOLOGY: Show S-333 (minus S-334) discharges under this test (monthly/seasonal/annual) and also tabulate/plot to compare with intra-annual flow frequency exceedance curves for pre-project base conditions (July 2002 through May or June 2015).

D. Compare the volume of water sent from WCA-3A to the SDCS (S-334) during this Field Test (revised Column 2 and S-334 operational criteria) to the historical volume (Column 2 operations used if G-3273 above 6.8) of water that was sent to the SDCS (S-334).

   METHODOLOGY: Same as C. for S-334 discharges (minus water supply).

E. Quantify the effect of S-356 operation on the L-29 Canal stage and describe conditions under which S-356 may limit the ability to discharge the WCA-3A Rainfall Plan target releases at S-333.

   METHODOLOGY: Develop relationship between S-356 discharges and L-29 Canal rise. Estimate the reduction in discharges from S-333 due to rise in tailwater stage in the L-29 Canal. USACE may reference the previous S-356 pump-test report for July 2006 operations (report was included in Appendix C of the 2006 IOP Final Supplemental EIS) as a template. Evaluations will complement the assessment of post-rainfall event responses at LPG-1 and LPG-2, including evaluation of recession rates and hydroperiod response at LPG-1 and LPG-2, which were established by the Corps during the 2016 Emergency Deviation and subsequent extended recovery period. The assessments of post-rainfall event responses, which is further detailed in Section C.6, are needed to ensure that existing levels of flood mitigation are maintained within the protected portion of the 8.5 SMA.

F. Compare the volume of water sent to the 8.5 SMA detention area (S-357) during this Field Test (G-3273 above 6.8 feet) to the historical volume (G-3273 operationally maintained below the 2012 WCP constraint of 6.8 feet, except under Column 2 operations) of water that was sent to the 8.5 SMA detention area. The analysis will describe how the operational triggers and/or constraints for S-357 (C-357/C-358 canal stages, gradient between Angel's Well stage and LPG-1 stage, 8.5 SMA detention area stage, and/or S-357N operations) are influenced by the Increment 2 operations within the L-29 Canal and NESRS. The frequency of the applicability of the 8.5 SMA detention area stage constraint will provide information to assess potential effects following

future construction and operation of the C-111 South Dade Project Northern Detention Area (NDA).

METHODOLOGY: Show S-357 discharges under this test (monthly/seasonal/annual) and also tabulate/plot to compare with intra-annual flow frequency exceedance curves for pre-project base conditions (July 2002 through May or June 2015). Develop intra-annual stage exceedance frequency curves for C-357 stage, gradient, detention cell stage (based on availability of records), including comparison to pre-project baseline developed for analysis item B. Find characteristics of data during current test, compared to pre-test conditions. Evaluations will complement the assessment of post-rainfall event responses at LPG-1 and LPG-2, including evaluation of recession rates and hydroperiod response at LPG-1 and LPG-2, which were established by the Corps during the 2016 Emergency Deviation and subsequent extended recovery period. The assessments of post-rainfall event responses, which is further detailed in Section C.6 (initially established for Increment 1.1 and 1.2), are needed to ensure that existing levels of flood mitigation are maintained within the protected portion of the 8.5 SMA.

G. Compare the volume of water sent to the L-31N/C-1W (S-331, S-338) during this Field Test (G-3273 above 6.8 feet) to the historical volume (G-3273 operationally maintained below the 2012 WCP constraint of 6.8 feet, except under Column 2 operations) of water that was sent to L-31N/C 1W (S 331, S 338). The analysis will describe the effects of pumping constraints at S-357 (C-357 canal stage, gradient between Angel's Well stage and LPG-1 stage, and 8.5 SMA detention area stage) on the L-31N Canal operating range for S-331 and associated S-331 discharges.

   METHODOLOGY: Show S-331 and S-338 discharges under this test (monthly/seasonal/annual) and also tabulate/plot to compare with intra-annual flow frequency exceedance curves for pre-project base conditions (July 2002 through May or June 2015). Capture volume of water to L-31N if S-356 is not in use due to operational constraints (L-29 or WCA-3A). Find characteristics of data during current test, compared to pre-test conditions.

H. The effect of the water management operating criteria, including S-357N and S-357, on water levels within the perimeter levee of the 8.5 SMA and the 8.5 SMA detention area will be assessed relative to G-3273 relaxation (G-3273 target stage from 6.8 feet up to 7.5 feet) prior to completion of the C-111 South Dade Project NDA.

   METHODOLOGY: Show groundwater/surface water contours and other flood mitigation metrics previously determined needed per the USACE 2009 report on 8.5 SMA operational testing (Increment 2 has similar constraints); the 2009 report was included as Appendix I of the June 2011 Environmental Assessment for the 8.5 SMA Interim Operating Criteria.

   UPDATE: This analysis item was superseded during the field test. Refer to Section C.6 for detailed methodology for real-time assessment of 8.5 SMA flood mitigation requirements.

I. Quantify the effects of the revised trigger criteria for S-197 discharges on flood damage reduction performance within the C-111 South Dade Basin and describe observed ecological effects within the ENP Taylor Slough Basin, ENP Eastern Panhandle, and Manatee Bay/Barnes Sound.

   METHODOLOGY: The Florida Department of Agriculture and Consumer Services (FDACS) and the SFWMD requested inclusion of operational changes to the C-111 Canal structures, including S-18C

and S-197, within the field test due to their concerns over water levels experienced within agricultural lands located east of ENP. Water levels observed at the following monitoring gauge locations during the Increment 2 field test (if data is available) were be evaluated using the rainfall frequency data and comparison with the corresponding stage level in the intra-annual stage frequency curves developed for the pre-project base conditions (pre-project base condition analysis methodology was previously summarized under item B): G-613, G-3350, TSB, G-864A, G-3620, G-3355, G-3901, G-789, G-3336, and G-3338; the initial set of wells recommended to assess regional groundwater levels in the South Dade area was developed following coordination with the SFWMD. Show S-177, S-178, S-18C, and S-197 discharges under this test (monthly/seasonal/annual) and also tabulate/plot to compare with intra-annual flow frequency exceedance curves for pre-project base conditions (July 2002 through May or June 2015). Identify timing and frequency of the revised trigger criteria during the Increment 2 field test. Assessment by water managers will be integrated with input from the ecological monitoring sub-team.

UPDATE: This analysis item was superseded during the field test. Hydrologic modeling was used during the COP Round 1 and Round 2 modeling, including sensitivity simulations, to more comprehensively assess the effects of changes to S-197 operations on upstream canal levels and adjacent urban and agricultural lands. The lessons learned were incorporated into the operations included in the COP criteria.

J. Develop an accurate water budget for the period of the Field Test from surface water and groundwater monitoring flow and water-quality data. The water budget will quantify contributions of surface and groundwater flow at important reaches surrounding the S 332B, S-332C, S-332D, S-199, and S-200 pump stations. Water budget calculations will be developed at the following reaches: 1) along L-31N/C-111 between S-331 and S 176; and 2) along the C-111 Canal from S-176 to S-177.

METHODOLOGY: The extent (stress and duration) of testing will be constrained by the limited hydraulic testing latitude prescribed within the framework of the Increment 2 Operational Strategy and the associated EA. With these constraints it is expected that additional, expanded future testing will be required to definitively explore how effectively increased pumping can further separate the canal levels from the water levels along the eastern boundary of ENP during the testing. The hydraulic testing with Increment 2 is essentially limited to better controlled and monitored existing operations. Better controlled operation would consist of hydraulic testing with representative regional conditions and more steady pumping rates. For example, operations may target pumping with steady flow rates at S-332B North, S-332B West, S-332C, S-332D, S-199, and S-200 during hydraulic testing. Hydraulic testing constraints realized with Increment 2 was planned if necessary, expanded future testing in subsequent years of Increment 2, which would be accompanied by appropriate NEPA analysis and documentation. It was determined this was not necessary to continue beyony increment 2

Hydraulic testing of the pump stations should consider the locations of the detention areas receiving their discharges. Since the S-332D pump station discharges into the S-332D Detention Area, which is located south of S-176 (the southern terminus of the L-31N and the northern terminus of the C-111 Canal), discharges from S-332D affect both the L-31N Canal (lowering water levels) and the C-111 Canal between S-176 and S-177. Based on preliminary analysis by SFWMD

water managers, the historical flow data for periods with low rainfall has consistently shown that, in absence of the operation of S-200, approximately half of the water pumped into the S-332D Detention Area flows as groundwater to the C 111 Canal. Based on this information, testing of S-332D should include testing of the C-111SC S-200 pump station (225 cfs design capacity) and its associated Frog Pond Detention Area (FPDA). Also, since the C-111 SC S-199 pump station and its associated Aero-Jet Flow Way/Canal are operated in concert with S-200, operations consistent with the C-111 SC Preliminary Project Operating Manual operational criteria for S-199 and S-200 was planned during Increment 2 hydraulic testing. The S-332B West (two diesel and one electric pump; 325 cfs design capacity) and S-332C (four diesel and one electric pump; 575 cfs design capacity) pump stations discharge into the C-111 South Dade Project SDA. Up to about 250 cfs from S-332D can be routed to the SDA through S-332DX1. Based on this information, the hydraulic testing program was b planned with the following separate or combined tests areas:

1. Testing of the Detention Areas between S-331 and S-176. Testing of the interim S-332B North detention area, which will be replaced by the C-111 South Dade Project NDA, and SDA should be done together. During this testing period, operations at S-331 and S-357 should be representative of normal operations while remaining as steady as practicable.
2. Testing of the Detention Areas between S-176 and S-177. Testing of the S-332D Detention Area and S-200 FPDA should be done together. During this testing period, operations at S-200 and S-199 should be representative of normal operations while remaining as steady as practicable.
3. Testing of the Detention Areas between S-331 and S-177. If there is sufficient water available and representative conditions are achievable, it would be both more efficient and representative to perform the test simultaneously on all of the detention areas.

A reconnaissance test to explore the ability of the detention areas to separate the ENP stage from the L-31N/C-111 Canal stage(s) would be best performed at the start of the dry season when stages along the eastern boundary of ENP are still relatively high. This test would start with the pump stations operating at or near their full capacity (75 to 100 percent of capacity) while maintaining the canals within the identified operational range (e.g. Column 2) and minimizing the volume of water delivered through G-211. This initial phase would be maintained for one week followed by a phase with the total pumping rates reduced by about 25 percent. The inflow through G-211 would be reduced to the extent that it does not cause the canal stage(s) to fall below the bottom of the acceptable range (e.g. Column 2). A goal would be to keep the inflow from G-211 and the S-357 and S-173/S-331 inflows as steady as practicable. This intermediate rate would be maintained for at least one week to allow stages in ENP (lowering), the detention areas (lowering), and the canal (rising) to reach equilibrium. A second reduction in pumping rate by about 25 percent would be performed when the stage in ENP allows the reduction of discharges while maintaining the canal stages within ranges with steady pumping. This phase would be also be maintained for at least one week to allow stages to reach equilibrium. It is expected that at this rate of pumping (approximately half of design pump capacity), the flow through G-211 would be minimized. During these tests, temporary stage monitoring may be installed in some of the existing agricultural wells to help identify flow patterns (drawdown and

capture distances). This information may be helpful in identifying the best location for more permanent stage monitoring for subsequent tests.

A reconnaissance test to explore the ability of lower pumping rates (e.g. one electric or one diesel per pump station) to slow the decline of water levels in ENP during the transition from flood control to water supply and during water supply periods may be worthwhile, if further hydraulic testing is able to be conducted within the planned one month duration during Increment 1. Once the water level in the L-31N Canal falls below the pumping range and no water is available to maintain the stage in the detention areas, the L-31N and C-111 canals begin to directly pull water from ENP as they recede to water supply stages.

UPDATE: Delays with the completion of the C-111 South Dade construction until September 2018 precluded application of hydraulic testing during the incremental field test. Water budget information will be reported in accordance with the methodology developed for item (A) above.

C.4.10.3 Revisions and Modifications

A surface water and groundwater data collection effort commenced in July 2015 in support of the Increment 1.1/1.2 field test. In addition to the ongoing high water levels in the WCAs throughout the 2017 wet season, a prolonged period of high water levels occurred from November 2015 through April 2016. These conditions limit the duration of S-356 pump station operation, and consequently the evaluation of the test results. However, it was possible to assess the limited dataset in order to identify redundancies and to assess sensor performance. As a result, there are changes in the surface water and groundwater monitoring plans. These changes are identified in the following sections. Revisions to the Groundwater Monitoring Plan were implemented upon completion of the groundwater quality monitoring contract in May 2019. These revisions are:

- Deletion of the groundwater quality monitoring project along L-29, L-30, L-31N, and WCA-3B.
- Installation of up to seven additional monitoring wells identified in this revised monitoring plan: 3 additional wells within the expanded C-111 South Dade Northern Detention Area, 2 additional wells in the Southern Detention Area, and up to 2 additional wells within the 8.5 SMA interior.
- Installation of six groundwater monitoring wells and soil moisture sensors along the Tamiami Trail to address FDOT concerns with raising L-29 operating stages and potential effects on the road base.

C.4.11 Administration and Implementation of the Monitoring Plan

Training or Certification: Field and laboratory training requirements are specified in the FDEP SOPs and FSQM for the field and in the NELAP standard and CLQM for the laboratory.

C.4.11.1 Organization Structure and Responsibilities

This monitoring effort is intended to be collaborative effort of the USACE, SFWMD, and ENP. The roles and responsibilities for field collection, laboratory analysis, and reporting are detailed by activity in Table C.4-4. The sampling plan relies heavily upon the ongoing regulatory compliance monitoring conducted by

the SFWMD. Field sampling responsibilities are split between the USACE, SFWMD, and ENP. Most of the surface water quality field sampling that is specific to the Increment 2 test is currently scheduled to be conducted by the SFWMD. SFWMD and ENP entered into a five-year cooperative agreement (June 2015 - June 2020), "Cooperative Monitoring, Assessment and Modeling to Support Everglades Restoration: Incremental Testing of G-3273 Constraint Relaxation/S-356 and S-357N Operation and Development of a Combined Operational Plan". This Cooperative Agreement covers additional monitoring of surface water and groundwater quality monitoring identified in this monitoring plan. Any surface water sampling within the Park will be conducted by ENP staff or ENP contractors. The USACE will conduct the groundwater level monitoring. The ADVM monitoring is scheduled to be conducted by the USGS though there is no formal agreement with the USACE or ENP that this work continues for the duration of Increment 2. The MDLPA groundwater monitoring is expected to be conducted for the duration of Increment 2 though there is no contract or guarantee that this will be performed.

For consistency purposes, the plan specifies that all water quality laboratory analysis will be performed by the SFWMD. Regardless of the agency performing the work, field activity will be conducted in general accordance with the SFWMD's Field Sampling Quality Manual (FSQM). Laboratory analysis and data validation responsibilities will be done in accordance with the SFWMD's Chemistry Laboratory Quality Manual (CLQM). These documents define the procedures used by SFWMD personnel to meet the Florida Department of Environmental Protection's (FDEP) Quality Assurance Rule, Florida Administrative Code (F.A.C.) 62-160.

Table C.4-4. Agency roles and responsibilities for each activity.

Activities	Station Registration in DBHYDRO	Field Collection & Lab Reporting	WQ Lab Analysis & Lab Reporting	Analysis and Reporting of Collected Data
Ongoing Surface Water Quality Compliance Monitoring	--	SFWMD	SFWMD	SFWMD**
Ongoing NESRS Water Quality Monitoring	--	ENP	SFWMD	USACE, ENP
Ongoing ADVM Monitoring of Flow in L-29 and L-31N	SFWMD	USGS	N/A	USACE, ENP
Ongoing Groundwater Stage Monitoring	--	USACE, SFWMD, ENP, MDLPA	N/A	USACE, ENP
Increment2 Specific Groundwater Stage Monitoring	SFWMD	USACE	N/A	USACE, ENP
C-111 Spreader Canal Monitoring / Reporting per PIR & Corps Regulatory Permit **	--	--	--	SFWMD

* Does not include QA/QC samples or field analytes. Computed using the frequency, number of stations, number of individual laboratory analytes, and two year duration of monitoring

** SFWMD will continue to separately provide the annual South Florida Environmental Report and the annual Settlement Agreement Report. In addition, the SFWMD will provide USACE with quarterly monitoring reports in accordance with the requirements of the Department of Army permit for C-111 Spreader Canal.

C.4.11.1.1 Monitoring Program Team Assignments

For this project, the monitoring will be conducted by personnel from the USACE, SFWMD, DOI, as well as contractors. Each agency will be responsible for identifying their monitoring team members and assigning responsibilities and reporting chains.

C.4.11.1.2 Implementation

This monitoring plan is part of a federal-state cost shared project. The USACE has completed construction of the MWD and C-111 South Dade project features, with assistance from SFWMD. Monitoring efforts will likely be conducted by the SFWMD given its extensive experience conducting on-going environmental monitoring.

C.4.11.1.3 Program and Protocol Review

Review Summary:

- October 2019: Monitoring plan revised for COP updates (previous update completed for Increment 2 in November 2017).

The surface water quality subteam has reviewed the existing monitoring plan in place for increment 2 and determined the existing monitoring regime is sufficient for COP at this time. No changes are proposed at this time to the surface WQ monitoring plan for the project area. As new features are added to the system or modifications to the operational plan are proposed or new permits are issued for features in the project area, the monitoring plan will be reviewed and modified as necessary.

C.4.12 Cost Estimates

Estimated costs are not available at this time.

C.4.13 Data Quality Objectives for Water Quality Data

While it is recognized that data quality objectives (DQOs) are typically developed separately for each specific monitoring project, all mandated monitoring conducted by the SFWMD must meet the objectives conveyed in the FDEP's Quality Assurance Rule, 62-160 F.A.C. The SFWMD has adopted a uniform set of DQOs following criteria detailed within the "Analytical Methods and Default QA/QC Targets" table of the SFWMD's Chemistry Laboratory Quality Manual (CLQM). For those samples analyzed by the FDEP Laboratory, the SFWMD has adopted the DQOs within the most recent version of the FDEP's Laboratory Chemistry Quality Manual.

Water Quality and sediment samples, including field testing and field quality control samples, are collected in accordance with the FDEP Quality Assurance Rule, 62-160 F.A.C. and the current version of the Field Sampling Quality Manual (SFWMD-FIELD-QM-001) (FSQM). Applicable sections of the FSQM include, but are not limited to, field sample collection procedures, decontamination procedures, field testing, quality control requirements, and documentation requirements.

The DQOs of the field testing parameters for this project are specified in the field testing section of the FSQM. This manual is updated annually, and therefore, the most recent version of the FSQM details the specific field testing data quality objectives for this project at the time of sample collection.

Samples are analyzed according to the provisions within the FDEP Rule 62-160 F.A.C. and the CLQM. This manual is annually updated, and therefore, the most recent version of the CLQM details the specific laboratory analyses' DQOs for this project at the time of sample collection

Data not meeting the quality objectives must be qualified using standard FDEP qualifier codes (F.A.C. 62-160) and corrective actions may be taken as outlined in the SFWMD's FSQM and CLQM and Data Validation and Reporting Sections SOPs.

C.4.14 Monitoring Data Elements/Indicators

Monitoring proposed for this project includes existing monitoring required for compliance with existing or future permits or the Settlement Agreement. In addition to demonstrating compliance with water quality criteria, the data collected under this plan will be used to assess overall water quality impact associated with operating the S-356 pump station, raising the L-29 Canal maximum operating limit, and removing the G-3273 stage limit at S-333.

C.4.15 Procedures and Methods

Sampling methods will follow well-defined methodologies that have been approved by Federal and state regulatory agencies. The SFWMD's FSQM shall be used for all water quality and sediment sampling procedures. Once the DQOs are established, the QASR should be consulted to identify the analytical methods that will meet the project objectives. Methods specified in the CLQM or their equivalent shall be used when specified.

The laboratory that processes the samples collected in this plan will report data using ADaPT (Automated Data Processing Tool) software. Staged Electronic Data Deliverable (SEDD) (http://www.epa.gov/fem/pdfs/sedd_adr_imp_overview.pdf) or the Automated Data Review (ADR) software may be used in addition to ADaPT.

Each discrete sample will be assigned a unique sample identification number that ensures that it can eventually be retained as a unique database record linked to a specific location. All these activities regarding a sample will be documented in a format that assures that the resulting data are traceable and of known and documentable quality.

C.4.15.1 Laboratory Qualifications

Laboratories used in this plan will be certified by the Florida Department of Health Environmental Laboratory Certification Program (FDOH ELCP). At the time the laboratory(s) are selected, this plan will be updated to include the laboratory certifications by the test method, analytes/parameters and matrix that are reported for the project. As specified by the CERP QASR Chapter 4.0, laboratories used for analysis of environmental samples will be pre-approved and subjected to comparative testing if available,

such as the performance evaluations overseen by the QAOT. These requirements shall be defined in the laboratory's contract or work order with the contracting agency.

C.4.15.2 Rationale for Indicator Selection

Field and laboratory analytes are collected per the requirements of the EFA, Settlement Agreement, and anticipated CERPRA and EFA permits. The focus of the monitoring efforts is on the collection of macronutrients as they are used as indicators of restoration success or project impact.

C.4.15.3 Sampling Frequency and Duration

Sampling frequencies proposed in this monitoring plan are either directly the result of the requirements of the EFA, Settlement Agreement, or Non-ECP permit, or are anticipated to be required for future EFA or CERPRA permits. See Table C.4-2 and Table C.4-3 for water quality sampling programs.

C.4.15.4 Assessment Process and Decision Criteria (triggers and thresholds)

Assessment frequency is annual as established by the requirements of the EFA, Settlement Agreement or Non-ECP permit. Decision criteria are established by the compliance values from these cited permits and settlements.

C.4.16 Data Collection

C.4.16.1 Sample/Data Collection Standards and Ethics

Every person performing field sampling must commit to following project specific requirements, SFWMD's FSQM, field SOPs, QASR requirements, and other instructions as issued, to assure that samples collected are of known and documented quality and are defensible.

C.4.16.2 Sample Submission

Requirements for sample handling, custody and analysis holding times are detailed in the SFWMD's Chemistry Laboratory Quality Manual and FDEP SOPs (DEP-SOP-001/01).

C.4.16.3 Chain of Custody

The Chain of Custody (COC) must accompany all samples submitted to internal or external laboratories. A COC form documents the possession of the samples from the time of collection to receipt in the laboratory. A COC form will be utilized and must be signed by the collector before it is relinquished to the laboratory. Field documentation must conform to the requirements specified in FDEP SOP FD1000 and the field documentation section of the SFWMD FSQM.

C.4.16.4 Quality Control of Samples

C.4.16.4.1 Laboratory Quality Control

Laboratories must meet NELAC requirements, the requirements detailed in Chapter 4 of the CERP QASR (http://www.evergladesplan.org/pm/program_docs/qasr.aspx) and applicable requirements as detailed in FDEP's Quality Assurance Rule, 62-160 F.A.C. All laboratory and applicable quality control data shall be submitted to the District in the ADaPT compatible format.

C.4.16.4.2 Field Quality Control Samples

Field Quality control samples will comply with the Field Quality Control section of the FSQM, Florida Department of Environmental Protection (FDEP) requirements (DEP-SOP-001/01,), and those developed in the DQO process. All requirements in the FDEP's Quality Assurance Rule should also be followed.

C.4.16.4.3 Field Record and Data Review

Field record and data review procedures are specified in the SFWMD FSQM and associated SOPs Responsibilities of the Laboratory Data Validation.

Data validation shall be performed in accordance with the requirements detailed in Chapter 5 of the CERP QASR. When preparing the ADaPT file the laboratory will review the data for completeness and accuracy.

C.4.16.5 Data Storage and Archiving

Long-term maintenance and management of digital information are vital to all PLMPs. Maintaining and managing digital data, documents, and objects that result from projects and activities is the responsibility of all parties involved. CGM54 will be followed to help ensure the continued availability of crucial project information and permit a broad range of users to obtain, share, and properly interpret that information. After the data validation process, all data are maintained so that end users can retrieve and review all information relative to a sampling event. Field notes are maintained on an internal server either by scanning actual field note pages or by uploading narratives from field computers path to server. All analytical data and field conditions are sent to the SFWMD database (DBHYDRO) for long-term storage and retrieval. If data are not suitable for DBHYDRO they will be entered into the CERP Integrated Database (CID) on CERPZone through the Morpho interface.

SFWMD or its surrogate shall maintain records of field notes and copies of all records relative to the chain of custody and analytical data. It is the responsibility of the SFWMD or its surrogate to maintain both current and historical method and operating procedures so that at any given time the conditions that were applied to a sampling event can be evaluated. Upon completion of the project, the collecting agency shall provide all original field notes to the District's WQB for permanent archival.

Records shall be maintained for the life of the project and five years thereafter, in a manner that will protect the physical condition and integrity of the records. Storage shall follow the District's records storage procedure. Access to archived methods shall be through designated records custodian. Corrections of data or records shall follow the established SFWMD SOPs.

C.4.17 Documentation

Field records shall be documented in accordance with the procedures specified in the SFWMD FSQM.

C.4.18 Quality Assurance and Quality Control

C.4.18.1 Laboratory and Field Audits

Audits will be performed according to the SFWMD FSQM and associated SOPs. Audit reports will be provided to the project manager. The authority of the auditor to stop work for processes that impact the quality of the data will also be defined, along with how and to whom the audit findings are reported and distributed.

C.4.19 Data Analysis and Records Management

The SFWMD has adopted a uniform set of DQOs following criteria detailed by the table entitled Field Quality Assurance Objectives found in the field testing section of the FSQM and within the "Analytical Methods and Default QA/QC Targets" table of the CLQM.

C.4.19.1 Data Quality Evaluation and Assessment

The data quality assessment (DQA) process uses scientific and statistical data evaluation procedures to determine if the data are of the right type, quantity, and quality to support their intended use. The DQA process is discussed in the QASR Chapter 11 and detailed guidance is described in EPA QA/G9R, Data Quality Assessment: A Reviewer's Guide (EPA, 2006a) http://www.epa.gov/quality/qs-docs/g9r-final.pdf.

The Science Policy Council has defined general data quality assessment factors (EPA, 2003) http://www.epa.gov/osa/spc/pdfs/assess2.pdf) that should be considered during the DQA process. These include soundness, applicability and utility, clarity and completeness, uncertainty and variability, and evaluation and review.

C.4.20 Adaptive Management Considerations

This monitoring is proposed for a limited period of time. Implementation of the Proposed Action will extend until the implementation of COP in late 2019.

C.5 Water Quality and Hydrology Monitoring Plan South of S-331

C.5.1 Introduction

The main water quality and surface hydrology monitoring plan document for Increment 2 (Appendix C.4) addresses monitoring required for areas primarily located north of the S-331 station. Section C.5 addresses water quality and hydrologic monitoring in areas south of the S-331 structure that may be affected by operations. Hydrologic and water quality monitoring is required south of the S-331 structure to assess the impact of operations, if any, on flooding within South Dade Agricultural area from south of the S-331 structure to the S-197 structure. This need was identified by FDACS, during discussions with PDT agency members participating in Increment 1 development, who were concerned that this project and the recently constructed C-111 Spreader Canal project might cause or contribute to flooding of nearby agricultural lands. To address this concern, the USACE will continue to rely upon the SFWMD to continue monitoring and to perform the flood impact analysis required in the C-111 Spreader Canal Western Project and codified through the requirements of the Department of Army permit for C-111 Spreader Canal which includes quarterly monitoring reports.

During the field test, USACE supplemented the SFWMD flood impact analysis with an assessment of groundwater stages and structure flows that occur in areas south of the S-331 structure, north of the S-176 control structure. The test did not significantly alter existing flow paths and for this reason, the existing water quality monitoring efforts south of the S-331 structure will not be augmented for this project.

C.5.2 Project Description

With implementation of the original Increment 1 field test, the sole change to the 2012 Water Control Plan for structures located south of the S-331 pump station during testing was the modification of opening criteria for the S-197 structure. This modification is likely to result in additional discharge at S-197 under hydrologic conditions and upstream operations that could result in increased potential risk of flooding of agricultural lands east of the C-111 canal. The modification was intended to ensure that flood impacts, if any, from test operations north of S-331 are mitigated through increased use of low level freshwater releases from the S-197 structure to the downstream Manatee Bay and Barnes Sound. Consistent with the requirements of the 2016 USFWS Biological Opinion, Increment 1.1 and 1.2 included additional operational changes to the 2012 Water Control Plan for S-332B, S-332C, and S-332D which moderately lowered the L-31N Canal to aid with achievement of the desired stage targets and recession rates for the Eastern CSSS sub-populations (C, E, and F) during the CSSS nesting window (mid-February through July) and to maintain the hydraulic ridge, extend hydroperiods, and promote more flow toward ENP during the months of August through mid-February; additional operational changes at S-194, S-196 and S-338 were also included for conditions when the capacity at S-332B, S-332C, and S-332D is unable to maintain the L-31N operational range (S-338 is located north of S-331).

The revised operating rules for S-197 include trigger criteria under Increment 1 were based on WCA-3A high water conditions, full gate openings at S-18C, and stage criteria in the C-111 basin at the S-178 tailwater to establish target flows at S-197. The Increment 1 operational plan also limited the Level 1 releases to 500 cfs for S-197 gate openings triggered by the S-178 tailwater stage. For Increment 1.1/1.2, the revised operating rules for S-197 included trigger criteria to achieve interim goals detailed in the operational strategy based on WCA-3A high water conditions and stage criteria in the C-111 basin at the S-18C headwater (including comparison of observed headwater compared to the historical monthly median stage) to establish target flows at S-197. The plan also capped the Level 1 releases to 500 cfs for S-197 gate openings triggered by the S-18C headwater stage criteria. Ideally, the complex operating rules at S-197 and for G-3273 constraint relaxation operations will provide discrete periods when potential effects from the C-111 Spreader Canal Western Project are separable from potential effects of the G-3273 relaxation operations.

Increment 2 further expanded the use of low-volume S-197 operations to include drier periods under Condition 1 when the stage at G-3273 is below 6.6 feet, NGVD and the WCA 3A stage is below the Increment 1 and 2 Action Line. The Increment 1.1 and 1.2 operational changes at S-332B, S-332C, and S-332D are retained for Increment 2.

To ensure that the existing level of flood protection is maintained within the C-111 Basin and adjacent areas potentially affected by the C-111 Spreader Canal Western Project, the Increment 2 monitoring plan will incorporate the ongoing SFWMD operations, monitoring, and performance assessments conducted as part of the CERP C-111 Spreader Canal Western Project. Extensive hydrologic modeling and socio-economic evaluations of the C-111 South Dade flood risk management performance was conducted during the parallel development of the COP.

C.5.3 Primary Objectives of Water Quality and Hydrology Monitoring Plan South of S-331

This is a supplemental monitoring effort associated with potential impacts to surface water and groundwater conditions south of the S-331 structure. There are four primary objectives:

1. Ensure existing levels of flood protection are maintained within the southern L-31N Basin (between S-331 and S-176).
2. Ensure existing levels of flood protection are maintained within the C-111 Basin (south of S-176).
3. Determine whether the COP operations contribute to flooding within the C-111 basin.
4. Determine whether the COP operational changes at S-197 ensure existing levels of flood protection are maintained within the C-111 Basin (south of S-176), including assessment of the trigger criteria used for S-197 gate openings.
5. Active Mandates and Permits

Water quality monitoring of inflows to ENP and park marsh stations is generally governed by the 1992 Consent Decree, and the TP Rule, and the 2012 Consent Order. Hydrologic monitoring in the lower L-31 basin and C-111 basins is primarily conducted to facilitate the complex structure operations. Continuing from Increment 2, COP will utilize a network of monitoring stations to demonstrate the effects of

operations on hydrology and water quality as well as compliance with water quality standards. Authorization to conduct the Increment 2 test was be obtained from the FDEP and this monitoring plan was included in that authorization by reference. The COP WQ monitoring plan for the S356 and other regional structures is already established and include in the existing FDEP operational authorizations or the Settlement Agreement monitoring requirements.

C.5.4 Monitoring Components

C.5.4.1 Project Baseline Monitoring

Existing water quality and hydrology data that have been collected in the L-31N and C-111 basins over the last 10-15 years (including the three increments of the MWD field test) will serve as the baseline data for the COP, similar to the approach used during the field tests. Refer to Section C.4.10.2.1 of Appendix C for additional details.

C.5.4.2 Construction Monitoring

Construction of the C-11 South Dade Project was completed in August 2018. No construction phase monitoring is anticipated for COP.

C.5.4.3 Post-Construction Monitoring (Effectiveness Monitoring)

Based on the water management and data evaluations conducted during Increment 2, the water quality and hydrologic monitoring plan for south of S-331 has been reviewed to match the needs of the COP update to the Water Conservation Areas - Everglades National Park - Everglades National Park to South Dade Conveyance System Water Control Plan.

C.5.4.4 Inventory of Existing Monitoring Networks

C.5.4.4.1 Surface Water Hydrology

At flow control structures, surface water hydrology measurements include headwater and tailwater stage and flow volume. At non-structure monitoring locations, surface water hydrology measurements include stage. Table C.5-1 shows a list of the existing, established hydrologic monitoring locations within the COP area of interest south of the S-331 pump. Reference maps which show these monitoring locations are included in Figure C.5-1, Figure C.5-2, and Figure C.5-3.

Table C.5-1. Gages and sensors for surface water hydrologic monitoring during the COP located south of S-331.

Feature	Parameter	Purpose	Responsible Party
S-331	HW, TW, Q	Canal level, flow volume	SFWMD
S-357	HW, TW, Q	Canal level, flow volume	SFWMD
G-3628	Stage	Depth, duration, recession	USGS
G-3437	Stage	Depth, duration, recession	USGS

Feature	Parameter	Purpose	Responsible Party
S-332B	HW, TW, Q	Canal level, flow volume	SFWMD
S-332C	HW, TW, Q	Canal level, flow volume	SFWMD
S-194	HW, TW, Q	Canal level, flow volume	SFWMD
S-196	HW, TW, Q	Canal level, flow volume	SFWMD
S-332D	HW, TW, Q	Canal level, flow volume	SFWMD
S-332DX1	HW, TW, Q	Southern Detention Area water level, flow volume	SFWMD
S-328	HW, TW, Q	Flow volume	SFWMD
RG4	Stage	Southern Detention Area water level	ENP
NTS18	Stage	Southern Detention Area water level	ENP
G-789	Stage	Depth, duration, recession	USGS
G-864A	Stage	Depth, duration, recession	USGS
G-613	Stage	Depth, duration, recession	USGS
G-3620	Stage	Depth, duration, recession	USGS
G-3355	Stage	Depth, duration, recession	USGS
G-3901	Stage	Depth, duration, recession	USGS
G-3627	Stage	Depth, duration, recession	USGS
S-176	HW, TW, Q	Canal level, flow volume	SFWMD
S-177	HW, TW, Q	Canal level, flow volume	SFWMD
S-178	HW, TW, Q	Canal level, flow volume	SFWMD
S-199	HW, TW, Q	Canal level, flow volume	SFWMD
S-200	HW, TW, Q	Canal level, flow volume	SFWMD
S-18C	HW, TW, Q, Precipitation	Canal level, flow volume	SFWMD
S-197	HW, TW, Q	Canal level, flow volume	SFWMD
ENP-TSB	Stage	Marsh water level	ENP
EVER8	Stage	Marsh water level	ENP
L31N to S-331*	Q	ADVMS (3) to measure flow volume	USACE
LPDC2	Stage	Water Level in 8.5 SMA Detention Cell and NDA Western Flow way	USACE
NDA1W	Stage	Water Level Monitoring in NDA Western Flow way	USACE
NDA1E	Stage	Water Level Monitoring in NDA Eastern Flow way	USACE
SDA1	Stage	Water Level Monitoring in SDA Western Flow way	USACE
SDA2	Stage	Water Level Monitoring in SDA Western Flow way	USACE

Notes: HW– headwater stage; TW– tailwater stage; Q– discharge (cfs)
* Proposed

C.5.4.4.2 Surface Water Quality

No new water quality monitoring efforts are planned for theCOP for areas south of the S-331 structure. The Increment 2 testing did not significantly affect water quality conditions south of the S-331 structure. For this reason, the existing water quality monitoring program which includes the collection of biweekly or monthly samples at the canal control structures will be sufficient for the purposes of this project. Readers are referred to the SFER report (SFWMD, 2013) for specifics on the location, frequency, and historic sampling results of monitoring performed at stations south of the S-331 structure.

C.5.4.4.3 Groundwater Hydrology

Several State and Federal agencies have constructed groundwater monitoring wells along the L-31N and C-111 canals. Table C.5-2 lists the existing groundwater level monitoring in these areas. The proposed groundwater monitoring plan will coordinate data acquisition from all wells shown in Figure C.5-1, Figure C.5-2, Figure C.5-3, Figure C.5-4 and Figure C.5-5. The result is a comprehensive groundwater monitoring network that will provide detailed data to evaluate effects of COP on the lower L-31 basin and C-111 basin.

C.5.4.4.4 Groundwater Quality

No new groundwater quality monitoring efforts are planned for the COP for areas south of the S-331 structure. The COP is not expected to significantly affect groundwater quality conditions south of the S-331 structure. For this reason, the existing water quality monitoring program which includes the collection of biweekly or monthly samples at the canal control structures will be sufficient for the purposes of this project. Readers are referred to the SFER report (SFWMD, 2013) for specifics on the location, frequency, and historic sampling results of monitoring performed at stations south of the S-331 structure.

Table C.5-2. Existing active and inactive monitor wells with real-time groundwater level data in the southern L-31N and C-111 basins.

Well	Location	Open Interval (ft NGVD29)	Access Data (real-time or near-time) and comments
G-613	25°24'27.4"N, 80°31'27.2"W; N side SR 9336 (Ingraham Hwy), 4 mi SW of Florida City	-10.8 to -12.9	http://waterdata.usgs.gov/nwis/uv?agency_code=USGS&site_no=252425080320001
G-3355	25°23'35.9"N,80°30'03.3"W, 40351 SW 192 Ave Everglades Alligator Farm	Total Depth - 7.4	http://waterdata.usgs.gov/nwis/inventory/?site_no=252332080300501&agency_cd=USGS
G-3620	25°23'07.5"N,80°32'29.3"W, S terminus SW 217th Ave 1.25 mi S of SR 9336	Total Depth - 5.5	INACTIVE:http://waterdata.usgs.gov/nwis/inventory/?site_no=252312080320301&agency_cd=USGS; well planned to be re-activated to support ongoing CERP C-111 Spreader Canal monitoring plan
G-3901	25°25'06.66"N,80°30'06.2"W SW 192nd Ave and SR 9663	Total Depth - 14.3	http://waterdata.usgs.gov/nwis/inventory/?site_no=252506080300601&agency_cd=USGS
G-864	Navy Wells Pineland Preserve, SW 354th St 25°26'20.8"N 80°30'30.4"W	Total Depth - 11.1	http://waterdata.usgs.gov/nwis/inventory/?site_no=252612080300701&agency_cd=USGS

Well	Location	Open Interval (ft NGVD29)	Access Data (real-time or near-time) and comments
G-864A	Navy Wells Pineland Preserve, SW 354th St 25°26'20.8"N 80°30'30.4"W	Total Depth - 11.7	http://waterdata.usgs.gov/nwis/inventory/?site_no=252619080310201&agency_cd=USGS
G-3437	25°34'01.2"N, 80°34'01.5"W, 0.17 mi N of SW 232 nd Ave & SW 216th St	Total Depth - 5.86	http://waterdata.usgs.gov/nwis/inventory/?site_no=253400080340401&agency_cd=USGS
G-789	25°29'28.7"N, 80°33'19.6"W Homestead Gen. Aviation Airport S	Total Depth - 22.4	http://waterdata.usgs.gov/nwis/inventory/?site_no=252928080332401&agency_cd=USGS
G-3336	25°20'16.1"N,80°33'56.3"W ENP: 2.6 mi WNW of S-18C	Total Depth - 33.5	http://waterdata.usgs.gov/nwis/inventory/?site_no=252007080335701&agency_cd=USGS
G-3338	25°20'15.86"N, 80°28.753”W, C-111 canal north of S-18C	Total Depth - 48.15	http://www.sfwmd.gov/dbhydroplsql/show_dbkey_info.date_selection?v_category=SW&v_category=GW&v_js_flag=Y&v_db_request_id=3647509&v_parameter_string=&v_dbkey=QS274&v_frequency=&v_sdate=20031106&v_edate=20150426
G-1251	25°19'15.9"N,80°33'56.7"W, ENP: 2.7 mi WSW of S-18C	Total Depth - 55.8	http://waterdata.usgs.gov/nwis/inventory/?site_no=251922080340701&agency_cd=USGS
G-3628	25'38.83"N, 80°32'04.74"W ENP: Eureka Dr 0.1 mi S of 8.5SMA detention area	Total Depth - 4.9	http://waterdata.usgs.gov/nwis/inventory/?site_no=253539080320501&agency_cd=USGS
G-3627	25°36'31.3"N,80°30'11.7"W Richmond Dr & SW 192nd Ave 0.46 mi SE of S-331	Total Depth - 4.1	http://waterdata.usgs.gov/nwis/inventory/?site_no=253632080321101&agency_cd=USGS
C111AW	25°23'35.5"N 80°33'13.4"W SW 224TH AVE 0.7 MI S OF SR 9336	Approximately -2 to -12	http://www.sfwmd.gov/dbhydroplsql/show_wilma_info.report_process?v_output_format=summary&v_os_code=win&v_station=C111AW
C111AE	25°23'33.4"N 80°32'29.8"W SW 217TH AVE 0.77 MI S OF SR 9336	Approximately -2 to -12	http://www.sfwmd.gov/dbhydroplsql/show_dbkey_info.show_dbkeys_matched?v_js_flag=Y&v_category=SW&v_category=GW&v_station=C111AE&v_dbkey_list_flag=Y&v_order_by=DBKEY
G-3349_G	25°20'27.0"N 80°29'37.0"W 2.1 MI ENE OF S-18C ON C-110	Total Depth - 59	INACTIVE:http://www.sfwmd.gov/dbhydroplsql/show_dbkey_info.show_dbkeys_matched?v_station=G-3349_G&v_js_flag=N
G-3350	25°21'15.0"N 80°29'35.0"W 1.4 MI S OF SW424TH ST ON C-110	Approximately 0.25 to 80.6	http://www.sfwmd.gov/dbhydroplsql/show_dbkey_info.show_dbkeys_matched?v_station=G-3350_G&v_js_flag=N

Well	Location	Open Interval (ft NGVD29)	Access Data (real-time or near-time) and comments
G-3354_B	25°18'42.4"N 80°28'38.0"W 0.82 mi N of Aerojet Canal 1.1 mi E of C-110	Not reported	INACTIVE:http://www.sfwmd.gov/dbhydroplsql/show_dbkey_info.show_dbkeys_matched?v_station=G-3354_B&v_js_flag=N
P-1, P-2, P-3, P-4, P-5, P-6, P-10*	CERP C-111 Spreader Canal Project Area (east of the L-31N Canal, located between S-331 and S-18C)	Design in Progress	Proposed wells may be installed by SFWMD contractors, concurrent with Increment 1.1/1.2 field test; well information may be incorporated into the Increment 1.1/1.2 monitoring, if available.
L31NW02 GW1; L31NW02 GW2; L31NW02 GW3 (prior P-2)	252933.3, 803233.3 (1.5 mi NE of S-332D)		C-111 Spreader Canal monitoring well completed by SFWMD in April 2017 (GW1 depth is 15 feet; GW2 depth is 35 feet; GW3 depth is 55 feet) http://my.sfwmd.gov/dbhydroplsql/show_dbkey_info.show_station_info?v_station=L31NW02GW1
L31NW03 GW1; L31NW03 GW2; L31NW03 GW3 (prior P-3)	252717.6, 803224.1 (2.5 mi SE of S-332D)		C-111 Spreader Canal monitoring well completed by SFWMD in March 2017 (GW1 depth is 15 feet; GW2 depth is 35 feet; GW3 depth is 55 feet) http://my.sfwmd.gov/dbhydroplsql/show_dbkey_info.show_station_info?v_station=L31NW03GW1
L31NW06	253247.0, 803242.5 (1.3 mi E of S-332B)		C-111 Spreader Canal monitoring well completed by SFWMD in February 2017. (Depth is 15 feet) http://my.sfwmd.gov/dbhydroplsql/show_dbkey_info.show_station_info?v_station=L31NW06GW
C111W11	252558.8 803237.8 (1.25 mi SE of S-200)		C-111 Spreader Canal monitoring well completed by SFWMD in February 2017. http://my.sfwmd.gov/dbhydroplsql/show_dbkey_info.show_station_info?v_station=C111W11
C111W12	252453.1, 803127.1 (2.4 mi NE of S-199)		C-111 Spreader Canal monitoring well completed by SFWMD in June 2015. http://my.sfwmd.gov/dbhydroplsql/show_dbkey_info.show_station_info?v_station=C111W12
C111W14	252438.9, 803201.1 (1.6 mi NE of S-199)		C-111 Spreader Canal monitoring well completed by SFWMD in August 2015.

Well	Location	Open Interval (ft NGVD29)	Access Data (real-time or near-time) and comments
			http://my.sfwmd.gov/dbhydroplsql/show_dbkey_info.show_dbkeys_matched?v_station=C111W14&v_js_flag=N
C111W15	252413.1, 803040.6 (2.9 mi E of S-199)		C-111 Spreader Canal monitoring well completed by SFWMD in August 2015. http://my.sfwmd.gov/dbhydroplsql/show_dbkey_info.show_dbkeys_matched?v_station=C111W15&v_js_flag=N
C111W16	252419.7, 802957.9 (3.7 mi E of S-199)		C-111 Spreader Canal monitoring well completed by SFWMD in May 2015. http://my.sfwmd.gov/dbhydroplsql/show_dbkey_info.show_dbkeys_matched?v_station=C111W16&v_js_flag=N
NDA1W	805066.7 452368.8 (NDA Western Flow Way)		DBHYDRO
NDA1E	805035.2 452240.2 (NDA Eastern Cell)		DBHYDRO
SDA1	797311.6 436248.9 SDA Western Flow Way)		DBHYDRO
SDA2	797469 426568.4 (SDA Western Flow Way)		DBHYDRO

NOTE: Additional resources will be required to activate those monitor wells indicated above as “INACTIVE”.
* Proposed new wells for CERP C-111 Spreader Canal project monitoring (wells are designated with interim well names).

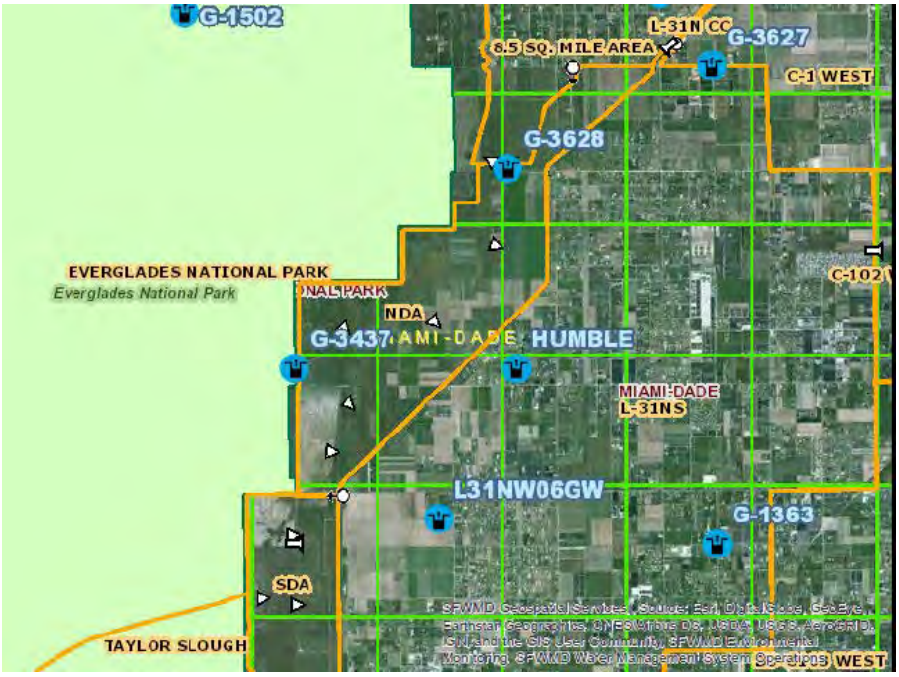


Figure C.5-1. Selected real-time groundwater monitoring stations and structures in southern L-31N basin.

Figure C.5-2. Selected real-time groundwater monitoring stations and structures in the northern C-111 basin.

Figure C.5-3. Selected real-time groundwater monitoring stations and structures in the central C-111 basin.

Figure C.5-4. Selected real-time groundwater monitoring stations and structures in the southern C-111 basin.

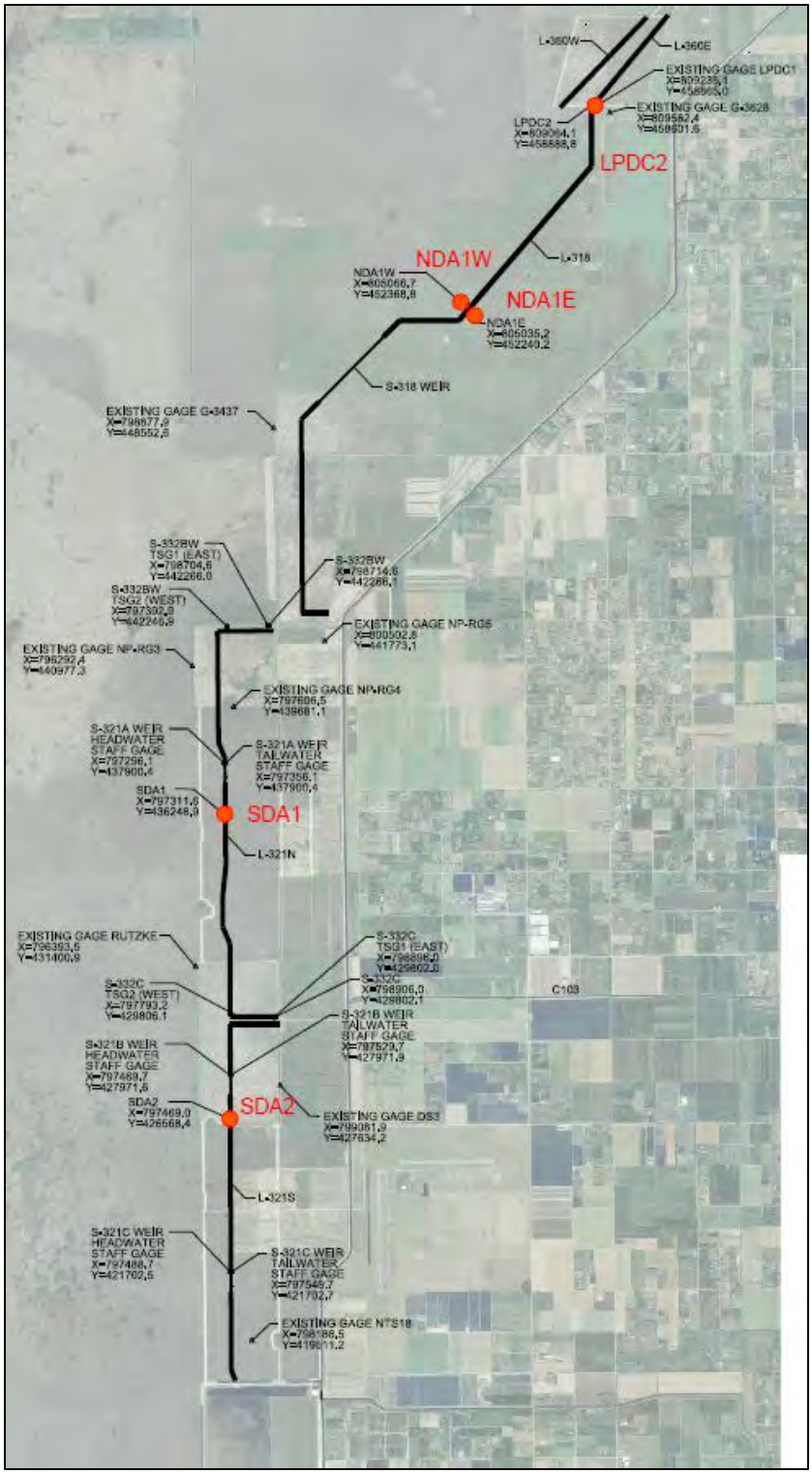


Figure C.5-5. Locations for the new monitoring stations in the C-111 Detention Areas.

C.5.4.5 Integration of Monitoring Components

New monitoring stations (refer to Section C.4.9) proposed as part of this project were selected based upon a review of the ongoing monitoring and the expected compliance requirements associated with the planned project features. Staff from SFWMD, USACE, DOI, and FDEP will work together to ensure that the new monitoring stations were consistent with the permit requirements and not duplicative of ongoing monitoring at existing stations.

C.5.5 Duration

This monitoring program is was conducted during the Increment 2 testing period, which is expected to last up to implementation of COP. The Increment 2 test i commenced prior to March 1, 2018. At the completion of Increment 2 testing, some of the new elements of this monitoring plan may be incorporated into the ongoing compliance monitoring efforts and/or ongoing water management operational assessments within the study area. At this time the Increment 2 surface water quality monitoring plan is expected to continue with the start of COP. Following implementation of COP, some of the surface water monitoring may be reduced in the future based on ongoing evaluations of requirements.

C.5.5.1 Modification or Termination Conditions

Modification of the water quality monitoring plan will be determined annually by the needs of the project, and the water quality monitoring plan has completely reassessed after the Increment 2 testing and no surface water quality monitoring changes are proposed. This monitoring plan may be changed to reflect any future design changes or permit requirements. It also may be terminated according to permit expiration dates or changes to the COP objectives. Decisions to adjust the monitoring plan will be coordinated through the project partners as well as the FDEP.

Monitoring plans for previous increments were developed assuming that major, ongoing monitoring programs that were not previously funded directly by the Project would continue to collect data relevant to the Project. Should any of these programs be discontinued or significantly curtailed, then the Federal and local sponsors of the COP Project will reevaluate monitoring priorities.

C.5.6 New Monitoring/Sampling Locations and Naming Convention

A description of new monitoring locations, or modifications to existing monitoring locations are provided below. Costs associated with the proposed monitoring plan are not provided in this document.

C.5.6.1 Surface Water Hydrology

C.5.6.1.1 Flow Measurements Along L-31N and C-111 South of the S-331 Structure

The flow measurements taken at the S-332X pump stations, S-331, S-176 are expected to be sufficient to characterize flow conditions in this reach of L-31N. Measurement of flows at the S-199, S-200, S-178, S-177, S-18C, and S-197 structures is sufficient to characterize flow conditions within the C-111 canal. In stream flow velocity measurements were considered during the development of this plan; however, several PDT members stated that it would be difficult to interpret this information given the transverse

flow from the groundwater system to the canal system. No additional installation of new ADVM sensors along L-31N was conducted during the field tests.

C.5.6.2 Surface Water Quality Monitoring Plan

No supplemental water quality monitoring below the S-331 structure is included in the plan.

C.5.6.3 Groundwater Hydrology

All existing groundwater monitoring stations described in Section C.4.7.4.3 will be included in COP.

C.5.6.4 Groundwater Quality

No supplemental groundwater quality monitoring is included for areas below the S-331 structure.

C.5.6.5 Access and Authority

New monitoring stations located at water control structures or along the L-31N Canal, if necessary, will be accessed via existing levees or public roadways. To perform environmental sampling within ENP, a sampling and access permit will first be obtained from the park service.

C.5.7 Project Reporting

Technical reporting and evaluations were reported by USACE during the MWD Incremental field tests in accordance with FDEP permit requirements, and the monitoring results were updated to the COP interagency PDT through regular quarterly meetings for the duration of the field tests. Information gained through the field test monitoring has been incorporated into the COP alternative formulation and hydrologic modeling process, culminating in the COP Recommended Plan detailed in the EIS and the supporting COP Water Control Plan. No further hydrologic data reporting will be conducted under COP based on the hydrometeorologic monitoring plan; rather, further reporting will be conducted in accordance with the commitments identified in the COP Adaptive Management and Monitoring Plan.

In addition to current operational monitoring along L-31N (north of S-176), this monitoring plan relies upon the continued monitoring and flood impact analysis reporting conducted by the SFWMD for the C-111 Spreader Canal Western Project. No water quality assessment will be specifically performed to identify COP impacts for areas below S-331. The SFER and Settlement Agreement Reporting for Taylor Slough will be referenced for water quality assessment in this area.

C.5.7.1 Frequency

Data will be analyzed during COP as described in this monitoring plan and operational strategy (Appendix C), in accordance with the commitments identified in the COP Adaptive Management and Monitoring Plan. Hydrometeorological monitoring information routinely tracked for assessment by USACE, SFWMD, and ENP water managers (refer to Section C.4.10.2.1 of Appendix C) will be updated on a daily basis and available for review on the Jacksonville District Water Management web pages:

http://www.saj.usace.army.mil/Missions/CivilWorks/WaterManagement.aspx

and

http://w3.saj.usace.army.mil/h2o/reports/r-fti1.html

C.5.7.2 Content and Format

These details are provided in the main monitoring report (Section C.4.10 of Appendix C).

C.5.7.3 Revisions and Modifications

- November 2016: Monitoring plan revised for Increment 1.1/1.2 updates. There was no significant changes in monitoring requirements. Only changes were addition of Western Shark Slough per 2016 USFWS BO and S-328 per SFWMD Florida Bay Initiative.
- November 2017: Five more wells were added to C-111 Basin monitoring as shown in Figure C.5-5: Three additional wells within the expanded C-111 South Dade Northern Detention Area and two additional wells in the Southern Detention Area. Installation of two additional wells within the 8.5 SMA interior is under consideration.
- October 2019: Monitoring plan revised for COP updates.

C.5.7.4 SFWMD C-111 Spreader Canal Reporting

Concurrent with the COP, the SFWMD will continue to operate the C-111 Spreader Canal Western Project. Consistent with the requirements of the February 2017 re-issued C-111 Spreader Canal regulatory permit from the Corps, the SFWMD is continuing to assess south Miami-Dade water conditions and existing operations, including those of the C-111 Spreader Canal Project, on a quarterly basis for a minimum of five years to ensure project features are constructed and operated not to adversely affect adjacent lands outside and within the C-111 Spreader Canal Western Project boundary with regards to water quantity, water quality, and/or flooding. The purpose of the assessment and quarterly reports are to ensure the SFWMD has the best available information to determine what operational system changes, if any, are necessary to avoid adverse water levels on adjacent lands. The enhanced reporting by SFWMD will also benefit the monitoring objectives of the current Increment 1.1 and 1.2 field test and the Increment 2 field test. It is anticipated that additional information generated from the ongoing SFWMD monitoring within the C-111 Spreader Canal Western Project area will be considered during development of the COP. The SFWMD quarterly assessment reports include discussion of project operations, hydrometeorological monitoring, observed environmental conditions (e.g., rainfall), and water management activities. Quarterly reporting of water management operations within the South Dade Conveyance System described below will be based on the daily average canal stages along the eastern boundary of ENP, the time of year, forecasts, availability of water, and preparation for transitional operations.

- The operational range for the L-31N from S-331 to S-176 will be from 4.0 to 4.6 feet NGVD, as maintained by the S-332B, S-332C, and S-332D pump stations in combination with the S-176 spillway.

- The operational range for the C-111 from S-176 to S-177 will be from 3.0 to 3.6 feet NGVD, as maintained by the S-200 and S-199 pump stations in combination with the S-177 spillway.
- The operational range for the C-111 from S-177 to S-18C will be from 2.0 to 2.6 feet NGVD, as maintained by the S-18C spillway.

The SFWMD is also continuing collection of groundwater monitoring data at the identified wells adjacent to the South Dade Conveyance System. This information is then utilized in the SFWMD Water Depth Assessment Tool (WDAT) South Florida tool. The WDAT-South Florida interpolates between existing ground water level gauges to produce spatially continuous estimates of mean daily groundwater elevations for the C-111 Basin. The gauges used for WDAT water level mapping vary depending on the activation, which is periodically re-assessed. Water depth surfaces are calculated by subtracting known ground surface elevations (or gridded elevation models) from the interpolated water elevation surfaces, and the resultant water levels reported on color ramped maps. WDAT can be accessed at the link https://my.sfwmd.gov/wdat/c111/animation/animation_current.html

C.5.8 Administration and Implementation of the Monitoring Plan

Training or Certification: Field and laboratory training requirements are specified in the FDEP SOPs and FSQM for the field and in the NELAP standard and CLQM for the laboratory

C.5.8.1 Organization Structure and Responsibilities

This monitoring effort is intended to be collaborative effort of the USACE, SFWMD, and ENP. The roles and responsibilities for field collection, laboratory analysis, and reporting are detailed by activity in Table C.5-3. The sampling plan relies heavily upon the ongoing regulatory compliance monitoring conducted by the SFWMD as well as the monitoring and analysis conducted by the SFWMD as part of the C-111 Spreader Canal project. Field sampling responsibilities are split between the USACE, SFWMD, and ENP. The USACE or SFWMD are likely to be the responsible parties if new monitoring wells are constructed in the areas that are useful to the Increment 2 test project. If the USACE installs new wells, they will likely contract with the USGS to conduct the stage monitoring and reporting of these wells. The USACE will provide information to the SFWMD so that additional stations can be registered in DBHYDRO.

Table C.5-3. Agency roles and responsibilities for each activity for monitoring south of the S-331 structure.

Activities	Installation of New Monitoring Locations	Station Registration in DBHYDRO	Field Collection & Lab Reporting	Well Installation	Analysis and Reporting of Collected Data
1. Ongoing Surface Water Quality Compliance Monitoring and Reporting per PIR and Corps Regulatory Permit	--	--	SFWMD	--	SFWMD
2. Ongoing C-111 Spreader Canal Monitoring*	--	--	SFWMD	--	SFWMD
3. Increment 2 Specific Groundwater Level Monitoring	USACE	SFWMD	USGS	USACE	USACE, ENP

*SFWMD will continue to separately provide the annual South Florida Environmental Report and the annual Settlement Agreement Report. In addition the SFWMD will provide USACE with quarterly monitoring reports in accordance with the requirements of the Department of Army permit for C-111 Spreader Canal.

C.6 Water Quality and Hydrology Monitoring Plan for 8.5 SMA Flood Mitigation

C.6.1 Purpose

While the near record-high Water Conservation Area (WCA) 3A stages during February-March 2016 created many water management challenges, the 2016 Temporary Emergency Deviation executed in response to these conditions provided valuable information on the responses within Everglades National Park (ENP) and the South Dade Conveyance System (SDCS) to raising of the L-29 Canal, including evaluation of operational limitations of the 8.5 Square Mile Area (SMA) flood mitigation project prior to completion of the Modified Water Deliveries (MWD) and Canal 111 (C-111) South Dade projects. Based on information gained during operation during the 2016 Temporary Emergency Deviation and the subsequent expanded recovery period, in addition to the inclusion of additional operational flexibility within the Operational Strategy for Increment 1.2 allowing operation of the L-29 Canal to a maximum operating limit of 7.8 feet NGVD, an expanded hydrologic monitoring plan for the 8.5 SMA was developed to complement the revised objectives of the Increment 1.1/1.2 Operational Strategy starting in February 2017. The expanded hydrologic monitoring plan for the 8.5 SMA was continued to inform water management decisions under Increment 2, starting in February 2018. Following completion of the C-111 South Dade Northern Detention Area (NDA) and Southern Detention Area (SDA), the L-29 Canal maximum operating limit was incrementally raised to 8.0 feet NGVD in July 2018, 8.25 feet NGVD in August 2018, and up to the MWD Tamiami Trail roadway design limit of 8.5 feet NGVD in September 2018. The maximum operating limit of 8.5 feet NGVD will govern Increment 2 operations through the implementation of the COP in 2020.

The monitoring plans for surface water hydrology and groundwater hydrology for the MWD Incremental Field Tests will continue to provide data to assess performance of the 8.5 SMA project components, including S-357 and S-357N (pending construction completion), to maintain the surface water and groundwater levels within the project areas of the 8.5 SMA, between the L-357W Levee and the L-31N Levee at the same levels as existed prior to the implementation of any MWD Project components. As retained throughout the MWD incremental field tests, Increment 2 enabled water managers to implement a testing protocol to assist in defining operating criteria for the new 8.5 SMA S-357N water control structure following completion of the structure construction in February 2018.

The preliminary recession rate and hydroperiod target limits identified within this Section C.6 will continue to be evaluated for the duration of the MWD Incremental Field Test. Ongoing hydrologic monitoring, data evaluation, and water management experience over the previous 3 years have demonstrated the robustness of these targets to guide weekly water management decisions and ensure continued compliance with the 8.5 SMA authorized flood mitigation requirements. Additional water management assessment criteria and/or further refined target limits may be incorporated in future updates to this monitoring plan, if needed to respond to new information collected during the Increment 2 field test or during implementation of the COP Adaptive Management and Monitoring Plan. Periodic updates will continue to be provided at the interagency PDT+ meetings.

C.6.2 History and Background

The 8.5 Square Mile Area (8.5 SMA), also referred to as the Las Palmas Community, is an inhabited area bounded on the west by the ENP, and separated from more intensively developed urban lands to the east by the L-31N Levee and borrow canal. In 1992, a flood mitigation plan was authorized for the 8.5 SMA as part of the MWD to ENP Project. The 1992 General Design Memorandum (GDM) plan included the construction of a protective levee and seepage canal around the north and west perimeter of the 8.5 SMA that would mitigate for higher stages associated with implementing the MWD Project. The GDM also included a 950 cfs pump station along L-31N to convey flood mitigation discharges from the 8.5 SMA into the L-29 Canal and the ENP NESRS. The 1992 GDM plan did not provide a hydraulic connection between the MWD 8.5 SMA and the C-111 South Dade Northern Detention Area (NDA).

In 2000, the USACE prepared the MWD General Reevaluation Report (GRR) and a Final Supplemental Environmental Impact Statement (SEIS) to assist in the selection of a Recommended Plan for providing flood mitigation to the 8.5 SMA while allowing for restoration of the Northeast Shark River Slough (NESRS) as authorized by the MWD Project. Consistent with the 1992 GDM analysis, it was a requirement of the reevaluation to analyze alternatives that provided no increase in flooding above and beyond what existed prior to the authorization of the MWD Project. The GRR recommended plan, Alternative 6D, included construction of a perimeter levee (Levee 357W [L-357W]), internal levees, an interior seepage collection canal (C-357), a new pump station (S-357), and a detention area (8.5 SMA Detention Cell) that would discharge into the proposed C 111SD NDA. The GRR/SEIS presented hydrologic modeling simulations, social impact assessments, policy analysis, real estate information, engineering design and cost analysis, environmental impact assessment, economics calculations and review of public concerns. The Record of Decision (ROD) for the 8.5 SMA GRR/SEIS stated that it would be implemented with added assurances and conditions described there in. One of those assurances and conditions is that “periodic flooding of landowners east of the proposed levee, before and after project implementation, will remain unchanged from conditions in existence prior to implementation of the MWD Project except where flowage easements are required.” The ROD further prescribed that: “Implementation of the Recommended Plan should not adversely impact the restoration levels of Everglades National Park's hydrology greater than that simulated through modeling of Alternative 6D” (the GRR Recommended Plan); “A monitoring, evaluation, and reporting program shall be implemented to ensure operations are consistent with these levels”; and “No deviations are intended from the operations specified in the Manual (i.e., increased pumping in the seepage canal or the inclusion of additional pumps) due to anticipated public demand for increased flood relief inside the perimeter levee of the 8.5 SMA Project.” The Hydraulic and Hydrogeologic Model Report (Appendix A) for the 2000 GRR also recognized that the final operation of the C-111SD pump stations and detention areas would require further study beyond the scope of the GRR effort, while also including recognition that the C-111SD components represented a large change in the local flow regime which could affect the study area.

The Corps completed construction of the 8.5 SMA features identified in the 2000 GRR in 2009. The features were operated and monitored under a testing mode, and the Corps and South Florida Water Management District (SFWMD) concluded that additional features were necessary to ensure the proper required level of mitigation is provided to the 8.5 SMA. The Corps completed construction of the final physical features of the MWD Project (Structure S-357N and Canal C-358) in February 2018. The

completed MWD Project will provide additional inflows to ENP by conditionally raising the maximum operating limit of the L-29 Canal up to 8.5 feet NGVD following the acquisition of the required real estate interests along the Tamiami Trail roadway by the Corps and DOI/ENP (completed in 2017) and functional completion of the C-111 NDA (completed in 2018), while maintaining adherence to both the FDOT constraints for protection of the Tamiami Trail roadway and the 8.5 SMA flood mitigation constraints. The Combined Operational Plan (COP) will implement a comprehensive integrated water control plan for the operation of the water management infrastructure associated with the MWD and C-111 South Dade Projects.

The 8.5 SMA is designed to provide mitigation for the increased water levels that will occur once the MWD project is fully implemented and the associated additional water flows are delivered to ENP. The 8.5 SMA flood mitigation features do not work independently, as full mitigation is dependent on both the MWD 8.5 SMA features and the C-111 South Dade project features. The MWD project and the C-111 South Dade project work together, and implementation of a Water Control Plan which provides more water deliveries (out of WCA-3A and into the ENP) could not occur without adversely impacting private property within the 8.5 SMA until the C-111 South Dade NDA is constructed, operational, and connected to the 8.5 SMA Detention Cell. The hydraulic connection between the 8.5 SMA and the NDA, which was envisioned by the 2000 MWD GRR/EIS for the 8.5 SMA, creates an interdependency between MWD and C-111SD project operations which affects the flood mitigation performance for the MWD 8.5 SMA components, the flood protection performance of the C-111SD project components, and the hydrologic/ecological benefits for both the MWD and C-111SD projects. Completion of the C-111 South Dade new NDA detention area and additional interior berms within the existing SDA was determined to be functionally complete in August 2018.

The full implementation of the MWD Project, including operations of the L-29 Canal up to the MWD Tamiami Trail roadway design limit of 8.5 feet NGVD, was limited prior to providing flood mitigation to the 8.5 SMA, and 8.5 SMA flood mitigation requirements were a constraint throughout all increments of the MWD field test and during development of the COP. With respect to operation of the L-29 Canal, the COP Water Control Plan includes: (1) raising of the maximum operational limit in the L-29 canal up to 8.5 feet NGVD; and (2) removal of the 6.8 foot NGVD constraint at G-3273; (3) priority use of the S-357 and S-357N water control structures to provide flood mitigation to the 8.5 SMA interior; and (4) conditional use of the S-331 pump station to provide supplemental assistance to S-357/S-357N during periods of extreme high water conditions within the 8.5 SMA interior flood mitigation area. Throughout all phases of the MWD field test and under COP implementation, USACE operations cannot cause the 8.5 SMA to endure a greater duration of high water and higher flood stages than they would have experienced prior to MWD implementation of increased flows to ENP. Given the nature of these constraints, raising of the L-29 Canal maximum operating limit under the COP requires continuous monitoring of conditions both along the Tamiami Trail roadway and within the 8.5 SMA.

Within the 2000 GRR, the simulated water levels within the 8.5 SMA for the Recommended Plan were shown to be at or below simulated pre-MWD water levels (referred to in the GRR as the “1983 Base”), using the 1995 rainfall as representative of wet hydrologic conditions. The “1983 Base” assumptions included no inflows from WCA-3A to the Northeast Shark River Slough, with S-333 and S-334 only used to

provide water supply deliveries to the South Dade Conveyance System. The hydrologic modeling in the GRR, which utilized the USACE MODBRANCH model, evaluated the following:

- Spatial extent of flooding across the 8.5 SMA protected area and agricultural areas located northeast of the 8.5 SMA;
- Flood duration/hydroperiod and recession rates assessed for May through September 1995 (week 21 through 37);
- Flood inundation depths, which were used to compute economic damages and flowage easement requirements (an event which approximated a Standard Project Flood event was used to assess achievement of flood mitigation – mitigation was assumed achieved if week 26 stages below "Base 1983").

The COP development utilized regional hydrologic modeling in order to balance the ecological restoration objectives of the MWD and C-111SD projects while demonstrating compliance with the project constraints, which included requirements to maintain the mitigation for project induced flood damages in the 8.5 SMA and to maintain the level of flood damage reduction associated with the 1994 C-111 GRR Recommended Plan. The results from the COP MD-RSM modeling were used to update the flood mitigation analysis for the MWD 8.5 SMA GRR (refer to Appendix H, Annex 6 of the COP EIS) and to update the flood risk management analysis from the 1994 C-111 South Dade GRR (refer to Appendix XX of the COP EIS), which did not then identify inter-basin transfer of water from the MWD 8.5 SMA to the C-111SD Project lands. Development of the COP was informed by the MWD Increment 1, Increment 1.1/1.2 and Increment 2 field tests. Constraints included in the monitoring plans for the field tests and COP may result in discontinuation of the field tests if adverse impacts to flood damage reduction are indicated as a result of the field test operations. The COP modeling analysis quantitatively characterizes the degree to which operational constraints for the Tamiami Trail roadway and/or the 8.5 SMA limit inflows and associated potential restoration benefits within Northeast Shark River Slough, if applicable.

C.6.3 Assessment Methodology

C.6.3.1 Recession Rates at LPG-1 and LPG-2

Local rainfall is a significant source of freshwater in the 8.5 SMA. Prior to construction of the MWD 8.5 SMA components, after intense precipitation, surface water was removed through evapotranspiration, seepage to the underlying Biscayne Aquifer, or drainage through the L-31N canal along the eastern portion of the 8.5 SMA (located 1.5 to 2.5 miles east of the western-most portion of the current 8.5 SMA protected area). Excess rainfall, particularly during the wet season, often inundated most of the 8.5 SMA, which historically contributed to the sheet flow that supplied surface water to the ENP on a regional scale. Canals, such as L-31N, tend to speed surface water drainage and preclude the natural seepage process to the underlying aquifer.

The 8.5 SMA S-357 pump station was initially operated in June 2009. Prior to completion of the COP, since no new comprehensive hydrologic modeling study for the 8.5 SMA has been completed since the 2000 GRR, pre-project conditions are characterized using the historical response of the 8.5 SMA basin to rainfall events prior to completion of the MWD 8.5 SMA levees, seepage collection canals, and pump station.

Angel's Well, located 0.25 miles west of the current 8.5 SMA leveed area, provides a surrogate for pre-project inundation duration (hydroperiod above ground surface) within the western 8.5 SMA (the area closest to ENP, where MWD will increase water levels); the current LPG-1 and LPG-2 monitoring gauges were not installed until 2009. Daily precipitation at the S-331 pump station, which is located adjacent to the southeast corner of the 8.5 SMA, provides a long-term record to correlate to the hydroperiods experienced at Angel's Well. The coincident period of record for Angel's Well and S-331 precipitation, prior to initial operation of the 8.5 SMA S-357 pump station (1991 through 2009), was used to establish general recession rate targets and acceptable hydroperiod durations to facilitate real-time assessment of flood mitigation performance. Although the Interim Operating Plan for the 8.5 SMA was identified in June 2011, data from the interim testing period from June 2009 through May 2011 was excluded from the pre-project assessment. Monitoring location G-1502, which has a period of record extending back to 1973, was not used for this analysis since this gauge is located nearly 3 miles west of the current 8.5 SMA perimeter levee and benefits from enhanced drainage associated with the historical Northeast Shark River Slough channel.

The following process, illustrated in Figure C.6-1, was used to characterize the pre-project hydrologic response for the 8.5 SMA.

- Recession event defined as consecutive days with decreasing groundwater elevation at Angel that occurs above ground surface elevation (6.3 feet NGVD);
- Hydroperiod defined as days above ground surface elevation;
- Precipitation total is the sum of daily rainfall that preceded the recession event;
- Evaluate top 90% of recession events (eliminate slowest observed recessions, as non-indicative of typical hydrologic response);
- Excluded daily rainfall less than 0.1 inch when establishing rainfall duration.

The pre-project response delineated target operational criteria for both a "target" performance range and an "acceptable" performance range during Increment 1 operations. Hydrologic response is intended to be continually analyzed across a wide range of temporal scales, including daily (early detection metrics), weekly, monthly, seasonal, and annual (water year) periods to inform real-time operations and identify potential performance limitations of the current 8.5 SMA and C-111 South Dade infrastructure configuration.

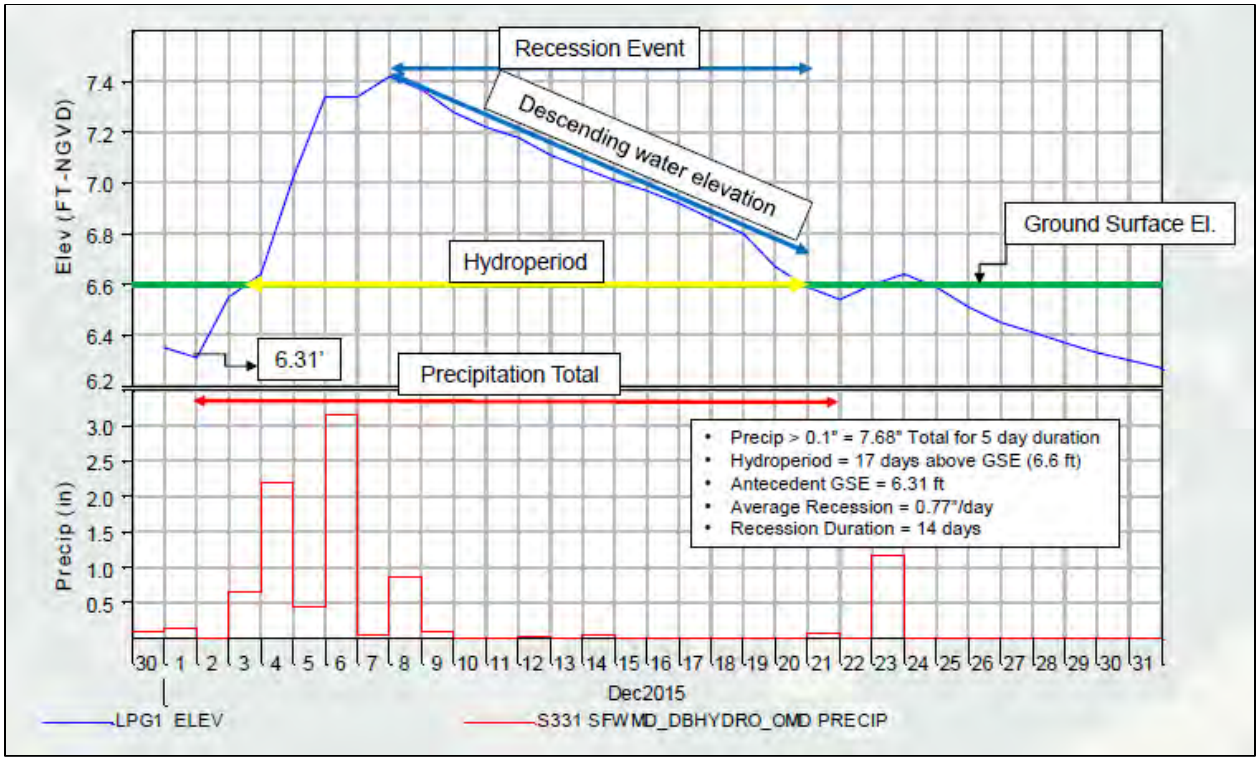


Figure C.6-1. Terminology for 8.5 SMA flood mitigation assessment.

With the configuration of the 8.5 SMA flood mitigation project under Increment 1.1 and 1.2, prior to operation of the C-111 South Dade NDA, water levels inside the 8.5 SMA were observed to be affected by the following factors: direct rainfall (westward drainage toward ENP may be restricted by the L-357 Levee); surface and groundwater levels within ENP (the G-3273 constraint of 6.8 feet NGVD limited water levels in NESRS prior to the Increment 1 field test, except during IOP/ERTP Column 2 operations); surface water levels inside the 8.5 SMA Detention Cell (which can result in increased return seepage into the C-358 Canal and around the southwest corner of the current L-357 Levee); and L-31N Canal stages, which are controlled by G-211 and S-331 east of the 8.5 SMA and controlled by S-332B, S-332C, S332D and S-176 southeast of the 8.5 SMA and east of the 8.5 SMA Detention Cell.

For short duration direct rainfall events (less than 7 days of continuous inundation within the 8.5 SMA interior flood mitigation area), the analysis of pre-MWD project data indicated that: (1) the recession rate is generally inversely related to rainfall accumulation, for a given duration; and (2) the recession rate is also affected by available groundwater storage (e.g., antecedent conditions). Antecedent conditions were classified as providing limited groundwater storage and infiltration capacity if groundwater levels were within 1.0 feet of the ground surface elevation at Angel's Well (6.3 feet NGVD). Table C.6-1 was derived from analysis of the pre-project data to provide performance recession rate targets for short duration rainfall events. The recession rate targets derived from this analysis have been used to inform operation of S-357 and S-331 during the MWD Incremental field test, based on real-time monitoring of recession rate responses at LPG-1 and LPG-2 following rainfall events which trigger pump operations at S-357 and/or

S-331. For example, if recession rate targets are not achieved following a rainfall event (assuming no continued rainfall), pumping at S-357 may be initially increased by lowering the C-357 target canal stage; if recession rate targets continue to not be achieved with increased pumping at S-357, then S-331 may be temporarily operated to lower L-31N Canal levels to improve the pump efficiency at S-357 to lower water levels at LPG-1 and/or LPG-2; if recession rates continue to not be achieved following lowering of both C-357 and L-31N, then inflows into the L-29 Canal may be temporarily reduced if necessary. This general sequence for operational priority was included within the Operational Strategy for Increment 1.1/1.2 and Increment 2, and the sequence is retained for the COP Water Control Plan. Recession rate targets for 1-3 day rainfall events are shown on Figure C.6-2, and recession rate targets for 4-7 day rainfall events are shown on Figure C.6-3.

Table C.6-1. Preliminary recession rate targets for short duration rainfall events.

Rainfall Duration	Rainfall Volume	Recession Rate (in/day) when Antecedent Conditions > 1 ft below GSE	Recession Rate (in/day) when Antecedent Conditions < 1 ft below GSE
1 - 3 days	0 - 2.5”	1.20	0.4
1 - 3 days	> 2.5”	0.84	0.4
4 - 7 days	> 2.5”	0.60	0.4

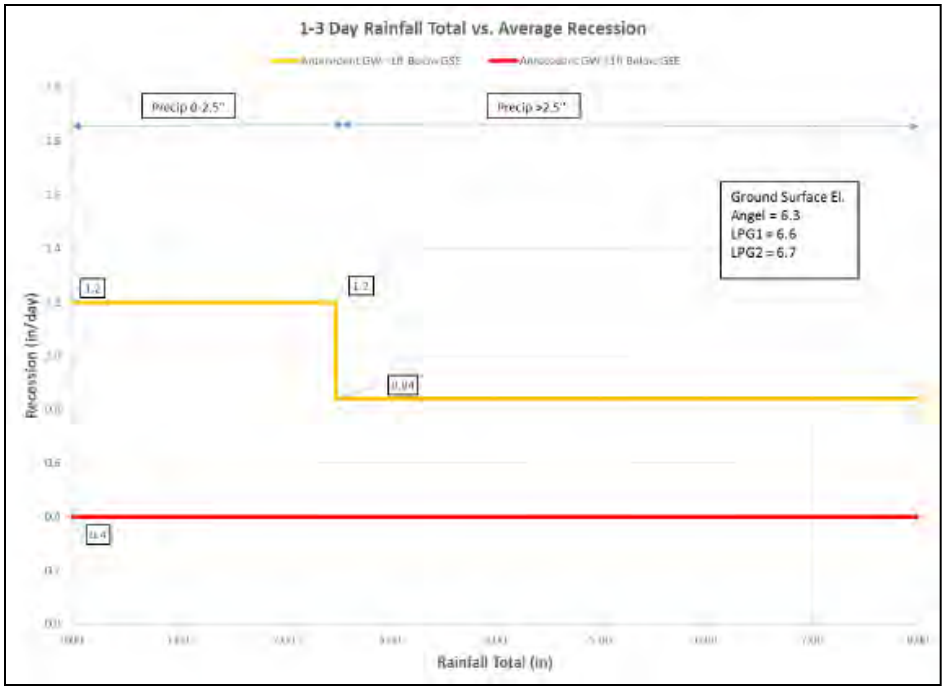


Figure C.6-2. Preliminary recession rate targets for rainfall events with duration of 1 to 3 days.

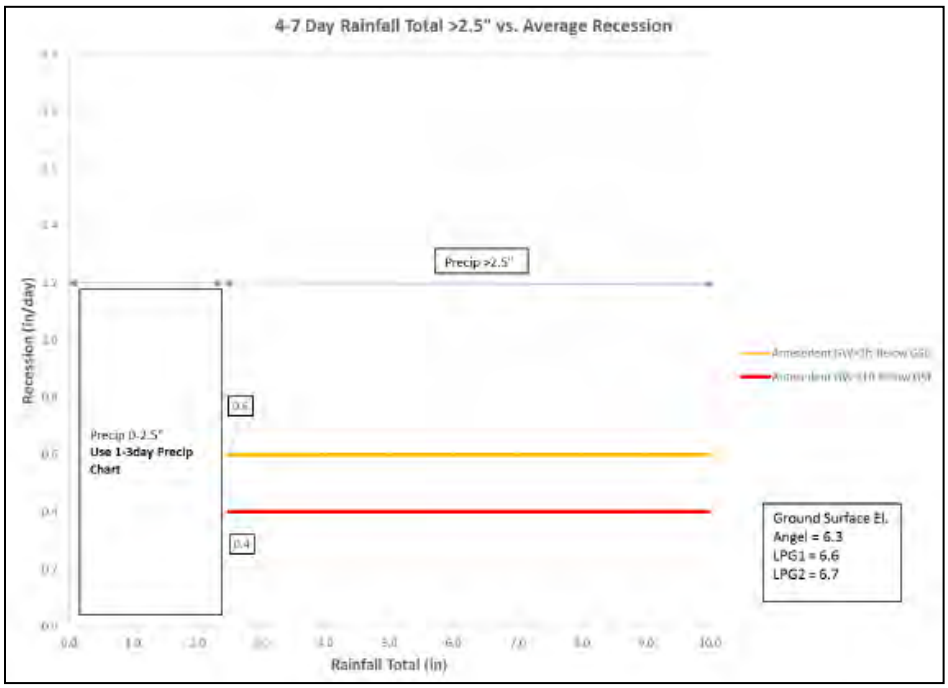


Figure C.6-3. Preliminary recession rate targets for rainfall events with duration of 4 to 7 days.

C.6.3.2 Hydroperiod Response to Rainfall Events

Hydrologic response within the 8.5 SMA immediately following isolated rainfall events which result in less than 7 days of continuous inundation within the 8.5 SMA interior flood mitigation area will be tracked using the recession rate targets identified in Section C.6.3.1. The cumulative number of consecutive days with water stages above ground at LPG-1, LPG-2, LPG-17 and other 8.5 SMA interior monitoring stations will also be monitored in response to longer-term accumulations of rainfall, including 15-day, 30-day, and 60-day rainfall totals. Figure C.6-4 was generated from an assessment of historical S-331 daily rainfall and historical rainfall events (1991 through 2009) which resulted in a prolonged continuous hydro-period at Angel's Well. To develop this graphic, and to account for the cumulative effects of continuous wet season rainfall patterns typical of South Florida: the maximum 15-day running rainfall total was computed for each hydroperiod event with durations less than 15 days; the maximum 30-day running rainfall total was computed for each hydroperiod event with durations between 16 and 30 days; and the maximum 60-day running rainfall total was computed for each hydroperiod event with durations greater than 30 days. Historical events with hydroperiods greater than 30 days are labeled with the corresponding event date. The lower limit for "acceptable" performance threshold (above the yellow line) was delineated using historical events within 0.5 standard deviations of the average for all historical events. The lower limit for "restricted" performance threshold (between the yellow and the red line was delineated using historical events within 1.0 standard deviation of the average for all historical events; given the limited sample size, durations within this range may not adhere with the historical pre-MWD drainage rates observed for the 8.5 SMA, and water management decisions during the field tests and COP should avoid hydroperiod durations which fall within this range. For the acceptable (yellow) and restricted (red) performance thresholds, 67% (24 of 36 events) and 89% (32 of 36 events) of historical observed rainfall and hydro-period events fell above these lines, respectively. Observed rainfall and hydro-period events which are projected to exceed (to the right of the red performance threshold) the lower limit of the "acceptable" performance threshold (11% of events) provide an indication that further operational changes are needed to ensure achievement of the required 8.5 SMA flood mitigation performance. During development of the field test operational criteria, operational changes were identified to include additional utilization of S-331 to reduce the necessity for S-357 pump operations, increased pump operations at S-357, and/or consideration of additional operational constraints for inflows to NESRS.

Based on monitoring, data evaluation, and water management experience during the field tests, the majority of the COP operational criteria for S-357 and S-331 were unchanged from the Increment 2 field test. For S-357, the notable change for COP iis the inclusion of operational flexibility to consider lowering the S-357 headwater stage range to a minimum limit of 2.3 to 3.0 feet NGVD and lowering of the S-331 headwater stage range to a minimum limit of 2.8 to 3.5 feet NGVD when the G-3273 stage is greater than 7.5 feet NGVD and the LPG-2 stage trend is not expected to recover in accordance with the 8.5 SMA flood mitigation criteria; these operations may be continued until LPG-2 can be maintained between 6.2 and 6.6 feet NGVD. Based on operational experience, at elevated water levels above 7.5 feet NGVD at G-3273, both S-357 and S-331 pump stations will need to be operated in tandem in order to manage the increased seepage from NESRS and L-31N Canal into 8.5 SMA while providing the required flood mitigation. The operating intent is to transition S-331 to normal operations prior to S-357 returning to normal operations. Similar to the field tests, the COP Water Control Plan also includes the ability for WCA-3A flows to NESRS to be temporarily suspended until water levels in 8.5 SMA (specifically the area west of C-357 Canal)

recede below ground surface elevations, if conditions are experienced when both S-357 and S-331 operate at the lowest canal settings and the 8.5 SMA flood mitigation hydroperiod response criteria are not met.

Concurrent with the development of the COP, operations during the MWD field test were conducted to target hydroperiod durations below the "acceptable" performance threshold for a given periodic rainfall accumulation, to the maximum extent possible given other field test operational considerations. The assessment methodology for 8.5 SMA flood mitigation will continue to be informed by new information collected during the MWD Incremental 2 field test and the COP Adaptive Management and Monitoring Plan, and may be periodically revised if warranted by new information.

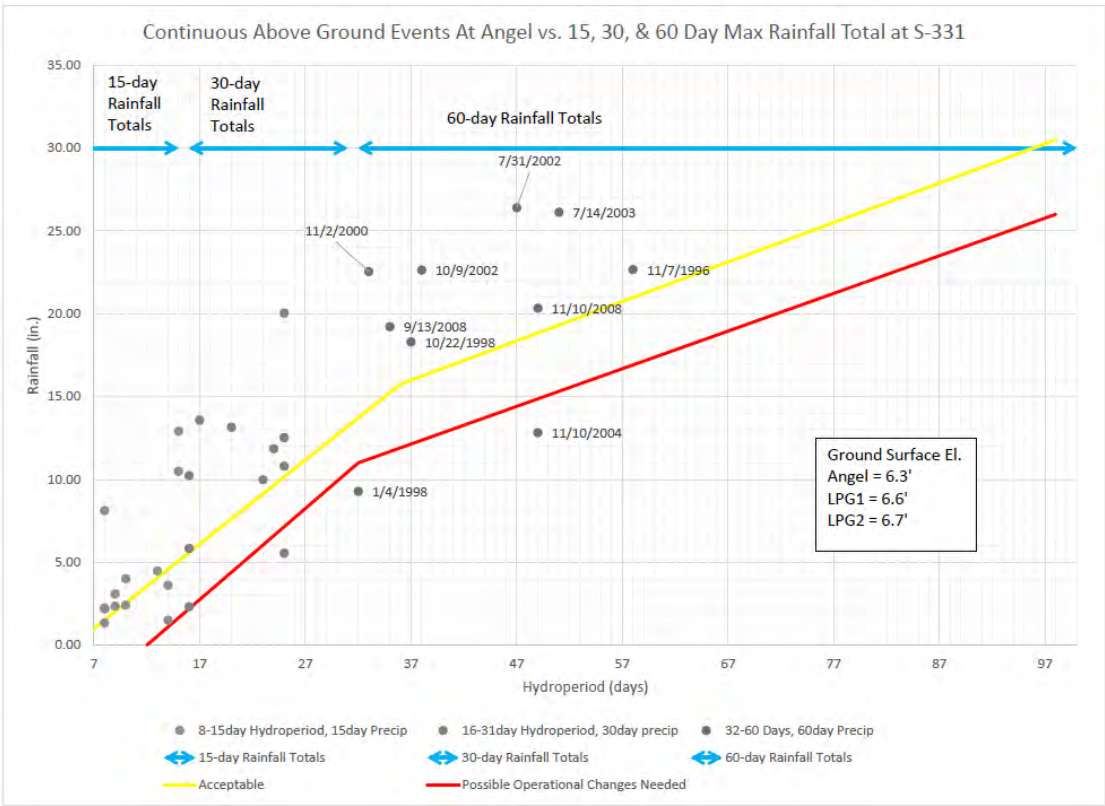


Figure C.6-4. Preliminary hydroperiod target limits for accumulated rainfall totals over 15 days, 30 days, and 60 days.

C.6.3.3 Project Hydro-period Response to Seasonal Rainfall Accumulation

Hydrologic response within the 8.5 SMA throughout the duration of the wet season (May through October) and dry season (November through April) for each water year will additionally be tracked using the hydro-period metrics defined in this section. The cumulative number of consecutive and non-consecutive days with water stages above ground at LPG-1, LPG-2, and LPG-17 will be monitored in response to seasonal accumulations of rainfall, starting from the beginning of the wet (01 May) and dry

season (01 November). Figure C.6-6 (wet season) and Figure C.6-8 (dry season) were generated from an assessment of historical S-331 seasonal rainfall totals and historical cumulative non-consecutive hydro-periods at Angel's Well. The historical rates of rainfall and cumulative hydro-period accumulations for the historical assessment period from 1991 through June 2009 (prior to initial operation of the MWD 8.5 SMA project), which are shown on Figure C.6-5 (wet season) and Figure C.6-7 (dry season) were evaluated to aid with delineation of the performance threshold lines at the beginning of the wet and dry season.

The lower limit for "acceptable" performance threshold (above the yellow line) was delineated using historical events within 0.5 standard deviations of the average for all historical events. The lower limit for "restricted" performance threshold (between the yellow and the red line) was delineated using historical events within 1.0 standard deviations of the average for all historical events; given the limited sample size, durations within this range may not adhere with the historical pre-MWD drainage rates observed for the 8.5 SMA, and water management decisions during the field tests and COP should avoid hydroperiod durations which fall within this range. For the acceptable (yellow) and restricted (red) performance thresholds, 61% (11 of 18 events) and 89% (16 of 18 events) of historical observed rainfall and hydro-period events fell above these lines, respectively. Observed seasonal rainfall and hydro-period events which exceed (to the right of the red performance threshold) the lower limit of the "acceptable" performance threshold following the conclusion of the corresponding wet or dry season period provide an indication that further operational changes are needed to ensure achievement of the required 8.5 SMA flood mitigation performance. Operational changes may include additional utilization of S-331 to reduce the necessity for S-357 pump operations, increased pump operations at S-357, and/or consideration of additional operational constraints for inflows to NESRS. Concurrent with the development of the COP, operations during the MWD field test were conducted to target hydroperiod durations below the "acceptable" performance threshold for a given periodic rainfall accumulation, to the maximum extent possible given other field test operational considerations.

The inclusion of additional operational flexibility within the COP, as detailed in Section C.6.3.2, are included in the COP Water Control Plan to ensure real-time adherence to the 8.5 SMA flood mitigation hydroperiod response criteria. The Hydro-period Response to Seasonal Rainfall Accumulation will continue to be assessed at the end of each wet and dry season, as conducted throughout the MWD field test duration. These seasonal computations will generally not be used to guide real-time water management decisions.

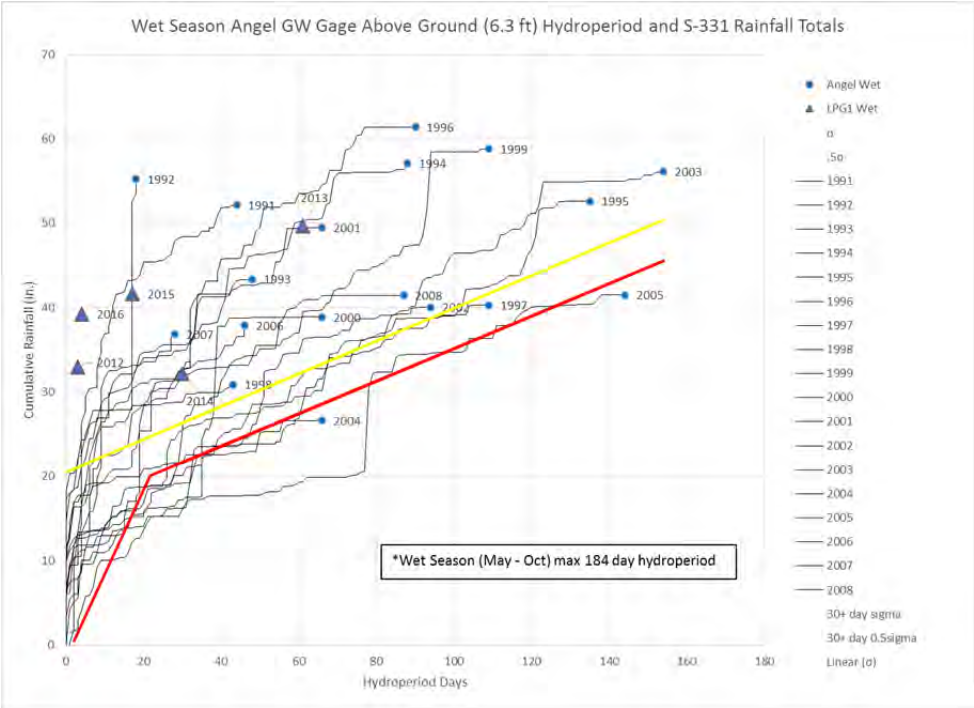


Figure C.6-5. Historical data used to identify preliminary hydroperiod target limits for accumulated wet season rainfall totals.

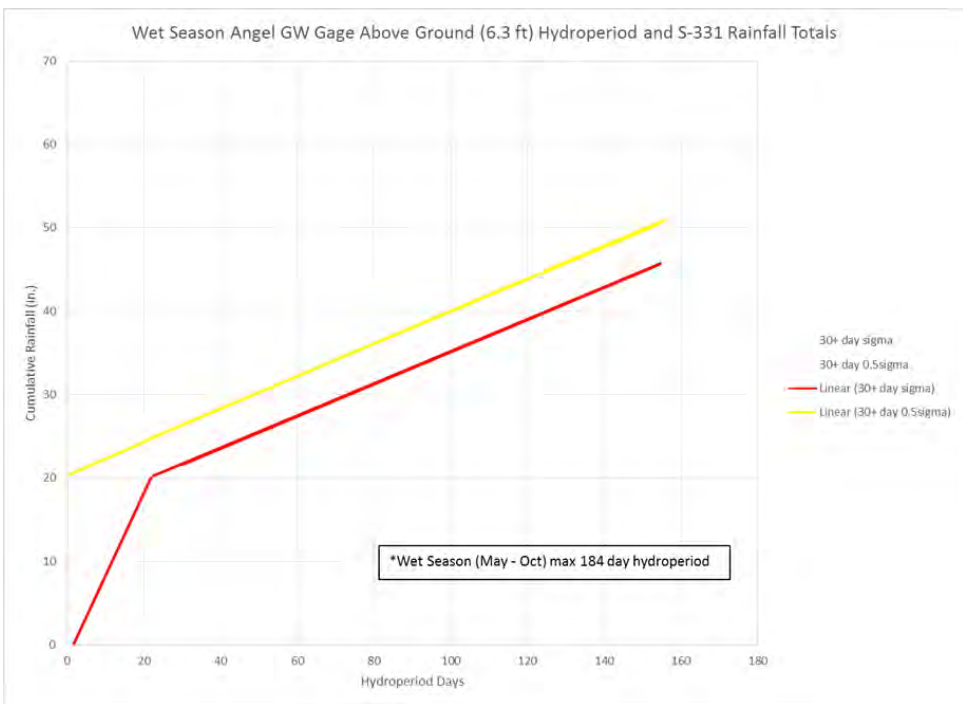


Figure C.6-6. Preliminary hydroperiod target limits for accumulated wet season rainfall totals.

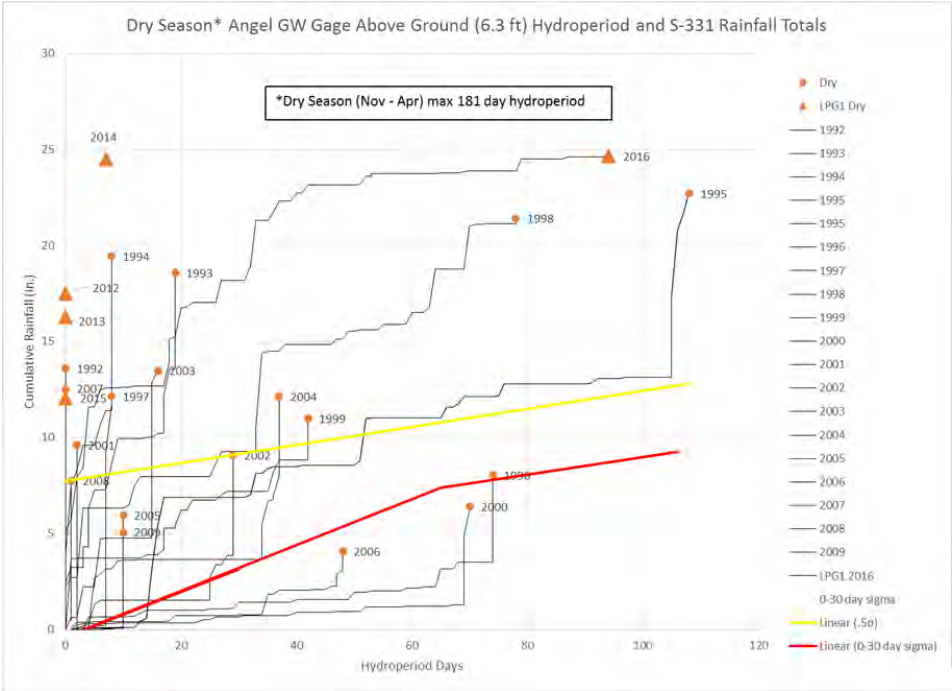


Figure C.6-7. Historical data used to identify preliminary hydroperiod target limits for accumulated dry season rainfall totals.

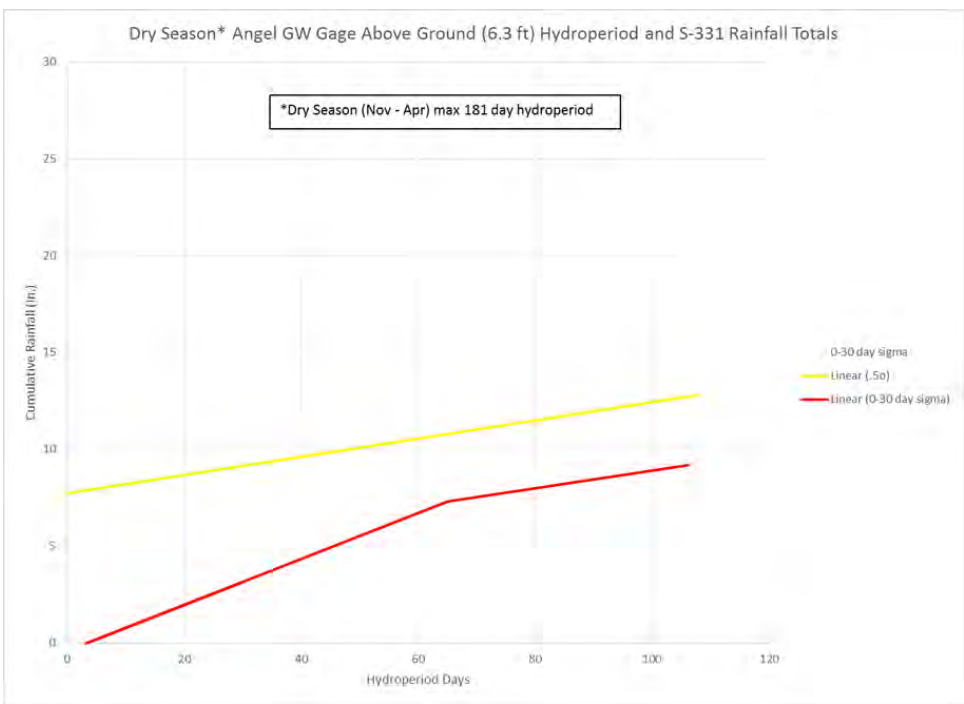


Figure C.6-8. Preliminary hydroperiod target limits for accumulated dry season rainfall totals.

C.6.4 Data Requirements for the COP Water Quality and Hydrology Monitoring Plan

To facilitate real-time tracking and assessments for the 8.5 SMA authorized flood mitigation performance, the information in Table C.6-2 was incorporated into the MWD Increment 2 Hydrometeorologic Monitoring Plan and retained for the COP Water Quality and Hydrology Monitoring Plan. The information compiled to support the 8.5 SMA monitoring plan requirements will be evaluated weekly during rainfall periods, with more frequent data assessments conducted if warranted following high-intensity rainfall events.

In addition to the continued monitoring at Angel's Well, LPG-1, and LPG-2, two new 8.5 SMA interior monitoring wells were installed concurrent with Increment 2 field test to supplement the previously available groundwater response data. Sited along a southeasterly transect between LPG-2 and the C-357 Canal (the Canal is located 0.9 miles southeast of LPG-2), LPG-17 is located approximately 0.25 miles southeast of LPG-2, and LPG-16 is located approximately 0.6 miles southeast of LPG-2. The new monitoring locations were fully instrumented and ground-surveyed in September 2019, although the data is not available in real-time (monthly downloads only). With the continued monitoring under the Increment 2 field test, the USACE will continue to consider adjustments to the flood mitigation criteria at LPG-2, such as using a hydroperiod duration criteria relative to a more representative elevation for this portion of the 8.5 SMA interior mitigation area. If the supplemental monitoring locations result in revisions to the COP Water Quality and Hydrology Monitoring Plan, this information may be incorporated into the Final COP EIS Monitoring Plan, or through the COP Adaptive Management and Monitoring Plan periodic reporting.

C.6.5 Periodic Updates to 8.5 SMA Assessment Methodology

The 8.5 SMA monitoring and assessment plan will be periodically reviewed throughout the duration of the MWD incremental field tests and the COP, and may be periodically revised if warranted by new information.

Table C.6-2. Additional 8.5 SMA monitoring and data collection requirements. Table shows real-time monitoring information required for 8.5 SMA Flood Mitigation Assessment. Data is expected to be used to assess conditions weekly with more frequent reporting in response to significant rainfall events (>2.5 inches).

Date of reporting xx-xx-2016	Rainfall (inches) S-331	Rainfall (inches) NEXRAD	Reces-sion Rate Angel's Well (inches/ day)	Reces-sion Rate LPG-1 (inches/ day)	Reces-sion Rate LPG-2 (inches/ day)	Ante-cedent Stage Angel's Well (ft NGVD)	Ante-cedent Stage LPG-1 (ft NGVD)	Ante-cedent Stage LPG-2 (ft NGVD)	Hydro-period Duration Angel's Well (day)	Hydro-period Duration LPG-1 (day)	Hydro-period Duration LPG-2 (day)
3-day event total	X	X	X	X	X	X	X	X	--	--	--
7-day event total	X	X	X	X	X	X	X	X	--	--	--
Last 15 days	X	X	--	--	--	--	--	--	X	X	X
Last 30 days	X	X	--	--	--	--	--	--	X	X	X
Last 60 days	X	X	--	--	--	--	--	--	X	X	X
Dry Season (Nov.-May)	X	X	--	--	--	--	--	--	X	X	X
Wet Season (June-Oct.)	X	X	--	--	--	--	--	--	X	X	X
Water Year (May-April)	X	X	--	--	--	--	--	--	X	X	X

C.7 Cultural Resources Monitoring Plan

Effects to cultural resources within Water Conservation Area 3 (WCA 3) and Everglades National Park (ENP) resulting from COP have been determined as not adverse based on the analysis conducted under the Everglades Restoration Transition Plan (ERTP) Programmatic Agreement (PA), current analysis of anticipated water elevations, and controls established through this monitoring plan. As discussed in the EIS, the Preferred Alternative is not anticipated to create any conditions that would be considered adverse in their effects to significant historic properties. It is anticipated that the relative increases in water depth within ENP are minor and should not inundate any known archeological sites beyond that which is typical throughout the year. Additionally, any decreases in water depth within WCA 3 would also be slight and should not over dry any known archeological sites beyond that which is typical throughout the year. However, cultural resources monitoring tools established under the ERTP Final Environmental Impact Statement and the associated ERTP PA will be utilized to understand how the COP performs in relation to relative water depth located adjacent to known archeological resources and tree islands within ENP and WCA 3. Conditions and stipulations applied within the ERTP PA will not be applied during the COP operational strategy as the PA has been finalized and there are no anticipated impacts to cultural resources. Active monitoring will occur utilizing the Everglades Depth and Elevation Network (EDEN) to better understand potential effects to cultural resources for future operational plans that propose adding to the existing water budget, and determine whether conditions significantly vary from those established within the current EA (http://sofia.usgs.gov/eden/water_level_percentiles_map.php).

Monitoring will allow a better understanding and insight into how water spreads south throughout Northeast Shark River Slough (NESRS) after being discharged into ENP. Monitoring will also provide a better understanding of the zone of influence of water as it flows across the cultural landscape. Finally, the monitoring efforts will provide valuable information to better understand the response of archaeological deposits to changes in water elevation for future operational plans (i.e. the Central Everglades Planning Project).

The EDEN monitoring will compile water elevation data associated with known archeological sites within ENP and WCA 3. There are 394 tree islands that are monitored through EDEN, 112 of which contain previously identified cultural resources (for protection of these resources their names and locations will not be listed). Based on previous monitoring efforts and detailed background research, there are 38 tree islands that have not been seasonally inundated during the period of record (1965-2005) and will be actively monitored (**Table C.7-1**). If conditions arise as a result of the COP where water levels may approach overtopping these sites, an assessment will be conducted by the Corps to determine the cause of the high water levels. The purpose of the analysis will be to examine the root cause or complexity of the issue and help understand the cause; if it is rainfall induced, related to operations, or a combination of both. If the cause is determined to be a result of Corps operations and will result in prolonged inundation, the Corps may initiate consultation with interested parties, including the State Historic Preservation Officer, the appropriate Tribal Historic Preservation Officer(s), and the appropriate interested Tribes.

Table C.7-1. Tree islands monitored during the COP.

Tree Island	Latitude	Longitude	Basin	Maximum Ground Elevation[1]	Observed Maximum Water Elevation [1,2]	Date of Observed Maximum Water Elevation[2]
3A_28_19	25.77774	-80.83052	WCA3A	10.515	10.24017734	1/5/1995
3A_6_9	26.02087	-80.77037	WCA3A	10.928	10.71050849	11/2/1999
3B_13_1	25.93758	-80.53088	WCA3B	9.705	7.868379308	10/16/1999
3B_13_3	25.90325	-80.54317	WCA3B	8.743	8.04814967	10/16/1999
3B_15_2	25.89322	-80.50021	WCA3B	9.331	7.883805803	10/16/1999
3B_21_1	25.83408	-80.53783	WCA3B	9.183	7.769557122	10/16/1999
3B_21_8	25.86764	-80.49196	WCA3B	8.757	7.852057209	10/16/1999
3B_25_1	25.77899	-80.50983	WCA3B	8.921	7.743753348	10/16/1999
3B_30_1	25.76608	-80.58155	WCA3B	8.32	8.005511667	10/16/1999
Black	25.61089	-80.68831	ENP	7.398	6.563759851	10/16/1999
Chekika	25.74496	-80.65728	ENP	8.343	7.270777445	10/16/1999
Grossman	25.61582	-80.58348	ENP	7.126	6.484809635	10/16/1999
Gumbo	25.63052	-80.74102	ENP	6.755	6.586604481	10/16/1999
Irongrape	25.64599	-80.66475	ENP	7.664	6.964816196	10/16/1999
Manatee	25.49811	-80.81532	ENP	3.904	3.483169285	10/17/1999
Mosquito	25.35641	-80.79853	ENP	2.927	1.989011189	6/10/1997
Panther	25.57347	-80.75916	ENP	5.869	5.540908854	10/16/1999
Satin	25.65968	-80.7559	ENP	7.208	7.188733419	10/16/1999
SS-05	25.58843	-80.70951	ENP	6.654	6.193871385	10/16/1999
SS-06	25.5713	-80.7275	ENP	6.198	5.789324242	10/16/1999
SS-07	25.5358	-80.76325	ENP	5.167	4.900295027	10/16/1999
SS-23	25.50675	-80.84813	ENP	3.241	3.049819676	10/17/1999
SS-27	25.52224	-80.82604	ENP	4.121	3.676932377	10/16/1999
SS-34	25.54734	-80.80133	ENP	5.039	4.557857363	10/16/1999
SS-36	25.55208	-80.81542	ENP	4.534	4.48964587	10/16/1999
SS-37INT	25.55344	-80.81595	ENP	4.685	4.48964587	10/16/1999
SS-38	25.5816	-80.80611	ENP	5.62	5.120357503	10/16/1999
SS-48	25.62063	-80.77404	ENP	6.306	6.22874683	10/16/1999
SS-50	25.64302	-80.75232	ENP	6.972	6.835538008	10/16/1999
SS-52	25.62935	-80.7186	ENP	7.238	6.717086652	10/16/1999
SS-63	25.68253	-80.70717	ENP	7.927	7.72216877	10/18/1995
SS-69	25.73301	-80.6423	ENP	9.075	7.207007921	10/16/1999

[1] feet NAVD88
[2] Observed during the Period of Record

Data obtained from the COP will be utilized to compare the period of performance to identify a similar rainfall cycle and compare changes in water elevation on known archeological resources. A comparison will also be performed against the previous water level analysis conducted as part of the EA for the ERTP planned deviations (i.e., Increment 1.1/1.2 and Increment 2) operational strategy so that a better understanding of the variation can also be developed. Periodic Scientists Calls will continue to be conducted throughout COP to ensure cultural resource issues are considered during the water management decision process.

C.8 References

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H-3.2 EXISTING CONDITIONS BASELINE 2019 ASSUMPTIONS

Hydrology and Hydraulics Bureau & Interagency Modeling Center

Regional Simulation Model Glades-LECSA (RSMGL)
Combined Operational Plan (COP)
Existing Condition Baseline 2019
Table of Assumptions

DRAFT

Summary:

Existing Condition. The existing condition is intended to represent conditions assumed in place at the time of implementation of the COP Water Control Plan in 2019. This base condition will include the following: (1) MWD Increment 1.1 and 1.2 (operational changes required under the July 2016 ERTP BO and in response to new information gained during the 2016 Temporary Emergency Deviation); (2) existing C&SF project infrastructure and Regulation Schedules (including 2008 Lake Okeechobee Regulation Schedule); (3) MWD Tamiami Trail Modifications 1-Mile Bridge and Raised Roadway; (4) Tamiami Trail Next Steps 2.6 Mile Western Bridge; (5) full construction of C-111 South Dade to include Contracts 8, 8A and 9; (6) 8.5 SMA project features to include C-358 and S-357N; (7) Miami-Dade Limestone Products Association (MD-LPA) 5-mile Seepage Reduction wall (partially-penetrating) along L-31 North; (8) current permitted operations for the SFWMD C-111 Spreader Canal project components (includes G-737 and S-199/S-200 at expanded 300 cfs each); (9) the expanded capacity at S-333 completed by the South Florida Water Management District (SFWMD) component of the Central Everglades Planning Project (CEPP), with operations as prescribed by the July 2018 permit issued by FDEP to SFWMD; (10) plug installed at junction of the old Tamiami Trail Roadway and ENP Shark Valley Tram Road, south of WCA 3A; and (11) operation of the Decomp Physical Model S-152 structure per the 2017 Environmental Assessment. Refer to COP Scope for further information. The assumptions table was derived starting from the RSM-GL Existing Condition Baseline and Future Without Project Baseline assumptions developed for the Western Everglades Restoration Project (WERP), dated March 2018.

Feature	
Meteorological Data	• Rainfall file used: rain_v3.0_beta_tin_14_05.bin • Reference Evapotranspiration (RET) file used: RET_48_05_MULTIQUAD_v1.0.bin (ARCADIS, 2008)
Topography	• Same as calibration topographic data set except where reservoirs are introduced (STA1-E, C4 Impoundment and C-111 reservoirs). • United States Geological Survey (USGS) High-Accuracy Elevation Data Collection (HAEDC) for the Water Conservation Areas (1, 2A, 2B, 3A, and 3B), the Big Cypress National Preserve and Everglades National Park.

Feature	
	monitoring location EVER4 for the protection of the CSS Critical Habitat Unit 3.
Water Conservation Area 1 (Arthur R. Marshall Loxahatchee National Wildlife Refuge)	• Current C&SF Regulation Schedule. Includes regulatory releases to tide through LEC canals • No net outflow to maintain minimum stages in the LEC Service Area canals (salinity control), if water levels are less than minimum operating criteria of 14 ft. The bottom floor of the schedule (Zone C) is the area below 14 ft. Any water supply releases below the floor will be matched by an equivalent volume of inflow. • Structure S10E connecting LNWR to the northeastern portion of WCA-2A is no longer considered part of the simulated regional system
Water Conservation Area 2A & 2B	• Current C&SF regulation schedule. Includes regulatory releases to tide through LEC canals • No net outflow to maintain minimum stages in the LEC Service Area canals (salinity control), if water levels are less than minimum operating criteria of 10.5 ft in WCA-2A, defined as when WCA2-U1 marsh gauge falls below 10.5 ft or L38 canal stage falls below 10.0 ft. Any water supply releases below the floor will be matched by an equivalent volume of inflow.
Water Conservation Area 3A & 3B	• Everglades Restoration Transition Plan (ERTP) regulation schedule for WCA-3A, as per SFWMM modeled alternative 9E1 (USACE, 2012) with the following updates: ○ Priority use of S-333 for WCA-3A Rainfall Plan deliveries, followed by S-12D, S-12C, S-12B, S-12A ○ S-12 A&B gate overtopping if headwater stage > 11.0 ft, NGVD, simulated as a weir. ○ Updated S-12 effective rating curves based on historical observations compared to 3A-28 (Site 65) gauge. ○ Inflows to ENP per Increment 1.1 and 1.2 including seasonal closures for S-12A, S-12B, S-343A/B, and S-344 from 01 October through 14 July; the WCA-3A high-water exit strategy during October and November (per the 2016 ERTP Biological Opinion) is included in the model. • Include S-152 operations (design capacity 750 cfs) per Decomp Physical Model, Phase 2 [assumes September 1 through May 31 operations of S-152] with flow limitation based on actual performance of S-152. ○ Modeled structure design capacity of 400 cfs with 0.5 feet of head, consistent with observed operations during 2016-2017 emergency deviations (flow may exceed 400 cfs with higher head differential) ○ Operational window limited to September 1 through May 31, consistent with historical water quality data evaluated in the 2017 DPM Phase 2 Environmental Assessment

Feature	
	• US Army Corps of Engineers (USACE) Digital Elevation Model (DEM) interim version 2017 for BCNP and Western Basins for areas not covered by HAEDC.
Tidal Data	• Tidal data from two primary (Naples and Virginia Key) and five secondary NOAA stations (Flamingo, Everglades, Palm Beach, Delray Beach and Hollywood Beach) were used to generate a historic record to be used as sea level boundary conditions for the entire simulation period.
Land Use and Land Cover	• Land Use and Land Cover Classification for the Lower East Coast urban areas (east of the Lower East Coast Flood Protection Levee) use 2008-2009 Land Use coverage as prepared by the SFWMD, consumptive use permits as of 2011 were used to update the land use in areas where it did not reflect the permit information. • Land Use and Land Cover Classification for the natural areas (west of the Lower East Coast Flood Protection Levee) is the same as the Calibration Land Use and Land Cover Classification for that area, 2008-2009. • Land Use and Land Cover Classification for the Feeder Basins, C-139 Annex, Seminole Tribe of Florida (STOF) and Miccosukee Tribe of Florida (MTOF) Reservations, 2012-2014 Land Use coverage as prepared by the SFWMD. • Modified at locations where reservoirs are introduced (STA1-E, Site 1 Impoundment, Broward WPAs, C4 Impoundment, Lakebelt Lakes and C-111 Reservoirs).
Seminole Big Cypress Reservation	• Big Cypress Reservation irrigation demands and runoff were estimated using the AFSIRS method based on existing 2001 planted acreage. • The 2-in-10 demand set forth in the Seminole Compact Work Plan equals 2,606 MGM. • AFSIRS modeled 2-in-10 demands equaled 2,659 MGM. Type of crop and water thru G409 were used to set seasonal distribution of demand, then all demands increased to Compact level. • While estimated demands, and therefore deliveries, for every month of simulation do not equate to monthly entitlement quantities as per the District's Final Order and Tribe's Resolution establishing the Big Cypress Reservation entitlement, tribal rights to these quantities are preserved. • LOWSM applies to this agreement.
Water Control Districts (WCDs)	• Water Control Districts in Palm Beach and Broward Counties and in the Western Basins assumed.
Lake Belt Lakes	• Based on the permitted 2020 Lake Belt Lakes coverage obtained from USACE.
CERP Projects	• 2nd Generation CERP – C-111 Spreader Canal Project includes the Frog Pond Detention Area, which is modeled as an above ground impoundment with the S200 A, B and C pumps as inflow structures. In addition, the Aerojet canal is modeled with the inflow pumps S199 A, B and C. S199 and S200 design capacities expanded to 300 cfs each. The S199 and S200 pumps are turned off based on the stage at the remote

Feature	
	○ May be operated when L-67A Canal stage at S-151 headwater exceeds 9.3 feet NGVD (surrogate for DPM Phase 2 water quality constraints, as recommended by SFWMD) ○ Closed if WCA-3B Site 71 stage exceeds 8.5 feet NGVD ○ Flows in the model are jumped to a cell east of L67C since actual canal infilling and levee degrading are not modeled. • Includes regulatory releases to tide through LEC canals. Documented in Water Control Plan (USACE, April 2012) • No net outflow to maintain minimum stages in the LEC Service Area canals (salinity control), if water levels are less than minimum operating criteria of 7.5 ft in WCA-3A, defined as when 3-69W marsh gauge falls below 7.5 ft or CA3 canal stage falls below 7.0 ft. Any water supply releases below the floor will be matched by an equivalent volume of inflow.
Western Basins	• C139 Annex flows routed to L-28 • L-28 weir, located immediately south of I-75, prevents northerly flow from the L-28 Canal towards the S-140 pump station • L-28 Tie-back Levee gaps modeled as a combined weir • Jetport runway modeled as no-flow boundary with 2 transverse culverts modeled as weirs.
Everglades Construction Project Stormwater Treatment Areas	• STA-1E: 5,132 acres total treatment area. • A uniform bottom elevation equal to the spatial average over the extent of STA-1E is assumed. • Note: STA-1W, STA-2, STA-3/4, STA-5, and STA-6 are not simulated within the RSM-GL (refer to WERP RSM-BN assumptions).
Everglades National Park	• Water deliveries to Everglades National Park are based upon Everglades Restoration Transition Plan (ERTP), with the WCA-3A Regulation Schedule including the lowered Zone A (compared to IOP) and extended Zones D and E1. ○ Priority use of S-333 for WCA-3A Rainfall Plan deliveries, followed by S-12D, S-12C, S-12B, S-12A ○ S-12 A&B gate overtopping if headwater stage > 11.0 ft, NGVD, simulated as a weir. ○ Updated S-12 effective rating curves based on historical observations compared to 3A-28 (Site 65) gauge. ○ Inflows to ENP per Increment 1.1 and 1.2 including seasonal closures for S-12A, S-12B, S-343A/B, and S-344 from 01 October through 14 July. • L-29 constraint for operation of S-333, 355A, 355B and 356 assumed to be consistent with Increment 1.1 and 1.2 (up to 7.8 feet NGVD) operational strategy.

Feature	
	• S-333 capacity increased to 2,500 cfs (per SFWMD expedited construction of this CEPP component), with Emergency Limited Operations of the additional 1150 cfs spillway (S-333N) to provide high water relief in WCA 3 during the following conditions (prescribed by Special Condition #19 of the 30 July 2018 FDEP permit issued to SFWMD): ○ When the average stages at gauges WCA 3A-62 and WCA 3A-63 exceed elevation 11.6 ft. NGVD for 72 hours, the Permittee may operate the S-333N Gated Spillway subject to the L-29 Canal stage constraint. Discharges from the existing S-356 Pump Station shall have priority over the S-333N Gated Spillway discharges. ○ The Permittee shall cease operations of the S-333N Gated Spillway when the L-29 Canal stage limits the ○ operations of the S-356 Pump Station, or when the average of the WCA 3A-62 and WCA 3A-63 gauges recedes below an elevation of 11.0 ft. NGVD. ○ During operations of S-333N Gated Spillway, the following operations shall take place: (I) There shall be no use of S-334 Gated Spillway to divert WCA-3A regulatory releases to the L-31N Canal; (ii) The S-356 Pump Station will have priority over the S-333N Gated Spillway. • G-3273 constraint for operation of S-333 assumed to be consistent with Increment 1.1 and 1.2 operational strategy (constraint is removed, subject to FDOT and 8.5 SMA constraints). • The one mile Tamiami Trail Bridge as per the 2008 Tamiami Trail Limited Reevaluation Report is modeled as a one mile weir. Located east of the L67 extension and west of the S334 structure. • Western 2.6 mile Tamiami Trail Bridge, modeled as a 2.6 mile long weir, and is located east of Osceola Camp and west of Frog City. • Tamiami Trail culverts east of the L67 Extension are simulated where the bridges are not located. • Explicit simulation of Old Tamiami Trail Borrow Canal, with Tram Road east-west culvert and approximations of gap and bridge features. • Simulation of blocking of the Old Tamiami Trail Borrow Canal between S-12C and S-12 B (at the junction with the Shark Valley Tram Road), along with the blocking of culverts under Shark Valley Tram Road. • 5.5 miles remain of the L-67 Extension Levee. • S-355A & S-355B are operated per Increment 1.1 and 1.2. • S-356 is operated per Increment 1.1 and 1.2. • S-334 is operated per Increment 1.1 and 1.2. • Full construction of C-111 project reservoirs consistent with the 2009 as-built information from USACE plus addition of contract 8,

Feature	

	contract 8A, and contract 9 features. A uniform bottom elevation equal to the spatial average over the extent of each reservoir is assumed.
	• S-332D seasonal pumping limits per the 2016 ERTP Biological Opinion: no constraint from 15 July – 30 November; 325 cfs from 01 December – 31 January; 250 cfs from 01 February – 14 July
	• S-332DX1 is operated per Increment 1.1 and 1.2.
	  ○ Operated to direct up to 75 cfs to the Southern Detention Area when S-332D is discharging more than 250 cfs (at least three pumps operating)
	  ○ Assume routing 100 cfs through S332DX1 will allow the flows at S332D to be conservatively increased during the CSSS calendar based flow limits: 375 cfs from 01 December – 31 January; 325 cfs from 01 February – 14 July
	• 8.5 SMA seepage canal is explicitly modeled. 8.5 SMA project feature as per federally authorized Alternative 6D of the MWD/8.5 SMA Project (USACE, 2000 GRR); operations per the Increment 1.1 and 1.2 operational strategy. 8.5 SMA detention cell modeled as part of the C-111 Northern Detention Area (NDA), with S-357 operated up to 500 cfs following completion of NDA. Dependency on S-331 to provide 8.5 SMA flood mitigation, with S-357 as secondary. The following operations maintain consistency with Increment 1.1 and 1.2 following assumed operation of the C-111 South Dade NDA:
	  ○ If LPG-2 < 5.5 feet, NGVD: S-357 operated at 5.5-6.0 feet, NGVD;
	  ○ If 5.5 <= LPG-2 < 6.0 feet, NGVD: S-357 operated at 5.0-5.5 feet, NGVD;
	  ○ If 6.0 <= LPG-2 < 7.0 feet, NGVD: S-357 operated at 4.0-5.0 feet, NGVD
	  ○ If LPG-2 > 7.0 feet, NGVD: S-357 operated at 3.5-4.0 feet, NGVD
	  ○ NDA tailwater stage constraint of 8.6 feet NGVD for S-357 and 8.5 feet for S-332B North (NDA inflows from S-357 have priority over NDA inflows from S-332B North)
	• An additional length of seepage canal (C-358 Richmond Drive Seepage Collection Canal) is assumed in the model to allow water to be collected for S357 operation, and includes operation of S-357N consistent with the Increment 1.1 and 1.2 operational strategy.
	  ○ S-357N capacity limited to 100 cfs for RSM-GL to avoid over-drainage of adjacent ENP (testing protocols only defined in Increment 1.1 and 1.2).
	  ○ S-357N modeled as a 27' wide weir with crest at 5.0 feet NGVD. Operated between 5.5-5.6 feet NGVD from 1 December to 30 April, and between 5.0-5.1 feet NGVD for the remainder of the year.

Feature	
	• Partial depth, approximately 5 mile long seepage reduction barrier south of Tamiami Trail (along L-31N), representative of the seepage reduction barrier installed by the Miami-Dade Limestone Product Association. • Supplemental flows to Taylor Slough from WCA-3A (up to 250 cfs), per Increment 1.1 and 1.2. ○ Limited to 8 weeks per year when WCA-3A stages are below the historical median (for simplified model representation, Supplemental Flows are delivered using the S-151/S-337/S-335/G-211/S-331 path during November and December only, when S-176 headwater stage is between 4.1-4.3 feet NGVD and subject to tailwater constraints at these structures)
Other Natural Areas	• Flows to Biscayne Bay are simulated through Snake Creek, North Bay, the Miami River, Central Bay and South Bay
Public and Industrial Water Supply	• Public Water Supply pumpage for the Lower East Coast was updated using 2010 consumptive use permit information as documented in the C-51 Reservoir Feasibility Study; permits under 0.1 MGD were not included • Seminole Big Cypress Reservation Public Water Supply groundwater volumes as reported for 2016 • Residential Self Supported (RSS) pumpage are based on 2030 projections of residential population from the SFWMD Water Supply Bureau. • Industrial pumpage is also based on 2030 projections of industrial use from the Water Supply Bureau. • Irrigation demands for the six irrigation land-use types are calculated internally by the model. • Seminole Hollywood Reservation demands are set forth under VI. C of the Tribal Rights Compact. Tribal sources of water supply include various bulk sale agreements with municipal service suppliers.
Irrigation	• Lower East Coasts Irrigation demands for the six irrigation land-use types are calculated internally by the model using AFSIRS. • Feeder Canal Basins – Land use as described above used for AFSIRS calculation distributed over permitted groundwater facilities.
Canal Operations	• C&SF system and operating rules in effect per Increment 1.1 and 1.2 operational strategy • Includes operations to meet control elevations in the primary coastal canals for the prevention of saltwater intrusion • Includes existing secondary drainage/water supply system • C-4 Flood Mitigation Project • Western C-4, S-380 structure retained open • C-11 Water Quality Treatment Critical Project (S-381 and S-9A) • S-25B and S-26 backflow pumps are not modeled since they are used very rarely during high tide conditions and the model uses a long-term average daily tidal boundary

Feature	
	• Northwest Dade Lake Belt area assumes that the conditions caused by currently permitted mining exist and that the effects of any future mining are fully mitigated by industry • ACME Basin A flood control discharges are sent to C-51, west of the S-155A structure, to be pumped into STA-1E. ACME Basin B flood control discharges are sent to STA-1E through the S-319 structure • Releases from WCA-3A to ENP and the South Dade Conveyance System (SDCS) will follow the Increment 1.1 and Increment 1.2 operational strategy ○ Structures S-343A, S-343B, S-344 are closed Oct. 1 to July 14; include extended closures for S-12A and S-12B (Oct. 1 to July 14); the WCA-3A high-water exit strategy during October and November (per the 2016 ERTP Biological Opinion) is included in the model (i.e. S-12A/B conditionally open in October depending on WCA-3A average stage; S-12B conditionally open in November dependent on WCA-3A average stage). ○ Regulatory releases from WCA-3A to the SDCS (Column 2) are only permitted when the WCA-3A stage is above the Increment 1 Action Line during the S-12A seasonal closure window (during operations Condition 3) • South Dade Conveyance System operations follow Increment 1.1 and 1.2 ○ Ramp-up operations for S332s ○ S-332B/C/D operating range is 4.2 to 4.8 following completion of the C-111 NDA ○ Priority for L-31N Canal structure operations: S-332D; S-332B/C; S-194/S-196; S-176 • S-176 discharges up to 200 cfs to Manatee Bay from 01 August – 14 February, conditional on S-176 HW stage above 4.5 ft, NGVD • S-177 discharges up to 200 cfs to Manatee Bay from 01 August – 14 February, conditional on S-177 HW stage above 3.2 ft, NGVD • Updated canal water supply maintenance levels: L-31S Canal (S-331 to S-176) ○ Maintenance level : 3.5 ft, NGVD (Not 4.0 ft) ○ Reserve level : 3.0 ft, NGVD (Not 3.5 ft) • Updated canal water supply maintenance levels: C-111 canal (S-176 to S-177) ○ Maintenance level : 2.5 ft (Not 3.0 ft) ○ Reserve level : 2.0 ft (Not 2.4 ft)
Canal Configuration	• Canal configuration same as calibration, with the following exceptions: ○ Only 5.5 miles remain of the L-67 Extension Canal. ○ Additional canals included in the model for WERP: ○ Northern WERP Area, 74 miles ○ Tamiami Trail Borrow Canal, 32 miles

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Feature	
	▪ Additional structures: 40 Tamiami Bridges, modeled as weirs ○ Loop Road, 23 miles ▪ Additional structures: 96 Loop Road Culverts, modeled as 17 weirs (multiple culverts aggregated into one weir within each grid cell)
Pre-storm drawdown	• Limited to high rainfall events only and applies for LEC canals (based on 2-week moving average of rainfall) and associated structures ○ Palm Beach County: ▪ C51 canal and coastal structures (S155, S41, S40) ○ Broward County: ▪ Hillsboro canal and coastal structure (G56) ▪ C-14 Canal and structure (S37B) ▪ C-14E and coastal structure (S37A) ▪ North Fork Middle River/L35A/C-13 and coastal structure (S36) ▪ North New River and coastal structures (G54, G123) ▪ C-11 Canal and structure (S13S/S13P) ○ Miami-Dade County: ▪ C-9 Canal and coastal structure (S29) ▪ C-8 Canal and coastal structure (S28) ▪ C-7 Canal and coastal structure (S27) ▪ C-6 Canal and coastal structure (S26) ▪ C-2/C-4 Canal and coastal structure (S25B, S22, G93) ▪ C-5/Comfort canal and coastal structure (S25) ▪ C-100B canal and coastal structure (S21) ▪ C-102 canal and coastal structure (S165) ▪ C-103S canal and coastal structure (S167) ▪ C-103N/S179 u/s canal and structure (S179) ▪ C-111 canal and structure (S177) • Pre-storm drawdown for named storms are not captured in the model
Seasonal drawdown	Coastal structures S21A on C-102 per SFWMD structure book: • High Range Operation (May 1 to October 15th) ○ Open/Close: 2.2/ 1.8 • Intermediate Range Operation (January 1 to April 30th) ○ Open/Close: 1.8/ 1.4 • Low Range Operation (October 16th to December 31th) ○ Open/Close: 1.4/ 1.0 Coastal structures S20F on C-103 per SFWMD structure book: • High Range Operation (May 1 to October 15th) ○ Open/Close: 2.2/ 1.8 • Intermediate Range Operation (January 1 to April 30th) ○ Open/Close: 1.7/ 1.3

Feature	
	• Low Range Operation (October 16th to December 31th) ○ Open/Close: 1.4/ 1.0
Canal Configuration	• Canal configuration same as calibration except only 5.5 miles remain of the L-67 Extension Canal • Old Tamiami Trail Borrow Canal added (WERP RSM-GL updates) • Additional canals simulated in Western Areas (WERP RSM-GL updates) ○ Lard-Can, Wingate and South Boundary Canals ○ Tamiami Trail Borrow Canal, west to SR29 • 40 Tamiami Bridges modeled as 40 weirs ○ Loop Road • 96 Loop Road Culverts modeled as 17 weirs (aggregated with average of 6 culverts each)
Lower East Coast Service Area Water Shortage Management	• Lower east coast water restriction zones and trigger cell locations are equivalent to SFWMM ECB implementation. An attempt was made to tie trigger cells with associated groundwater level gages to the extent possible. The Lower East Coast Subregional (LECsR) model is the source of this data. • Periods where the Lower East Coast is under water restriction due to low Lake Okeechobee stages were extracted from the corresponding Western Everglades Restoration Project WERP RSM-BN ECB simulation.

Notes:

- The RSM is a robust and complex regional scale model. Due to the scale of the model, it is frequently necessary to implement abstractions of system infrastructure and operations that will, in general, mimic the intent and result of the desired project features while not matching the exact mechanism by which these results would be obtained in the real world. Additionally, it is sometimes necessary to work within established paradigms and foundations within the model code (e.g. use available input-driven options to represent more complex project operations).

- The boundary conditions along the northern boundary of the RSMGL model were provided from either the South Florida Water Management Model (SFWMM) or the RSM Basins Model (RSMBN). The SFWMM (ECB1.3 CEPP) was the source of the northern boundary groundwater/surface water flows, while the WERP Existing Condition Baseline RSM-BN (svn revision 13413) was the source of the northern boundary structural flows. Additional boundary conditions included for WERP:
  - Okaloacoochee flows
  - Stage boundary conditions along Deer Fence Canal
  - Stage boundary conditions along L2/L3 canal

United States Department of the Interior

FISH AND WILDLIFE SERVICE
South Florida Ecological Services Office
1339 20th Street
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January 17, 2020

Angela Dunn
Environmental Branch Chief, Planning and Policy Division
U.S. Army Corps of Engineers
701 San Marco Blvd.
Jacksonville, Florida 32207

Service Consultation Code: 04EF2000-2020-F-0283
Date Received: December 11, 2019
Project: Combined Operating Plan

Dear Ms. Dunn:

The U.S. Fish and Wildlife Service (Service) has reviewed the U.S. Army Corps of Engineers' (Corps) request to initiate consultation and the accompanying Biological Assessment (BA) dated December 11, 2019 for the Combined Operating Plan (COP). This letter is submitted in accordance with section 7 of the Endangered Species Act of 1973 (ESA), as amended (Act) (87 Stat. 884; 16 U.S.C. 1531 *et seq.*).

Effects Determinations Comments

As discussed during a December 20, 2019 teleconference, the Service requested clarification and provided recommendations regarding the effects determinations in the BA. Subsequently, the Corps provided a response January 6, 2020, clarifying "No Effect" and "May affect, not likely to adversely affect" determinations. We appreciate the prompt response and we are providing the following guidance regarding effects determinations to facilitate consistency for the current and future BAs.

One of the three following effects determinations should be applied to each species and designated CH identified as occurring in the action area:

- *"No effect"* is the appropriate finding when the action agency determines its proposed action will not affect a listed species or designated critical habitat. This determination is usually not appropriate if suitable habitat, designated critical habitat, or species are present in the action area.

- *"May affect, is not likely to adversely affect"* (MANLAA) is the appropriate finding when the action agency determines that **all effects** to federally-listed species or designated critical habitat from the proposed action would be insignificant, discountable, or completely beneficial. **Insignificant effects** relate to the size of the impact and

include those effects that are not measurable. **Discountable effects** are effects that are extremely unlikely to occur. Based on best judgement, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur. **Beneficial effects** are contemporaneous positive effects without any adverse effects to the species or designated critical habitat. (50 CFR 402.13a).

- *"May affect, likely to adversely affect"* is the appropriate finding when the action agency determines if any adverse effects to listed species or designated critical habitat may occur as a direct or indirect result of the proposed action or its consequences, and the effect is not insignificant, discountable, or completely beneficial. Adverse effects can result from habitat loss, habitat alteration, or impacts to the species life history needs. A "*May affect, likely to adversely affect*" determination requires the initiation of formal Section 7 consultation in accordance with the ESA.

The BA states that the effects of the action will be insignificant to several species and designated critical habitats. The BA then concludes with a "no effect" determination for those species and designated critical habitats. See the definition of "insignificant" in the second bullet above. In accordance with 50 CFR 402.13a, when effects are determined to be insignificant, "*May affect, is not likely to adversely affect*" is the appropriate determination. Therefore, we recommend changing these effects determinations accordingly.

The table in the cover letter requesting formal consultation has the following three categories for their determination: *May affect, not likely to adversely affect, May Affect*, and *No Effect*. Please note that "*May affect*" is not listed above as one of the three effects determinations that should be applied. *"May affect"* is the appropriate determination when the proposed action may pose any effects on listed species or designated critical habitat. When the Federal action agency determines that a "*May affect*" situation exists, the action agency must either initiate formal consultation or seek written concurrence from the Service that the action "is not likely to adversely affect" listed species or designated critical habitat. A "*May affect*" determination includes those actions that are "not likely to adversely affect" as well as actions that are "likely to adversely affect" listed species and/or designated critical habitats. Thus, we recommend changing the "*May Affect*" column and the "*May affect*" determinations in the BA accordingly.

Cape Sable Seaside Sparrow Comments

Page 46 of the BA references palynological data from Bernhardt and Willard (2006) and infers that marl prairies west of Shark River Slough are not natural features of the Everglades landscape since core samples from the area contained sawgrass pollen. The Service believes this reference, when taken out of context, is misleading. Statements such as this, when taken out of context, have been used by others to minimize the importance of subpopulation A for the Cape Sable seaside sparrow (CSSS) and establish a line of reasoning against CSSS management for this subpopulation.

A review of the literature indicates that the authors, Bernhardt and Willard, analyzed two core samples located in depressional features in Rattlesnake Ridge. The limited palynological sampling did indicate that some areas were historically sawgrass marsh rather than marl prairie. However, these samples were taken to the west of most of the CSSS habitat and, therefore, should not serve as a basis for excluding the entire area. To conclude that all "marl prairies west of Shark River Slough are not a natural feature of the Everglades landscape" based on the two core samples analyzed by this study is not appropriate. The authors, Bernhardt and Willard, concluded that "further sampling of modern marl prairie communities and adjacent communities is necessary to document the pre- and post-drainage distribution of marl prairie. It is possible, but by no means certain, that the surface soils with low organic carbon in the western part of Shark River Slough were a result of prolonged dry conditions created by the reduction in flow of water towards the Everglades National Park due to construction of the Tamiami Trail, which was completed in 1928. Only an extensive study of multiple soil cores well distributed throughout the landscape would reveal the historical hydrologic pattern (Sah et al. 2008). Additionally, CSSS have been documented west of Shark River Slough as early as 1932, and within the Big Cypress and Ochopee areas since the 1940s (Stimson, 1956), indicating that sufficient CSSS habitat existed west of Shark River Slough prior to water management actions.

Furthermore, in addition to the context regarding the palynological data, the BA should state that the CSSS is listed as "Wherever Found" under the ESA. Therefore, in accordance with 50 CFR 17.11(d), ESA protections apply to all individuals of the CSSS wherever found. Thus, even if this area of marl prairie habitat resulted from drier conditions caused by water management practices, the ESA requires consideration of the present condition and distribution of a species, such as the CSSS, when assessing the effects of an action.

Page 106 of the BA states that recent evidence has shown that CSSS have successfully nested in areas in which "water levels were extremely high approaching knee-deep at times with 100% coverage the entire summer" (Virzi and Davis 2013). This may be an accurate observation, but similar to the palynological data, it is misleading when taken out of context. As stated, it could be interpreted by some to imply that marl prairie is not necessary for successful CSSS breeding and that inundated sawgrass would be used if marl prairie habitat were not available.

Even though some CSSS nests in these conditions may have been successful, these high water levels also expose CSSS to increased predation and greater vulnerability to smaller changes in water level which result in nest flooding. Increased flooding events, if they were to occur, could be the result of water management actions and therefore, would need to be addressed appropriately in the BA and BO.

It should be noted that Virzi and Davis 2013 documented CSSS nesting in a portion of the Dogleg site (subpopulation B) where sawgrass was dominant and "knee deep" water prevailed. However, Virzi and Davis were not able to make any conclusions as to the influence that philopatry (the tendency of an organism to stay in, or return to, its home area) and/or conspecific attraction (the tendency for animals to settle near other members of their species), may have factored in the bird's nest-site selection and to remain in those areas. The authors also noted that

in subpopulation A, CSSS did not move into "apparently" recovered habitat burned in 2008, choosing to remain in formerly occupied habitat. The authors attribute this possibly to philopatry and/or conspecific attraction. Those same birds in subpopulation B did move in 2013, subsequent to the onset of the rainy season, across the study area into habitat that was drier after rainfall began to flood other areas. They concluded that this showed the importance of having alternative sites available across the landscape for sparrows to breed after the onset of the rainy season.

Pine Rockland Species (Plants and Butterflies) Comments

As the Corps has stated, the pine rockland area serves as habitat for several federally listed species. Over the recent past, conditions in the pine rockland have appeared to get wetter. Flooding of Long Pine Key appears to be occurring on a more frequent basis and for longer durations. These wetter conditions could adversely affect the listed plant and butterfly species using this habitat. The model runs for the proposed action indicate that additional flooding of pine rockland areas would be minimal. However, because there is still the potential that water management actions could affect butterfly host plants and various listed plants, the Service believes that the Corps' determination of "*No effect*" for the butterflies and listed pine rockland plants for such a long term plan, is a risky call. The Service recommends that the Corps change that determination to "*May affect, not likely to adversely affect*" for the Florida leafwing and Bartram's scrub-hairstreak butterflies, and also for Everglades bully, Florida pineland crabgrass, Florida prairie-clover, pineland sandmat, Garber's spurge, and Blodgett's silverbush.

American Alligator Comments

The Corps made a determination of "*May affect, not likely to adversely affect*" for the American alligator. The analysis indicated that ALTQ provided improved conditions in 17 of the 41 years. However, the remaining 24 years exhibited a decrease in alligator habitat suitability (AHS). Additionally, the analysis stated that the maximum percent improvement to AHS was ~7% while the maximum negative change to AHS was ~19% with an overall average of -2%. It appears that the Corps based their determination of the effects on the -2% average while not fully evaluating the extent of impacts associated with the 23 years of negative effects. Figure D.2-59 of the BA illustrates the predicted percent change in alligator habitat suitability under ALTQ per year for the 41 year period of record. It is apparent that the magnitude and duration of declining years is greater than the magnitude and duration of improved years. It does not appear that the Corps took into consideration the magnitude and duration of such events when completing its analysis. The Service recommends clarification as to the overall effects of these long duration (up to 8 years) declines in AHS in their assessment.

Thank you for your cooperation and effort in protecting federally listed species. If you have any questions regarding this correspondence, please contact James Gruhala at 772-469-4250.

Sincerely,

Donald Progulske,
Everglades Program Supervisor
South Florida Ecological Services Office

cc: electronic only
Corps, Fort Myers, Florida (Robert Tewis)
FWC, Tallahassee, Florida (FWC-CPS)

LITERATURE CITED

Bernhardt, Christopher E. and Willard, Debora A.. 2006. Marl Prairie Vegetation Response to 20th Century Hydrologic Change. U.S. Geological Survey; Eastern Earth Surface Processes Team; Reston, Virginia.

Sah, Jay P.; Ross, Michael S.; Snyder, James R.; Ruiz, Pablo L.; Stofella, Susana; Kline, Mike; Shamblin, Broke; Hanan, Erin; Lopez, Lawrence; and Hilton, T.J.. 2008. Effect of Hydrologic Restoration on the Habitat of the Cape Sable Seaside Sparrow – Final Report (2009).

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Virzi, T. and M.J. Davis. 2013. Recovering small Cape Sable seaside sparrow subpopulations: breeding and dispersal of sparrows in the Everglades. November 2013 report to National Park Service, Everglades National Park. Rutgers, The State University of New Jersey, School of Environmental and Biological Sciences; New Brunswick, New Jersey.

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, JACKSONVILLE DISTRICT
701 SAN MARCO BLVD
JACKSONVILLE, FL 32207-8175

Planning and Policy Division
Environmental Branch

FEB 1 4 2020

Mr. Larry Williams, Field Supervisor
U.S. Fish and Wildlife Service
1339 20th Street
Vero Beach, FL 32960

Dear Mr. Williams:

The Jacksonville District, U.S. Army Corps of Engineers (Corps) received correspondence from the U.S. Fish and Wildlife Service (USFWS) dated January 17, 2020 in response to initiation of consultation under Section 7 of the Endangered Species Act of 1973 for the Combined Operational Plan (COP). A Biological Assessment (BA) for the COP was provided to USFWS on December 11, 2019, requesting formal consultation under the ESA for the following species; the Cape Sable seaside sparrow (CSSS) and its designated critical habitat, the Everglade snail kite and its designated critical habitat, and the wood stork. The correspondence dated January 17, 2020, provided recommendations regarding the effects determinations in the BA for federally listed species in the pine rocklands stating that the Corp's determination of "*No effect*" be changed to a "*May affect, not likely to adversely affect*" for the Florida leafwing, and Bartram's scrub-hairstreak butterflies, and also for the Everglades bully, Florida pineland crabgrass, Florida prairie-clover, pineland sandmat, Garber's spurge, and Blodgett's silverbush.

The Corps is providing this correspondence to amend the BA provided to USFWS on December 11, 2019, based on coordination during a teleconference on December 20, 2019, and subsequent email exchanges, in which the USFWS agreed that the ESA consultation record be updated through preparation of this correspondence. The Corps therefore reaffirms the 2019 COP BA species effects determinations for the following listed species: Florida panther, West Indian manatee and its critical habitat, Florida bonneted bat, American alligator, American crocodile and its critical habitat, eastern indigo snake, piping plover, red-cockaded woodpecker, roseate tern, Miami blue butterfly, Schaus swallowtail butterfly, Stock Island tree snail, crenulate lead-plant, Okeechobee gourd, Big Pine partridge pea, Cape Sable thoroughwort, Carters small-flowered flax, Florida brickell-bush, Florida semaphore cactus, Florida bristle fern, and sand flax. The Corps has changed its effect determinations from the 2019 COP BA for the following listed species based on new information regarding the presence of these species in the action area: deltoid spurge, Garber's spurge, Small's milkpea, tiny polygala, Bartram's hairstreak butterfly, Florida leafwing butterfly, Blodgett's silverbush,

Everglades bully, Florida pineland crabgrass, Florida prairie clover, and pineland sandmat. Reference **Table 1**.

Correspondence from the USFWS dated January 17, 2020, also provided recommendations regarding information in the 2019 COP BA that referenced marl prairies west of Shark River Slough as not natural features of the Everglades and evidence that the CSSS have successfully nested in areas of high water. This information will be reviewed and modified as appropriate in future requests for ESA consultation in which species descriptions for the CSSS are provided. Furthermore, the USFWS commented on the analysis presented in the 2019 COP BA for the American alligator, noting that the evaluation failed to take into consideration the magnitude and duration of potential decreases in alligator habitat suitability in the study area. The Draft COP Environmental Impact Statement (EIS) was released for public review on January 31, 2020, prior to the preparation of this correspondence. The Corps intends to revise the Final EIS, anticipated to be released in June of 2020, to accurately reflect the ESA consultation record and the revised effects determinations, and will address the overall effects to the American alligator within that document, further disclosing potential negative effects as modeled by the ecological planning tool.

The Corps is also providing this correspondence to amend the 2019 COP BA based on coordination with the USFWS on February 3, 2020, regarding the eastern black rail. The USFWS announced a 12 month petition finding on a petition to list the eastern black rail as threatened on October 9, 2018 (83 FR 50610) in the Federal Register. The eastern black rail has the potential to exist in the COP study area based on its current range (**Figure 1**) and observation of the bird in Everglades National Park (ENP) (USFWS personnel communication). The eastern black rail occupies portions of the eastern United States (east of the Rocky Mountains), Mexico, Central America, and the Caribbean (**Figure 1**). In the United States, eastern black rails are found in both coastal and interior areas, but the majority of detections are from coastal sites. Eastern black rails are found in a variety of salt, brackish, and freshwater marsh habitats that can be tidally or non-tidally influenced. Within these areas, the birds occupy relatively high elevations along heavily vegetated wetland gradients, with soils that are moist or flooded to a shallow depth (1 to 6 centimeters (cm)). Eastern black rails forage on a variety of small (< 1 cm) aquatic and terrestrial invertebrates, especially insects, and seeds. Occupied habitat tends to be primarily composed of fine-stemmed emergent plants (rushes, grasses, and sedges) with high stem and dense canopy cover. The eastern black rail requires dense vegetative cover that allows movement underneath the canopy, providing shelter and protection for nest sites. Flooding is a frequent cause of nest failure. Water levels must be below the nests during egg laying and incubation, which occurs from May to August, for nests to be successful. The COP is an

operational plan to redistribute the amount and timing of releases from WCA 3A to ENP. Due to increased water flow and changes in water distribution it is anticipated that currently over drained areas in ENP would be rehydrated. The eastern black rail uses the ecotone between emergent wetlands and upland grasslands as refugia during high water events cause by precipitation and tidal flooding. Eastern black rails require elevated refugia with dense cover to survive high water events due to the propensity of juvenile and adult black rails to walk and run rather than fly and due to the chick's inability to fly. The increase in stage and hydroperiods under the COP is unlikely to significantly affect higher elevations. Threats to the species include habitat fragmentation and conversion, resulting in the loss of wetland habitats across its range, sea level rise and tidal flooding, land management practices, and human disturbances. Based on this information, the USACE has determined that COP may affect, but is not likely to adversely affect the eastern black rail. Reference Section D.2.4.2 of the 2019 COP BA for a description of expected differences in water depths and hydroperiods under COP in WCA 3 and ENP in comparison to the existing condition baseline (ECB19RR).

We request that the USFWS provide concurrence on the Corps species effect determinations and provide a Draft Biological Opinion (BO) within 90 days of the COP BA provided on December 11, 2019, and provide a Final BO within 135 days from that date. If you have any questions or concerns please contact Ms. Melissa Nasuti by email Melissa.A.Nasuti@usace.army.mil or telephone 904-232-1368 regarding this consultation request.

Sincerely,

Angela E. Dunn
Chief, Environmental Branch

Enclosure

cc:
Mr. Donald Progulske, U.S. Fish and Wildlife Service, 1339 20th Street, Vero Beach, FL 32960
Mr. Miles Meyer, U.S. Fish and Wildlife Service, 1339 20th Street, Vero Beach, FL 32960
Mr. Kevin Palmer, U.S. Fish and Wildlife Service, 1339 20th Street, Vero Beach, FL 32960

Table 1. Status of Federally Threatened and Endangered Species with the Potential to occur within the COP Action Area and the Corps' Revised Effects Determination (E: Endangered; T: Threatened; SA: Similarity of Appearance; CH: Critical Habitat, C: Candidate Species; Pr T: Proposed Threatened)

Common Name	Scientific Name	Status	May Affect Not Likely to Adversely Affect	May Affect	No Effect
Mammals					
Florida panther	*Puma concolor coryi*	E	X		
Florida manatee	*Trichechus manatus latirostris*	E, CH	X		
Florida bonneted bat	*Eumops floridanus*	E	X		
Birds					
Cape Sable seaside sparrow	*Ammodramus maritimus mirabilis*	E, CH		X	
Everglade snail kite	*Rostrhamus sociabilis plumbeus*	E, CH		X	
Piping plover	*Charadrius melodus*	T			X
Red-cockaded woodpecker	*Picoides borealis*	E			X
Roseate tern	*Sterna dougallii*	T			X
Wood stork	*Mycteria americana*	T		X	
Eastern black rail	*Laterallus jamaicensis jamaicensis*	Pr T	X		
Reptiles					
American Alligator	*Alligator mississippiensis*	T, SA	X		
American crocodile	*Crocodylus acutus*	T, CH	X		
Eastern indigo snake	*Drymarchon corais couperi*	T	X		
Gopher tortoise	*Gopherus polyphemus*	C			X
Invertebrates					
Bartram's	*Strymon acis bartrami*	E, CH	X		

Common Name	Scientific Name	Status	May Affect Not Likely to Adversely Affect	May Affect	No Effect
hairstreak butterfly					
Florida leafwing butterfly	*Anaea troglodyta floridalis*	E, CH	X		
Miami blue butterfly	*Cyclargus thomasi bethunebakeri*	E			X
Schaus swallowtail butterfly	*Heraclides aristodemus ponceanus*	E			X
Stock Island tree snail	*Orthalicus reses (not incl. nesodryas)*	T			X
Plants					
Crenulate lead plant	*Amorpha crenulata*	E			X
Deltoid spurge	*Chamaesyce deltoidea spp. deltoidea*	E			X
Garber's spurge	*Chamaesyce garberi*	T	X		
Okeechobee gourd	*Cucurbita okeechobeensis ssp. okeechobeenis*	E			X
Small's milkpea	*Galactia smallii*	E	X		
Tiny polygala	*Polygala smallii*	E	X		
Big pine partridge pea	*Chamaecrista lineata var. keyensis*	E			X
Blodgett's silverbush	*Argythamnia blodgettii*	T	X		
Cape Sable thoroughwort	*Chromolaena frustrata*	E, CH			X
Carter's small-flowered flax	*Linum carterivar. carteri*	E, CH			X
Everglades bully	*Sideroxylon reclinatum spp. austrofloridense*	T	X		
Florida brickell-bush	*Brickellia mosieri*	E, CH			X
Florida bristle fern	*Trichomanes punctatum spp. floridanum*	E			X
Florida pineland crabgrass	*Digitaria pauciflora*	T	X		
Florida prairie-	*Dalea carthagenesis*	E	X		

Common Name	Scientific Name	Status	May Affect Not Likely to Adversely Affect	May Affect	No Effect
clover	*floridana*				
Florida semaphore cactus	*Consolea corallicola*	E, CH			X
Pineland sandmat	*Chaemaesyce deltoidea pinetorium*	T	X		
Sand flax	*Linum arenicola*	E			X

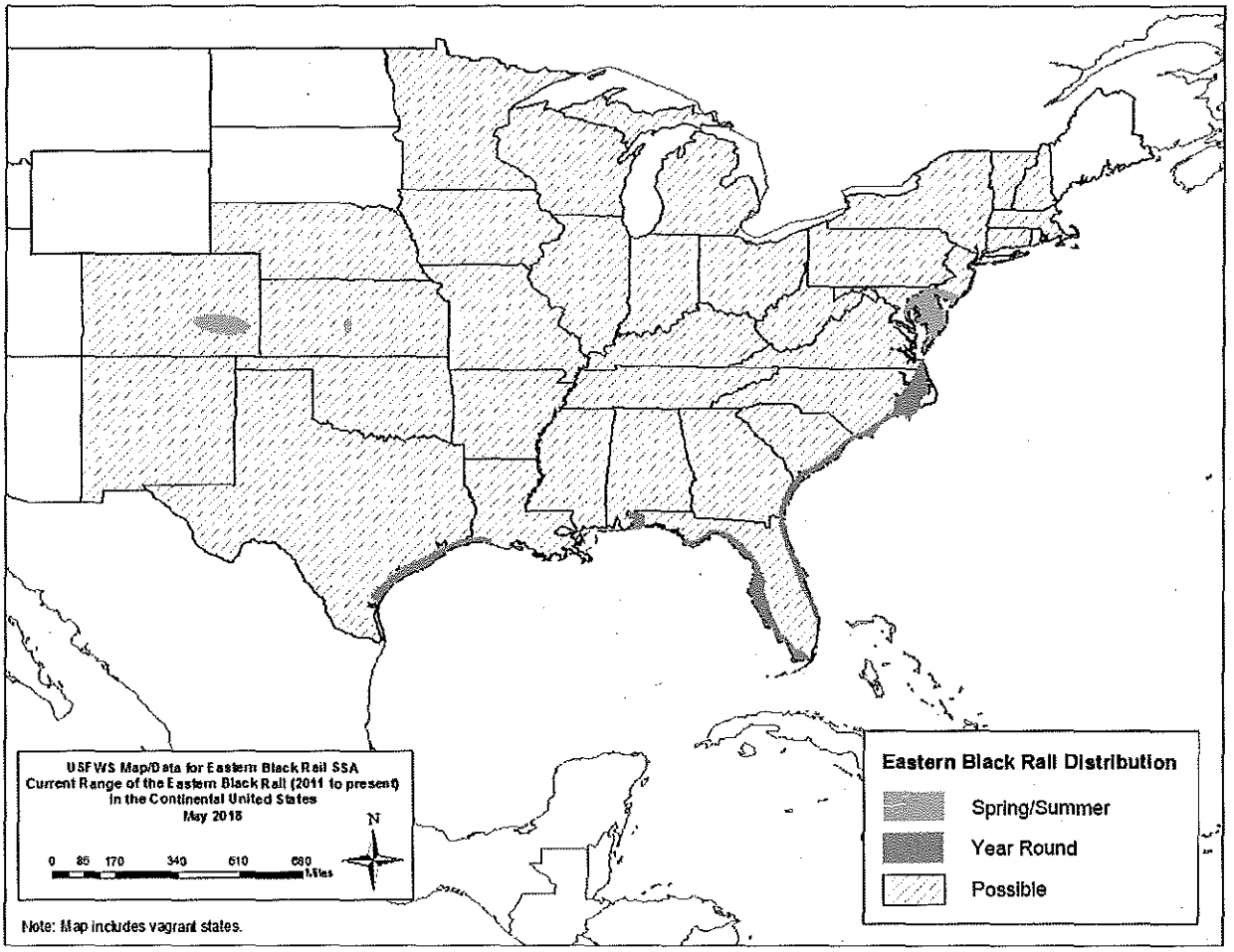

Figure 1. Current range of eastern black rail (Reference USFWS 2018. Species status assessment report for the eastern black rail (*Laterallus jamaicensis jamaicensis*), Version 1.2. June 2018. Atlanta, GA.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
South Florida Ecological Services Office
1339 20th Street
Vero Beach, Florida 32960

March 16, 2020

Andrew D. Kelly, Colonel
District Commander
U.S. Army Corps of Engineers
701 San Marco Boulevard
Jacksonville, FL 32207

Service Consultation Code: 04EF2000-2020-F-0283
Date Received: December 11, 2019
Project: Combined Operating Plan

Dear Colonel Kelly:

The U.S. Fish and Wildlife Service (Service) has reviewed the U.S. Army Corps of Engineers' (Corps) request to initiate consultation and Biological Assessment (BA) dated December 11, 2019 for the proposed Combined Operating Plan (COP). The Service has also reviewed the Corps' February 14, 2020 correspondence to amend the BA that was submitted in response to the Service's January 17, 2020 recommendations regarding effects determinations for several federally listed species and designated critical habitats. This letter is submitted in accordance with section 7 of the Endangered Species Act of 1973, as amended (Act) (87 Stat. 884; 16 U.S.C. 1531 *et seq.*). This letter does not complete ESA consultation for the COP.

PROJECT DESCRIPTION

The COP is an integrated operational plan for two modifications of the Central & South Florida (C&SF) Project. The two modifications are known as Modified Water Deliveries (MWD) to Everglades National Park (ENP) and the Canal 111 (C-111) South Dade Projects. The purpose of COP is to define the water management operations for Water Conservation Area (WCA) 3A and WCA 3B outlets, structures in the L-31N and the C-111 basins constructed as part of the C&SF Project and the recently constructed components of the MWD and C-111 South Dade Projects. The COP water management operations will be consistent with their respective project purposes as defined by the authorizing legislation and further refined by subsequent general design memorandums, general reevaluation reports, and limited reevaluation reports completed for the MWD and C-111 South Dade Projects. The intent of COP is to balance ecological restoration objectives of the MWD and C-111 South Dade completed infrastructure by redistributing the existing WCA 3A and ENP water budget, while remaining compatible with future expected flow increases. The proposed operations will also be consistent with the original purposes of the C&SF Project as follows: to provide flood control; water supply for agricultural irrigation, municipalities and industry, and ENP; regional groundwater control and prevention of saltwater intrusion; enhancement of fish and wildlife; and recreation. The COP action area is approximately 2,374,782 acres (See Figure 1).

The Corps has concluded with a "*May affect, not likely to adversely affect*" effects determination for the federally listed species, proposed species, and critical habitats identified in Table 1.

Common Name	**Scientific Name**	**Status**	**May Affect, Not Likely to Adversely Affect**
	Mammals		
Florida panther	*Puma concolor coryi*	E	X
Florida bonneted bat	*Eumops floridanus*	E	X
Florida manatee	*Trichus manatus latirostris*	T	X
	Birds		
Eastern black rail	*Laterallus jamaicensis jamaicensis*	P,T	X
	Reptiles		
American alligator	*Alligator mississippiensis*	T, SA	X
American crocodile	*Crocodylus acutus*	T, CH	X
Eastern indigo snake	*Drymarchon corais couperi*	T	X
	Invertebrates		
Bartram's hairstreak	*Strymon acis bartrami*	E, CH	X
Florida leafwing	*Anaea troglodyte floridalis*	E, CH	X
	Plants		
Blodgett's silverbush	*Argethamnia blodgetti*	T	X
Deltoid spurge	*Chamaesyce deltoidea spp. deltoidea*	E	X
Everglades bully	*Sideroxylon reclinatum spp. austrofloridense*	T	X
Florida pineland crabgrass	*Digitaria pauciflora*	T	X
Florida prairie clover	*Dalea carthagenesis var. floridana*	E	X
Garber's spurge	*Chamaesyce garberi*	T	X
Pineland sandmat	*Chaemaesyce deltoidea ssp. pinetorum*	T	X
Small's milkpea	*Galactia smallii*	E	X
Tiny polygala	*Polygala smallii*	E	X

Table 1. E = Endangered; T = Threatened; P = Proposed; SA = Similarity of Appearance; CH = Critical Habitat.

It is important to note that *"May affect, is not likely to adversely affect"*(MANLAA) is the appropriate finding when the action agency determines that **all effects** to federally-listed species or designated critical habitat from the proposed action would be insignificant, discountable, or completely beneficial. **Insignificant effects** relate to the size of the impact and include those effects that are not measurable. **Discountable effects** are effects that are extremely unlikely to occur. Based on best judgement, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur. **Beneficial effects** are contemporaneous positive effects without any adverse effects to the species or designated critical habitat (50 CFR 402.13a).

Florida Panther

Florida panthers are known to inhabit the proposed action area of the COP. The proposed action area of the COP overlaps the Florida panther "Primary Zone". The "Primary Zone" was established as part of a landscape-level strategy for the conservation of the panther population in south Florida and was developed using a Florida panther potential habitat model. The model is based on the following criteria: (1) forest patches greater than 4.95 acres (2 hectares); (2) non-urban cover types within 656 feet (200 meters) of forest patches; and (3) exclusion of lands within 984 feet (300 meters) of urban areas. The Primary Zone is currently occupied and supports the breeding population of panthers.

Because Florida panthers are known to occur in the proposed action area and suitable habitat occurs in the action area, increased water deliveries to ENP could affect Florida panther habitat. However, as lands in the study area become restored to their more historic natural values, improvements to prey may result in greater use by the Florida panther. Small mammals that constitute the Florida panther's prey-base, including raccoons and river otters, would benefit from increased crayfish and small prey fish biomass in areas in ENP that would be rehydrated as a result of the COP. According to the BA, the Everglades Landscape Vegetation Succession Model (ELVeS) was used to predict vegetation community change over time in response to environmental conditions. Results of the COP modeling indicate that at the broad landscape scale there were vegetation community changes predicted to occur within most of the action area including decreases in floating emergent marsh within portions of WCA 3A adjacent to the L-67A/C levee. The predicted changes to the Florida panther prey-base and vegetation communities are not likely to significantly adversely affect the Florida panther. Therefore, the Service concurs with the Corps' effects determination that the COP may affect, but is not likely to adversely affect the Florida panther.

Florida Manatee and Florida Manatee Critical Habitat

Florida manatees are known to occur in canals throughout the action area of the COP. The proposed action area also overlaps designated critical habitat for the Florida manatee. No specific primary or secondary constituent elements were included in the critical habitat designation for the Florida manatee. However, the Service and researchers agree that essential habitat features for Florida manatee include seagrasses for foraging, shallow areas for resting and calving, channels for travel and migration, warm water refuges during cold weather and freshwater for drinking.

As previously described, the COP is an operational plan to redistribute the amount and timing of releases from WCA 3A to ENP. The COP does not include associated construction activities (i.e. canal removal/backfilling) that would significantly affect canals that Florida manatees inhabit. Additionally, according to COP modeling evaluations, as described in the BA, the COP is not expected to significantly adversely affect the essential features listed above that Florida

manatees require. Therefore, the Service concurs with the Corps' effects determination that the COP may affect, but is not likely to adversely affect the Florida manatee and Florida manatee critical habitat.

Florida Bonneted Bat

The Florida bonneted bat has not been observed within the action area of the COP by visual site inspections (peeping potential roost sites, guano presence, etc). However, the species has been detected within the action area via acoustic monitoring along portions of the L-67A and L-67C canals and levees, and adjacent to Northeast Shark River Slough along the L-31N canal and levee. Therefore, there is reasonable certainty that the species occurs within and adjacent to the action area of the COP, and the area is within the Service's defined Florida bonneted bat consultation area.

The Florida bonneted bat uses trees and snags (standing dead trees) as roosts. This bat species is suspected to have high roost site fidelity, so the loss of a roost site may cause greater stress to the species than the loss of a roost site for other, more labile species. Similar to many other insectivore bat species, Florida bonneted bats generally forage over canals, streams, and wetlands. Thus, any actions that involve the removal of trees and snags, and/or the filling in or degradation of canals, streams, or wetlands within the range of the species have the potential to adversely affect the Florida bonneted bat.

As previously described, the COP is an operational plan to redistribute the amount and timing of releases from WCA 3A to ENP. The COP does not include associated construction activities that would result in the removal of trees and snags or the filling in or degradation of canals, streams, and wetlands. Therefore, the COP is not expected to significantly adversely affect the suitable roosting and foraging habitat for the Florida bonneted bat. Based on this information, the Service concurs with the Corps' effects determination that the COP may affect, but is not likely to adversely affect the Florida bonneted bat.

Eastern Black Rail

The action area of COP is within the known range of the eastern black rail. The eastern black rail is currently a proposed species. A proposed species is a species that is proposed in the Federal Register to be listed under Section 4 of the ESA. In accordance with Section 7(a)(4) of the ESA, the Corps has requested a conference concurrence for the potential effects of the COP to the eastern black rail. The conference concurrence can be adapted as a concurrence letter if the eastern black rail is listed as threatened or endangered under the ESA.

Eastern black rails are found in a variety of salt, brackish, and freshwater marsh habitats that can be tidally or non-tidally influenced. Within these areas, the birds occupy relatively high elevations along heavily vegetated wetland gradients, with soils that are moist or flooded to a shallow depth (1 to 6 centimeters (cm)). Eastern black rails forage on seeds and various small

(< 1 cm) aquatic and terrestrial invertebrates, especially insects. Occupied habitat tends to be primarily composed of fine-stemmed emergent plants (rushes, grasses, and sedges) with high stem and dense canopy cover. The eastern black rail requires dense vegetative cover that allows movement underneath the canopy, providing shelter and protection for nest sites. Flooding is a frequent cause of nest failure. Water levels must be below the nests during egg laying and incubation, which occurs from May to August, for nests to be successful.

According to the Corps' amendment to the BA dated February 14, 2020, the expected differences in water depths and hydroperiods under the COP in comparison to the existing baseline condition are unlikely to significantly affect areas of higher elevations that coincide with suitable eastern black rail habitat as previously described. Therefore, the Service concurs with the Corps' effects determination that the COP may affect, but is not likely to adversely affect the eastern black rail.

American Alligator

The American alligator occurs throughout the COP action area and are most abundant in canals and the deeper slough habitats of the central Everglades. The American alligator is dependent on spatial and temporal patterns of water fluctuations that affect courtship and mating, nesting, and habitat use.

For the COP, a Habitat Suitability Index (HSI) for alligators was employed in the BA to evaluate potential effects to the American alligator. The HSI measured annual habitat suitability for five components of alligator production: (1) land cover suitability, (2) breeding potential (female growth and survival from April 16 of the previous year - April 15 of the current year), (3) courtship and mating (April 16 – May 31), (4) nest building (June 15 – July 15), and egg incubation (nest flooding from July 1 – September 15).

In summary, the alligator HSI concluded that the COP would not result in significant adverse effects to the above-listed components of alligator production. Therefore, the Service concurs with the Corps' effects determination that the COP may affect, but is not likely to adversely affect the American alligator.

American Crocodile and American Crocodile Critical Habitat

The American crocodile occurs within the southern portion of the COP action area. The current distribution of the American crocodile is limited to extreme South Florida, including coastal areas of Miami-Dade, Monroe, Collier, and Lee Counties near Florida Bay. The American crocodile is found primarily in mangrove swamps and along low-energy mangrove lined bays, creeks, and inland swamps. Natural nesting habitat includes sites with sandy shorelines or raised marl creek banks adjacent to deep water.

Growth and survival of hatchling and juvenile crocodiles is influenced by salinity. Optimal salinity for these life stages is 0 to 20 practical salinity units (psu) in the wetlands and coastal creeks during the wet season and partway through the dry season (approximately June through

January). Changes in hydrology that would increase existing salinity conditions in the crocodile reproduction areas would degrade juvenile habitat for the American crocodile.

Critical habitat for the American crocodile includes but is not limited to both Florida Bay and Biscayne Bay. The COP modeling in the BA indicates that changes in freshwater flow in the headwaters of designated critical habitat for the American crocodile were variable for each alternative depending upon the location. The COP modeling evaluations showed that the proposed action has the potential to improve freshwater flows to Florida Bay, and the preferred alternative, ALTQ, increased average annual flows by 36,000-acre feet.

Results from the Restoration Coordination and Verification (RECOVER) team's southern coastal systems performance measure indicate that significant adverse effects to Florida Bay are not anticipated from the COP due to the degree of observed salinity changes. The COP is expected to improve seasonal inflow deliveries to Florida Bay, thus resulting in more favorable salinity conditions for juvenile crocodile growth and survival. Therefore, the Service concurs with the Corps effects determination that the COP may affect, but is not likely to adversely affect the American crocodile and American crocodile critical habitat.

Eastern Indigo Snake

The eastern indigo snake is known to occur within the proposed action area of the COP. This snake species prefers drier habitats with well drained sandy soils, and commonly uses burrows and other natural holes as dens. Eastern indigo snakes may be found in a variety of habitats including pine flatwoods, scrubby flatwoods, floodplain edges, sand ridges, dry glades, tropical hammocks, edges of freshwater marshes, muck land fields, coastal dunes, cabbage palm hammocks, and xeric sandhill communities. Eastern indigo snakes are also known to inhabit abandoned agricultural land and human-altered habitats in South Florida which could include levees within the C&SF system.

According to the BA, the increase in water flow, hydroperiods, and changes in water distribution resulting from the COP is unlikely to significantly affect the upland habitats preferred by the eastern indigo snake. The COP does not include associated construction activities that would result in significant alteration of upland habitats that indigo snakes typically inhabit. Based on this information, the Service concurs with the Corps effects determination that the COP may affect, but is not likely to adversely affect the eastern indigo snake.

Bartram's Hairstreak Butterfly, Florida Leafwing Butterfly and their Critical Habitats

The Bartram's hairstreak butterfly and the Florida leafwing butterfly have a substantial portion of their populations within the action area of the COP. More specifically, both of these butterfly species are known to occur within the pine rocklands of ENP on Long Pine Key, and the only existing population of Florida leafwing is on Long Pine Key. Both species were federally listed as endangered, in part, due to their reliance on a single host plant, pineland croton (*Croton cascarilla*) which is restricted to pine rockland communities. Pine rockland communities occur on areas of relatively high elevation and consequently, have been reduced and continue to be threatened by development.

Designated critical habitat for the Bartram's hairstreak and the Florida leafwing also occurs within the action area of the COP. These critical habitat units consist of pine rockland communities of ENP.

Modeling output in the BA indicates that the changes in hydrologic conditions resulting from the COP are not likely to significantly affect pine rocklands habitat. Thus, the effects of COP to these butterfly species and their critical habitats are expected to be insignificant. Based on this information, the Service concurs with the Corps effects determination that the COP may affect, but is not likely to adversely affect the Bartram's hairstreak butterfly and the Florida leafwing butterfly, and the critical habitat of Bartram's hairstreak and Florida leafwing butterflies.

Blodgett's Silverbush, Deltoid Spurge, Everglades Bully, Florida Pineland Crabgrass, Florida Prairie Clover, Garber's Spurge, Pineland Sandmat, Small's Milkpea, and Tiny Polygala

The Blodgett's silverbush, deltoid spurge, Everglades bully, Florida pineland crabgrass, Florida prairie clover, Garber's spurge, pineland sandmat, Small's milkpea, and tiny polygala all occur within the action area of the COP. More specifically, each of these federally listed plant species are endemic to the pine rocklands habitat of ENP on Long Pine Key. Therefore, potential effects from the COP to each of these species are generally the same.

Modeling output in the BA indicates that the changes in hydrologic conditions resulting from the COP are not likely to significantly affect pine rocklands habitat. Thus, the effects of COP to these plant species are expected to be insignificant. Based on this information, the Service concurs with the Corps effects determination that the COP may affect, but is not likely to adversely affect the Blodgett's silverbush, deltoid spurge, Everglades bully, Florida pineland crabgrass, Florida prairie clover, Garber's spurge, pineland sandmat, Small's milkpea, and tiny polygala.

CONCLUSION

In summary of these findings, the requirements of section 7 of the ESA for the federally listed species, proposed species, and designated critical habitats identified in this letter have been fulfilled for the COP. However, reinitiation of consultation for these species is recommended if: 1) modifications are made to the COP; or 2) additional information regarding potential effects to these federally listed and proposed species, and their designated critical habitats becomes available.

This letter does not complete ESA consultation for the COP. The Corps has also requested to enter into formal consultation for the effects from the COP to the endangered Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*) and its designated critical habitat, the endangered Everglade snail kite (*Rostrhamus sociabilis plumbeus*) and its designated critical habitat, and the federally threatened wood stork (*Mycteria americana*). When the Federal action agency determines that a "*May affect, Likely to Adversely Affect*" situation exists, the action agency is required to request formal consultation with the Service for those species. The formal

consultation process for the COP's effects to the Cape Sable seaside sparrow and its critical habitat, Everglade snail kite and its critical habitat, and the wood stork is underway.

Thank you for your cooperation and effort in protecting federally listed species. If you have any questions, please contact James Gruhala of my staff at 772-469-4250.

Sincerely yours,

Donald R Progulske

Donald (Bob) Progulske
Everglades Program Supervisor
South Florida Ecological Services Office

cc: electronic only
USACE, Jacksonville, (Angela Dunn, Melissa Nasuti)
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Miccosukee Tribe of Indians of Florida (Craig van der Heiden)

Figure 1. Overview of the COP Action Area.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
South Florida Ecological Services Office
1339 20th Street
Vero Beach, Florida 32960

May 5, 2020

Andrew D. Kelly, Colonel
District Commander
U.S. Army Corps of Engineers
701 San Marco Boulevard
Jacksonville, Florida 32207

Service Consultation Code: 04EF2000-2020-F-0283
Date Received: December 11, 2019
Project: Combined Operational Plan

Dear Colonel Kelly:

This document transmits the U.S. Fish and Wildlife Service's (Service) Biological Opinion (BO) for the proposed Combined Operational Plan (COP). The BO is in accordance with section 7 of the Endangered Species Act of 1973, as amended (87 Stat. 884; 16 U.S.C. 1531 *et seq.*). The U.S. Army Corps of Engineers (Corps) completed a Biological Assessment (BA) for the COP which was received at the Service's South Florida Ecological Services Field Office on December 11, 2019.

This enclosed BO evaluates the potential effects of the COP on the federally endangered Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*) (CSSS) and its designated critical habitat, the federally endangered Everglade snail kite (*Rostrhamus sociabilis plumbeus*) (snail kite) and its designated critical habitat, and the federally threatened wood stork (*Mycteria americana*). The Service's conclusion after evaluating the COP is that its implementation will not jeopardize the continued existence of the CSSS, snail kites, or wood stork. And the COP implementation will not adversely modify designated critical habitat for the CSSS or snail kite.

This BO is based on best available science, including information provided in the Corps' BA, meetings, analysis of modeling output, published peer reviewed research, Corps' annual assessment reports, and additional information. A complete administrative record of this consultation is on file in the South Florida Ecological Services Field Office, Vero Beach, Florida.

The COP represents the first major change in system-wide water management since the authorization of the Comprehensive Everglades Restoration Plan in 2000. It is the culmination of the Modified Water Deliveries (MWD) to Everglades National Park and C-111 South Dade Conveyance System projects, which have been in various stages of planning, construction and

operation for well over two decades. The COP will serve as the operating plan for the completely built-out features of the Tamiami Trail Modification, 8.5 Square Mile Area, S-332 Detention Area, Frog Pond Detention Area, and several other projects built in previous years. It will allow unprecedented flow deliveries into Northeast Shark River Slough, which have long stymied Everglade's restoration progress. The COP lays the groundwork for future CERP projects to be planned and constructed at a faster pace.

The COP replaces the Everglades Restoration Transition Plan – 2016 (ERTP-2016) and associated water operations. The conclusion of the ERTP-2016 BO was that current water operations at that time would jeopardize the continued existence of the CSSS. In order to prevent jeopardy to the CSSS, the Corps developed a Reasonable and Prudent Alternative (RPA) to the proposed action. Included in that RPA were several actions and timelines that the Corps agreed to implement including extended closures of the S-12A/B structures, the ability to increase the L-29 canal stage to 8.5 feet, and completion of several incremental stages of MWD culminating in the completion of the COP analysis. The Corps will achieve all those actions and timelines with the implementation of COP in July-August 2020.

Thank you for your cooperation and effort in conserving federally listed species. If you have any questions regarding this BO, please contact Miles Meyer at 772-469-4281.

Sincerely yours,

Donald (Bob) Progulske
Everglades Program Supervisor
South Florida Ecological Services Office

Enclosure

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BIOLOGICAL OPINION
FOR THE
COMBINED OPERATIONAL PLAN (COP)

Service Consultation Code: 04EF2000-2020-F-0283

Submitted to:
Jacksonville District
U.S. Army Corps of Engineers
Jacksonville, Florida

Prepared by:
U.S. Fish and Wildlife Service
South Florida Ecological Services Office
Vero Beach, Florida

May 5, 2020

Approved By: Donald (Bob) Progulske, Everglades Program Supervisor

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Acronyms and Abbreviations

Abbreviation	Definition
3AVG	3-gauge average (gauges 3A-3, 3A-4, and 3A-28 also known as sites 63, 64 and 65)
Act	Endangered Species Act of 1973, as amended (87 Stat. 884; 16 U.S.C. 1531 *et seq.*)
ALT	Alternative
AMMP	Adaptive Management and Monitoring Plan
AOU	American Ornithologists Union
AVM	Avian Vacuolar Myelinopathy
BA	Biological Assessment
BCNP	Big Cypress National Preserve
BO	Biological Opinion
C-111 SD	C-111 South Dade Conveyance System Project
C&SF	Central & Southern Florida
CEPP	Central Everglades Planning Project
CERP	Comprehensive Everglades Restoration Plan
CFR	Code of Federal Regulations
cfs	cubic feet per second
cm	centimeters
COP	Combined Operational Plan
Corps	U.S. Army Corps of Engineers
CSSS	Cape Sable Seaside Sparrow
CSOP	Combined Structural and Operational Plan
CWA	Clean Water Act
District/SFWMD	South Florida Water Management District
DPM	Decompartmentalization Physical Model
DOI	Department of the Interior
EAA	Everglades Agricultural Area
EBM	Ecological Based Management Group
ECB19RR	Existing Condition Base run for COP
EDEN	Everglades Depth Estimation Network
EHWL	Extreme High Water Line
EIS	Environmental Impact Statement
ELVeS	Everglades Landscape Vegetation Succession Model
ENP	Everglades National Park
ERTP 2010	Everglades Restoration Transition Plan, Phase 1
ERTP 2016	Everglades Restoration Transition Plan, 2016 Biological Opinion
ET	Ecological Target
FDACS	Florida Department of Agriculture and Consumer Affairs
FDOT	Florida Department of Transportation

Abbreviation	Definition
FDEP	Florida Department of Environmental Protection
FEIS	Final Environmental Impact Statement
ft	feet
FONSI	Finding of No Significant Impact
FWC	Florida Fish and Wildlife Conservation Commission
GDM	General Design Memorandum
GRR	General Re-evaluation Report
GSE	Ground Surface Elevation
IDS	Integrated Delivery Schedule
IOP	Interim Operational Plan
ISOP	Interim Structural and Operational Plan
ITS	Incidental Take Statement
KCOL	Kissimmee Chain of Lakes
kg	kilograms
km	kilometer
lbs	pounds
m	meter
MANLAA	May Affect, Not Likely to Adversely Affect
µg	micro gram
MHHW	Mean Higher High Water
MIN	Annual Minimum Stage
MSTS	Multi-Species Transition Strategy
MWD	Modified Water Deliveries to Everglades National Park
NASA	National Aeronautics and Space Administration
NDA	North Detention Area
NEPA	National Environmental Policy Act
NGVD	National Geodetic Vertical Datum
NESRS	Northeast Shark River Slough
NRC	National Research Council
PAL	Planning Aid Letter
PCE	Primary Constituent Element
PM	Performance Measure
POR	Period of Record
PSC	Periodic Scientist Calls
PVA	Population Viability Analysis
ROD	Record of Decision
RPA	Reasonable and Prudent Alternative
RPM	Reasonable and Prudent Measure
SDAS	South Detention Area
SDCS	South Dade Conveyance System
SFWMM	South Florida Water Management Model

Abbreviation	Definition
SEI	Sustainable Ecosystems Institute
SEIS	Supplemental Environmental Impact Statement
Service	U.S. Fish and Wildlife Service
SLR	Sea Level Rise
SMA	8.5 Square Mile Area
SRS	Shark River Slough
STA(s)	Stormwater Treatment Area(s)
TTFF	Tamiami Trail Flow Formula
USC	United States Code
USGS	U.S. Geological Survey
WCA(s)	Water Conservation Area(s)
WCP	Water Control Plan
WSRS	Western Shark River Slough
WY	Water Year

Executive Summary

The Combined Operational Plan (COP) represents the first major change in system-wide water management since the authorization of the Comprehensive Everglades Restoration Plan (CERP) in 2000. It is the culmination of the Modified Water Deliveries (MWD) to Everglades National Park (ENP) and C-111 South Dade Conveyance System (C-111 SD) projects which have been in various stages of planning, construction and operation for well over two decades. The COP will serve as the operating plan for the completely built-out features of the Tamiami Trail Modification, 8.5 Square Mile Area (8.5 SMA), S-332 Detention Area, Frog Pond Detention Area and several other projects built in previous years. It will allow unprecedented flow deliveries into Northeast Shark River Slough (NESRS) which have long stymied Everglade's restoration progress. The COP is expected to be the water operations plan for this area for the next 7 years.

The COP replaces the 2016 Everglades Restoration Transition Plan (ERTP-2016) and associated water operations. The conclusion of the ERTP-2016 Biological Opinion was that current water operations at that time would jeopardize the continued existence of the CSSS. In order to prevent jeopardy to the CSSS the Corps, in consultation with the Service, developed a Reasonable and Prudent Alternative (RPA) to the proposed action. Included in that RPA were several actions and timelines that the Corps agreed to implement including extended closures of the S-12A/B structures, the ability to increase the L-29 canal stage to 8.5 feet, and completion of several incremental stages of Modified Waters Delivery culminating in the completion of the COP analysis. The Corps will achieve all those actions and timelines with the implementation of COP in August 2020. The COP includes many of the monitoring requirements and performance targets from ERTP.

An increase in flows to NESRS of over 229,000 acre-feet per year are expected to not only begin the restoration of degraded slough habitat within ENP but also restore the hydrology in the shorter hydroperiod marl prairies on the banks of the major sloughs. These are unique habitats within ENP and used by many plant and animal species, in addition to the federally endangered Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*) (CSSS), the federally endangered Everglade snail kite (*Rostrhamus sociabilis plumbeus*), and the federally threatened wood stork (*Mycteria americana*). Prolonged ponding in Southern Water Conservation Area 3A (WCA-3A), which has degraded ridge and slough habitat, damaged tree islands, and affected suitability of nesting habitat for snail kites, will also be improved. The COP will improve the system's ability to handle emergency high water conditions in WCA-3A and allow an increased volume of discharge south from Lake Okeechobee. The COP carefully considered the hydrology of upstream areas in northern WCA-3A and is not expected to significantly exacerbate drying conditions in these areas while we wait for future Central Everglades Planning Project (CEPP) components to restore this area. The COP lays the groundwork for future CERP projects to be planned and constructed at a faster pace.

The U.S. Army Corps of Engineers (Corps) has determined that the proposed action, COP Alternative Q+ (ALT Q+), "may affect" the federally endangered CSSS and its designated

critical habitat, the federally endangered Everglade snail kite,and its designated critical habitat, and the federally threatened wood stork.

It should be noted that ALT Q+ was not specifically modeled by the Corps but performs similarly to Alternative Q (ALT Q) which was modeled. Therefore, the results from ALT Q are used for analysis purposes throughout this document.

This Biological Opinion provides an evaluation of the potential effects of the COP on the federally endangered Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*) (CSSS) and its designated critical habitat, the federally endangered Everglade snail kite (*Rostrhamus sociabilis plumbeus*) (snail kite) and its designated critical habitat , and the federally threatened wood stork (*Mycteria americana*). The Services' conclusion after evaluating the COP is that its implementation will not jeopardize the continued existence of the CSSS, snail kites, or wood stork and the COP implementation will not adversely modify designated critical habitat for the CSSS or snail kite.

Consultation History

Previous Consultations

This project and related components have an extensive consultation history going back to the mid-1980s. A complete history of the previous consultations can be found in the ERTP 2016 BO. The ERTP BO resulted in a jeopardy determination for water operations affects to the CSSS. The Corps, in consultation with the Service, developed a Reasonable and Prudent Alternative to avoid jeopardy.

Consultation History for Combined Operational Plan (COP)

The 2016 Everglades Restoration Transition Plan (ERTP 2016) Biological Opinion (BO) was issued on July 22, 2016. As part of that BO, the Corps committed to expediting the COP review and implementing the project by the end of calendar year 2019.

On September 22, 2017, The Corps provided correspondence to the Service indicating that they were beginning preparation of the National Environmental Policy Act (NEPA) assessment for the COP. This correspondence requested comments from the agencies, tribes, and interested parties. Scoping comments were accepted through October 21, 2017.

On September 26, 2017, the Corps requested a list of federally listed threatened and endangered species within the action area.

By letter dated October 24, 2017, the Corps requested written confirmation of concurrence on the use of a single environmental baseline for purposes of the Endangered Species Act consultation. This single environmental baseline was developed for purposes of alternative evaluation which represented the conditions in place at the expected time of the COP implementation in 2019.

On October 31, 2017, the Service provided the list of species to the Corps.

The Service provided a Planning Aid Letter (PAL) on November 13, 2017, requesting consideration of the addition of the following items to the Corps' Existing Condition Base: (1) structure S-333N expansion expedited by the South Florida Water Management District (SFWMD) and considered under the Central Everglades Planning Project (CEPP) (Corps 2014); (2) MWD Increment 2 (operational changes required under the July 2016 Everglades Restoration Transition Plan (ERTP 2016) Biological Opinion (BO)) (Corps 2018); and (3) relaxation of the G-3273 Constraint. The Service also commented on and concurred with the Corps use of performance metrics and ecological planning tools to evaluate the effects of the COP.

On November 27, 2017, the Service provided an updated species list via email which included recently listed species.

On August 10, 2018, the Service received a letter from the Corps requesting that the Biological Opinion (Service 2016) for the Environmental Restoration Transition Plan (ERTP) be amended to reflect a change in the completion date of the Combined Operational Plan (COP) project.

On September 7, 2018, the Service provided an acknowledgement letter to the Corps stating that the 2016 ERTP BO would be revised to reflect the new COP completion date of May 25, 2020.

On August 24, 2018, Service staff attended a workshop to review and comment on draft alternatives for COP which were drafted by the "lead" agencies consisting of the Corps, SFWMD and ENP. It was noted at this meeting that though the Service was not invited to the previous design charrettes the Corps decided it was best to retain the sparrow protections as a constraint and include them in the COP alternatives.

On September 30, 2019, the Service received a letter from the Corps requesting that the Biological Opinion (BO) (Service 2016) for the Everglades Restoration Transition Plan (ERTP) be amended again to reflect a change in the implementation date of the Combined Operational Plan (COP).

By letter dated October 9, 2019, the Service acknowledged the Corps' request to move the COP completion date out to August 2020 for the Record of Decision to be signed.

On December 11, 2019, the Service received the Corps' Biological Assessment (BA) for the COP. The Corps' BA determined that the proposed project "may affect, but is not likely adversely affect" (MANLAA) the following species: Florida panther (*Puma concolor coryi*), Florida manatee (*trichechus manatus latiostris*), Florida bonneted bat (*Eumops floridanus*), American alligator (*Alligator mississippiensis*), American crocodile (*Crocodylus acutus*) and Eastern indigo snake (*Drymarchon corais couperi*). The Corps also determined that the project "may affect, but not likely adversely affect" (MANLAA) the following: manatee critical habitat, American crocodile critical habitat, Bartram's hairstreak butterfly critical habitat, and Florida

leafwing critical habitat. The Corps determined that the project "may affect" the Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*) and its designated critical habitat, the Everglade snail kite (*Rostrhamus sociabilis plumbeus*) and its designated critical habitat, and the wood stork (*Mycteria americana*). The Corps requested to enter into formal consultation for these species and critical habitats. The BA also included "no effect" determinations for several species.

On January 17, 2020, the Service replied to the Corps with a letter with recommendations to reconsider the "effects determinations" for several species addressed in the BA.

On February 14, 2020, the Corps responded to the Service's January 17, 2020, correspondence with an amendment to their BA. This BA amendment changed effects determinations from "no effect" to "may affect, not likely to adversely affect" determinations for the following species: Bartram's hairstreak butterfly (*Strymon acis bartrami*), Florida leafwing butterfly (*Anaea troglodyte floridalis*), Garber's spurge (*Chamaesyce garberi*), Small's milkpea (*Galactia smallii*), Tiny polygala (*Polygala smallii*), Blodgett's silverbush (*Argythamnia blodgettii*), Everglades bully (*Sideroxylonreclinatum spp. austrofloridense*), Florida pineland crabgrass (*Digitaria paucifloria*), Florida prairie-clover (*Dalea carthagenesis floridana*) and Pineland sandmat (*Chaemaesyce deltoidea pinetorium*).

On March 16, 2020, the Service provided a concurrence letter regarding the Corps' "May Affect, Not Likely to Adversely Affect" species determinations.

On March 16, 2020, the Draft BO was provided to the Corps by email for comments. The Corps provided their comments by email on March 23, 2020.

By email dated March 19, 2020, the draft BO was provided to the Miccosukee Tribe of Indians of Florida for their review. The Service requested comments be provided by March 31, 2020. As of the signing of this BO no comments have been received from the Miccosukee Tribe.

On April 22, 2020, the Service provided a revised draft BO to the Corps by email for review. The Corps provided their comments by email on April 23, 2020.

On April 30, 2020, the Service provided a draft final version of the BO for the Corps to review. The Corps provided their comments on May 1, 2020.

A complete administrative record of this consultation is on file in the Service's South Florida Ecological Services Field Office located in Vero Beach, Florida.

BIOLOGICAL OPINION

A Biological Opinion (BO) is the document required under the Endangered Species Act (Act) that states the opinion of the Service as to whether a federal action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of

designated critical habitat (50 CFR §402.02). This BO addresses the effects resulting from the Corps' proposed action of the Combined Operational Plan (COP) to the Cape Sable seaside sparrow (CSSS) and its critical habitat, Everglade snail kite and its critical habitat, and the wood stork. "*Jeopardize the continued existence of*" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of the species (50 CFR §402.02).

"Destruction or adverse modification" means a direct or indirect alteration that appreciably diminishes the value of critical habitat "as a whole" for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features (50 CFR §402.02).

This BO is based on best available science, including information provided in the Corps' Biological Assessment, meetings, analysis of modeling output, published peer reviewed research, Corps' annual assessment reports, and additional information. A complete administrative record of this consultation is on file in the South Florida Ecological Services Office, Vero Beach, Florida.

1.0 DESCRIPTION OF THE PROPOSED ACTION – COMBINED OPERATIONAL PLAN (COP)

The Corps' Biological Assessment (BA) dated December 11, 2019, for the Combined Operational Plan (COP) describes the Proposed Action as an integrated water operational plan which includes two modifications of the Central & Southern Florida (C&SF) Project. These modifications are the Modified Water Deliveries (MWD) to Everglades National Park (ENP) and the C-111 South Dade Conveyance (C-111 SD) Projects. The COP is the final iteration of operational plans for the foundational projects which precede the Comprehensive Everglades Restoration Plan (CERP) and includes infrastructure that has been put in place since the ERTP 2016 Biological Opinion was issued. The purpose of the COP is to define the water management operations for the WCA-3A and WCA-3B outlets, structures in the L-31N and C-111 basins constructed as part of the C&SF Project, and the recently constructed components of the MWD and C-111 SD Projects. The COP will balance ecological restoration objectives of the MWD and C-111 SD completed infrastructure by redistributing the existing WCA-3A and ENP water budget while remaining consistent with the original purposes of the C&SF Project to provide flood control; water supply for agricultural irrigation, municipalities and industry, and ENP; regional groundwater control and prevention of saltwater intrusion; enhancement of fish and wildlife; and recreation.

The Corps' proposed action is called Alternative Q+ (ALT Q+) for planning purposes. While this alternative was not specifically modeled during the planning process, it performs similarly to Alternative Q (ALT Q) which was modeled. Therefore, results from ALT Q are used as a

surrogate for analyses within this document. ALT Q+ and ALT Q may be used interchangeably within this document.

Additionally, CSSS-Ax, which is mentioned throughout the analysis contained in this document, was originally described in the ERTP 2016 BO (Service 2016). CSSS-Ax includes expansion areas to the northeast and southeast of the original CSSS-A polygon which was delineated as part of the proposed critical habitat designation in 2007. CSSS-A is not designated critical habitat for CSSS. The expansion areas were delineated based on hydrologic models which indicate that marl prairie conditions may improve in these areas under ERTP and COP operations. It should be noted that analyses within this document refer to CSSS-Ax which is the original CSSS-A plus the expansion areas (roughly 82,000 acres).

According to the Corps' Integrated Delivery Schedule (IDS), the COP water management activities will be continuous over either: (1) the 7-year period identified in the IDS; (2) until construction of new CEPP infrastructure, including features which would enable increased flow deliveries into the WCAs, ENP, and Florida Bay; or (3) if new information becomes available through implementation of the COP Water Control Plan and/or the COP Adaptive Management and Monitoring Program (AMMP) that would necessitate a need to modify water management operations. Therefore, the expected reasonable duration of the COP operations is 7 years.

The Corps' BA (Corps 2019a) lists the COP goals and objectives as follows:

1. Improve water deliveries (timing, location, volume) into ENP and take steps to restore natural hydrologic conditions in ENP given current C&SF infrastructure and features expected to be completed by the time of implementation, to the extent practicable by

    a. Changing schedule of water deliveries so that it fluctuates in consonance with local meteorological conditions, including providing for long term and annual variation in ecosystem conditions in the Everglades (Timing) (P.L. 101-229, Section 101b);

    b. Restoring NESRS as a functioning component of the Everglades hydrologic system (Location) (P.L. 101-229, Section 101b); and

    c. Adjusting the magnitude of water discharged to ENP to minimize effects of too much or too little water (Volume) (1992 MWD GDM, Section 44).

2. Maximize progress toward restoring historic hydrologic conditions in the Taylor Slough, Rocky Glades, and eastern Panhandle of ENP.

3. Protect the intrinsic ecological values associated with WCA-3A and ENP.

4. Minimize the damaging freshwater flows to Manatee Bay/Barnes Sound through the S-197 structure and increase flows through Taylor Slough and coastal creeks (1994 C-111 GRR, Section 5.2).

5. Include consideration of cultural values and tribal interests and concerns within WCA-3A and ENP.

The COP defines operations for the constructed features of the MWD and C-111 SD Projects. A detailed description of the proposed action is found under Section 1.3 Proposed Actions for the COP. Minor changes to the current WCA-3A regulation schedule (removal of Zone E1) are being proposed under the COP and no changes to associated infrastructure are proposed at this time; however, the Corps' proposed action does contain several features that are anticipated to improve hydrologic conditions for the Cape Sable seaside sparrow and other endangered species. Among the proposed features which will have the biggest effects on hydrology in the region are the Tamiami Trail Flow Formula, increased stages in the L-29 borrow canal and a fully functional detention area along the eastern boundary of ENP. The Corps should continue to search for and employ operational flexibilities within the current regulation schedule to maximize benefits for all natural resources within the Greater Everglades. The Corps has agreed to continue working with the U.S. Fish and Wildlife Service (Service) and the South Florida Water Management District (SFWMD) to optimize operation of the C-111 South Dade Conveyance System (SDCS) and detention areas for the conservation of listed species.

1.1 Conservation Measures

As part of the proposed action, the Corps has committed to implementing the following conservation measures, which are essentially the Terms and Conditions from the ERTP 2016 Biological Opinion. These measures are listed below as they appear in the Corps' Biological Assessment (Corps 2019a). Conservation Measures are included as part of the proposed action to monitor and minimize affects to listed species.

1. Species and habitat monitoring currently being conducted in compliance with the ERTP 2016 BO (Service 2016) will continue to identify population trends for the CSSS, snail kite, wood stork and the vegetation characteristic of their habitats.

2. Under the COP, the Corps will continue to implement the Periodic Scientist Calls (PSC) to provide real-time assessment of conditions within the action area to ensure wildlife recommendations are considered during the water management decision process.

3. The COP Adaptive Management and Monitoring Plan (AMMP) includes the following: (1) Part 1 Adaptive Management and Ecological Monitoring Plan; (2) Part 2 Water Quality Monitoring Plan; (3) Part 3 Hydrometerological Monitoring Plan, and (4) Part 4 Cultural Resources Monitoring Plan. The COP AMMP identifies the monitoring information needed to inform the COP implementation and to document progress towards meeting the project goals and objectives.

4. The Corps will continue to evaluate how water management operations within the flexibility available to water managers under the water control plan, may be conducted to maximize beneficial effects for the CSSS.

5. The Corps will continue to utilize best available methods to monitor and estimate the spatial and temporal extent of hydrologic conditions (water above or below ground surface) relative to the CSSS habitat targets (*i.e.*, dry nesting days and annual discontinuous hydroperiod).

6. The Corps will continue to implement provisions of the ERTP 2016 BO which require the Corps to provide a report to the Service on the results of this monitoring at least twice annually to evaluate progress toward meeting the performance targets (Service 2016). Bi-annual reports will evaluate nesting season conditions and include information such as the operations that occurred and their effectiveness, and the spatial and temporal extent of hydrologic conditions within each CSSS subpopulation (Service 2016).

7. The Corps will continue discussions with the Service in the event of operational modifications of the COP if such modifications are proposed to occur in the future. The Corps will track implementation of the COP and communicate the status of all actions to the Service as appropriate through regular interagency discussions (*i.e.*, COP PSC, COP AMMP Meetings). ESA consultation will be revisited as needed. If any effects to listed species associated with the COP are revealed that were not previously considered in this BA, the Corps will reinitiate ESA consultation as appropriate.

1.2 COP Background and Context

Water management and flood control in south Florida is accomplished through an extensive network of canals, levees, pumping stations, and control structures constructed as part of the C&SF Project, including three WCAs. The WCAs store excess water coming from the Everglades Agricultural Area (EAA), other parts of the east coast region, and Lake Okeechobee flood discharges. The WCAs are designed to prevent Everglades' floodwaters from inundating the east coast urban areas, provide a water supply for those same areas and ENP, recharge aquifers, reduce seepage, and protect against saltwater intrusion in coastal well-fields.

The regulation schedules for the WCAs and other facilities contain seasonal and monthly guidelines for acceptable water level ranges at many monitoring stations throughout numerous projects and watersheds. The regulation schedules generally prescribe low stages at the beginning of the wet season (late spring) and high stages at the end of the wet season (late fall). These regulation schedules must accommodate various, often apparently conflicting, water management purposes. Although the seasonal distribution of rainfall determines overall water availability in the system, the regulation schedules modify the timing, duration, and magnitude of extreme water levels (both low and high) that would otherwise occur.

The last decade of hydrologic management in the Everglades have been primarily under the Everglades Restoration Transition Plan (ERTP) except for the MWD Incremental Testing Phases 1, 1.1, 1.2 and 2 which made relatively minor incremental changes between 2016 and 2020. The largest difference from these testing phases was the movement of water east into NESRS similarly to how COP will manage these flows. These operations were disrupted by emergency management actions for high water events in 2017 and again in 2018. Analysis of these events showed the tremendous amount of water that could be moved eastward and into NESRS. These testing phases became the building blocks for COP. The initial Biological Opinion for ERTP was signed on November 17, 2010 (Service 2010a). The proposed action authorized by the ERTP 2010 BO was the continuation of the Interim Operational Plan (IOP) and the operations of the IOP structures and impoundments in the C&SF Project for up to 1 year until the ERTP Record of Decision (ROD) could be signed. The continuation of the IOP included the operations of the Modified Water Deliveries (MWD) and C-111 structural features and impoundments of the C&SF Project as described in the Service's 2006 IOP Biological Opinion (Service 2006a). The ERTP operations replaced the IOP after the ROD for ERTP was signed on October 19, 2012.

The purpose of ERTP was to define water operations for the constructed features of the MWD and C-111 projects until those projects were fully completed and the currently proposed action called the Combined Operational Plan (COP) could be planned and implemented. The ERTP actions included modifications of the IOP and the operations of the IOP structures and impoundments in the C&SF Project under the 2002 IOP Alt-7R plan, including operational flexibilities and were intended to improve or maintain hydrological conditions to benefit multiple listed species and other resource values in the project area. The IOP, a Reasonable and Prudent Alternative (RPA) under the Service's 1999 Biological Opinion, was developed to avoid jeopardy to the CSSS while meeting other needs and constraints of the region, including restoration of sheetflow to ENP and maintenance of flood control in adjacent urban areas. ERTP represented a transition between the IOP and implementation of the MWD, C-111, and CERP project features. COP is the proposed operational plan that will include the MWD, C-111 and CERP features.

Completion of these project features is believed necessary to provide suitable conditions for the recovery of multiple listed species including the CSSS, Everglade snail kite, and wood stork within the project area (Sustainable Ecosystems Institute [SEI] 2003, 2007a, 2007b; National Research Council [NRC] 2008, 2010). Under the ERTP 2016 projected timeline, the Record of Decision for the revised water control plan, COP, was scheduled for completion in 2020. Many other components of Everglades CERP restoration such as those included in the most recent CEPP South are not scheduled to be completed until 2027. Considering the still declining status of the CSSS, the timing of future CERP and other associated projects (*e.g.*, CEPP South, Decompartmentalization, water storage, C-111 Spreader Canal phase 2, etc.) and the uncertainty of their completion dates gives reason for continued concern.

The overall CSSS population was low at the inception of IOP but was considered stable by researchers through 2009 at approximately 3,000 sparrows (Basier et al. 2008; Boulton et al.

2009; Cassey et al. 2007; Slater et al. 2009; Virzi et al. 2009). However, in five of the last nine years (2011, 2013, 2014, 2016 and 2019) the population estimates have been below 3,000 sparrows, with the lowest estimates from 2016 when the population was estimated at only 2,416 birds followed closely by preliminary estimates for 2019 which estimated the population at 2,688 and 2014 which had 2,720. The populations did increase in 2017 and 2018 with an estimated population of 3,280 and 3,184 sparrows respectively, however, as mentioned above, 2019 numbers fell below 3,000 again. Overall, the intrinsic rate of increase for the CSSS has been negative in 10 of the last 14 years. Recent investigations have expressed concern about the future viability of the population and habitat conditions (Virzi and Davis 2013; Slater et al. 2014).

Since around 1992, prolonged high water in WCA-3A has persisted, likely contributing to degradation of tree islands and marsh habitat (Zweig and Kitchens 2008). In addition, the Everglade snail kite range-wide estimated population declined from a high of approximately 3,500 kites in 1999 to an estimated low of approximately 662 kites in 2009 (Cattau et al. 2009). During this time, the snail kite population essentially declined by half from 2000 to 2002 and again from 2006 to 2008, at least in part, due to two severe regional droughts and a tropical storm (Cattau et al. 2009). By 2012, the population estimate had increased to 1,218 birds (Cattau et al. 2012). In 2015, the population estimate was significantly higher (2,127 birds [95 percent CI = 2,000-2,338]) primarily due to stable fledging rates in Lake Okeechobee, an increase in fledging in the Everglades and STAs, and a large amount of successful nesting in a new area (Mary A. Mitigation Bank in Brevard County) (Fletcher et al. 2016). As shown in Figure 15, in 2016, the population estimate slightly decreased to approximately 2,100 birds. But, in 2017 the estimate rose to approximately 2,600 birds. The 2018 population estimate slightly decreased to 2,347 birds. The 2019 population is currently being calculated (Fletcher et al. 2019).

Given the resource concerns at the time, the objective of ERTP 2016, which essentially extended ERTP for four more years, was to utilize operational flexibility in order to improve conditions for the Everglade snail kite, maintain nesting and habitat requirements for the CSSS, and enhance wood stork and native habitats. The ERTP 2016 was expected to provide these water management flexibilities by emphasizing an east-to-west distribution of water, explore preemptive releases of water, and keep the implementation of the COP on schedule, while maintaining the C&SF Project purposes (flood control and water supply). Around the same time ERTP 2016 was being finalized the Corps began implementing a series of operational tests called the MWD Incremental Field Tests. Increment 1 was implemented prior to completion of ERTP 2016 but was later revised during increments 1.1 and 1.2 to include expanded closure periods for the S-12A, S-12B, S-343A, S-343B, and S-344 structures as required by the RPA in the ERTP 2016 BO. Increment 2 maintained the required closure periods for these structures and analyzed a set of alternatives to address the mandated RPA of the ERTP 2016 BO to raise the maximum operating limit in the L-29 Canal up to a maximum of 8.5 feet NGVD, subject to identified constraints. As mentioned previously, these field tests were interrupted by the high water years of 2017 and 2018 but the results were very promising in that it was demonstrated that increased amounts of water could be delivered to NESRS. The benefit of these actions to sparrows in CSSS-Ax was less evident since sparrows and their habitat respond at longer time frames than

the few years these tests were conducted. For more detail regarding the Incremental Field Tests see the Corps' draft EIS for the COP.

The 2010 ERTP was intended to cover operations until full implementation of the Combined Operational Plan (COP) in 2013. However, the prerequisite projects (MWD and C-111) required to implement the COP were not yet completed. Since the completion of the ERTP 2016 BO, the Corps has kept the planning of the COP generally on schedule and the ROD is expected to be signed in August 2020. This date was extended on two separate occasions and since staying on schedule was a part of the Service's ERTP 2016 RPA (Service 2016), the Service followed up with correspondence on July 13, 2018, and October 9, 2019 to acknowledge the delays. The COP is expected to be in place for (1) the 7-year period identified in the Integrated Delivery Schedule (IDS); (2) until construction of new CERP infrastructure, including features which would enable increased flow deliveries into the WCAs, ENP, and Florida Bay; or (3) if new information becomes available through implementation of the COP Water Control Plan and/or the COP Adaptive Management and Monitoring Program (AMMP) that would necessitate a need to modify water management operations.

1.3 Proposed Actions for the COP

The Action currently proposed in the Corps' BA is the Combined Operational Plan which defines operations for the constructed features of the Modified Water Deliveries (MWD) and C-111 Projects. Under the COP, the Corps and SFWMD will begin to restore historic flows to Northeast Shark River and Taylor Sloughs in ENP by adjusting proportionate flow volumes across Tamiami Trail to what they were originally, 30 percent on the west side and 70 percent on the east side. Two features of the COP will allow this to happen and are discussed in more detail below. One is structural modifications to the east side of Tamiami Trail (U.S. Hwy 41) that will allow stages in the L-29 borrow canal to increase to 8.5 feet NGVD, subject to identified constraints. The Florida Department of Transportation currently restricts the amount of time that water levels can be at 8.5 NGVD due to roadbed integrity concerns. The final phase of the Tamiami Trail Next Steps project, when completed, should eliminate the need for these restrictions by raising the roadbed. The second is an operational feature called the Tamiami Trail Flow Formula (TTFF) which will replace the current rainfall plan which dictates the amount and timing for flows through the S-333 structure to the eastern side of Tamiami Trail.

Under the COP, all the previously sought flexibility in system operations (*e.g.*, prioritizing S-12 flow from east to west and early or delayed open/close of S-12A, S-12B, S-343A and S-343B) will become inherent in the project. The COP will promote more suitable discontinuous hydroperiods within CSSS habitat by reducing flows to CSSS-Ax and provide an increase in flows into parts of the eastern subpopulations that are overly dry due to drainage by neighboring canals. The Corps should continue to explore the use of operational flexibility to improve the timing of flow deliveries throughout the system. The TTFF will incorporate previous operational flexibility such as preemptive releases. The Adaptive Management and Monitoring Plan (AMMP) is intended be able to capture areas where additional operational flexibility can be incorporated into the COP. This flexibility will assist in maintaining target stages within

WCA-3A and allow for further flexibility in discharges through the S-12 and S-333 structures. The elements of the proposed action are discussed in more detail in the following sections.

1.3.1 Tamiami Trail Flow Formula

Since before the implementation of ERTP in 2010, water releases through the S-333 and S-12 structures which are part of the WCA-3A Regulation Schedule, were determined by the 1985 WCA-3A Rainfall Plan (Corps 2019a). This Rainfall Based Water Management Plan consisted of a rainfall-based delivery formula that specified the amount of water to be delivered to ENP in weekly volumes through the S-333 and S-12 structures. The COP will replace this formula with the Tamiami Trail Flow Formula (TTFF) which is designed to provide more natural deliveries of water. The 2020 WCA-3A Regulation Schedule has two zones; Zone A and Zone B along with an Extreme High Water Line (EHWL). Zone A is above Zone B and delineated by a seasonally varying line that ranges from a maximum of 10.5 feet NGVD (November 1) to a minimum of 9.5 feet NGVD. In Zone A, maximum releases at S-333, S-333N, S-12D, S-12C, S-12B, S-12A, S-343A, S-343B, S-344, and S-151 are subject to the applicable closure periods and downstream constraints and the FDEP permit in the case of S-333N. In Zone B, the WCA-3A release targets are computed by the TTFF for S-333, S-12D, S-12C, S-12B, S-12A (listed in priority order) to prioritize releases to Northeast Shark River Slough (NESRS) first and Western Shark River Slough (WSRS) second.

The TTFF represents a more robust "rainfall plan" and is geared more towards enhanced ecosystem and landscape performance while also recognizing constraints such as flood protection, water supply and other C&SF Project requirements. It improves upon the old rainfall plan by achieving flow deliveries that mimic natural processes, moderates flow rates and more evenly distributes flow across the entire slough. The TTFF uses an existing network of stage gauges, potential evapotranspiration, and rainfall gauges in WCA-3A and ENP to guide real-time operations to convey water from WCA-3A across Tamiami Trail to ENP to meet ecological, flood protection, and water supply needs in WCA-3A and ENP. The TTFF uses multiple stage stations for the start of the current week and the previous week's flow in a linear approximation formula to compute a flow target for the coming week. Some of the variables used in the equation include:

- the spatial average of observed stages (feet NGVD) at WCA-3A gauges A-3 (Site 63), A-4 (Site 64) and A3-28 (Site 65) for the start of the current week
- the observed stage (feet NGVD) at ENP gauge NESRS2 for the start of the current week
- the daily average of observed releases (sum of S-12C, S-12D, S-333, S-333N, S-12A, and S-12B flows) for the previous week
- the areal average for the total weekly rainfall (inches) for the entire WCA-3A and Mullet Slough for current week
- the total weekly potential evapotranspiration (inches) at the 3AS3WX gauge location, and
- the Zone A regulation stage (ft, NGVD) value for the beginning of the current week

The TTFF may need to be adjusted once implemented under the COP so the Adaptive Management and Monitoring Plan (AMMP) features two management uncertainties to be closely monitored (Uncertainty ID #12a and #12b). For more detailed information about the TTFF refer to Appendix H of the Corps Environmental Impact Statement (EIS) for the COP.

1.3.2 S-12, S-343, S-344, S-346 Structures/Shark Valley Tram Road Culvert Plugs

Seasonal closures of the S-12A/B, S-343A/B, and S-344 structures were retained in the ERTP 2016. Based on sensitivity runs, the seasonal closures of the S-344 structure will be removed under the COP. S-344 has a design discharge capacity of 135 cfs and releases water west from WCA-3A to the L-28 canal along the Big Cypress National Preserve. It is opened when the WCA-3A regulations schedule is in Zone A and closed when in Zone B. It will no longer be subject to seasonal closures for protection of the CSSS. All the other structures listed above will be operated similarly to ERTP 2016.

In 2010, the ERTP removed the seasonal closures of S-12C and to compensate for its removal, inflatable culvert plugs were installed along the Shark Valley Tram Road within ENP. These culvert plugs were intended to help prevent the westward flow of water from S-12C under the Shark Valley Tram Road and help to maintain shorter hydroperiods within the western marl prairies where CSSS-Ax is located. These plugs were not durable enough in this application and were later replaced by more permanent sandbags. Removal of the S-12C seasonal closure was recommended during the transition to Everglades restoration to better achieve the objective of managing water levels within WCA-3A for the protection of multiple species and their habitats while also providing additional outlet capacity to address high water concerns within WCA-3A especially during periods when the S-333 outlet structure was constrained due to the G-3273 constraint.

Hydrologic modeling for the COP indicates that S-12C discharges will be reduced to 93,100 ac/ft per year on average from 142,000 ac/ft in the ECB19RR (a reduction of 49,800 ac/ft per year). The G-3273 constraint has been removed with the completion of the 8.5 SMA flood protection features. The modeling also shows that hydroperiods will be improved in the northeastern portions of CSSS-Ax under the COP. Given these developments and in consideration of road maintenance and structural integrity of the Tram Road, the Service does not see the need to continue this culvert plug operation. Standard hydrologic monitoring of annual discontinuous hydroperiod in CSSS-Ax will continue. The expectation from COP modeling, as assessed in this document, is that hydroperiods in this area could be shortened by up to 30 days. If this does not occur or the hydroperiod increases after four years of COP operations, then the Corps in conjunction with ENP and the Service should seek to investigate all sources of flow into this area to determine the cause.

1.3.3 Tamiami Trail Modifications and L-29 Stage

To date, the Modified Water Deliveries Project's Tamiami Trail: Next Steps Modification project has constructed two bridges (2.6 mile western and 1.0 mile eastern) and raised the low

spots in the 10-mile stretch of Tamiami Trail (U.S. Hwy 41) from the L-67 Extension east to the L-31 N levee. The final phase of the project which will further raise the roadbed and install box culverts is slated for completion in 2023. These modifications, along with the completion of the 8.5 SMA protection features, have allowed the removal of the G-3273 constraint (6.7 feet NGVD to protect the 8.5 SMA). However, the 8.5 SMA flood mitigation constraint may continue to limit raising L-29 Canal stages above 8.5 feet NGVD under specific conditions. The major remaining constraint to raising the L-29 Canal stage above 8.5 feet NGVD is the FDOT's constraint on roadbed integrity. The L-29 canal can be maintained up to 8.5 feet NGVD for up to 90 cumulative days per water year (May 1 through 30 April), with the opportunity to increase the duration based on written FDOT approval. The number of either cumulative or consecutive days will be measured when L-29 stages exceed 8.3 feet NGVD. L-29 stages at 8.5 feet NGVD for longer than 90 days will need FDOT written approval. Once the final phase of Tamiami Trail is completed, water managers will be able to maintain L-29 stages at 8.5 feet NGVD for longer durations and possibly go higher.

1.3.4 S-332B, S-332C and S-332D Operations

The S-332B and S-332C structures are expected to be upgraded to permanent pumping stations. Design of the permanent pump stations is anticipated to begin within the next year. When S-332B is completed it will consist of four 125 cfs diesel units (maximum operational capacity of 575 cfs) and two 75 cfs electric back-up units. It will be able to pump into the Southern and Northern Detention Areas. During the CSSS nesting season (written as February 15 through July 31 in the Corps' Water Control Plan) the operating range will be a headwater stage of 4.0 to 4.8 feet NGVD. Once the S-332C is completed it will consist of four 125 cfs diesel pumps (maximum operational capacity of 575 cfs) and two 75 cfs electric back-up pumps. This pumping station will discharge into the Southern Detention Area and will have seasonal variations in operational criteria with operating range of 4.0 to 4.8 feet NGVD during the sparrow nesting season.

Based on modeling sensitivity run analysis the Service further reduced its previously maintained protections for the CSSS by altering the pumping restrictions at the S-332D structure. This pumping station has four 125 cfs diesel pumps and one 75 cfs pump for a total capacity of 575 cfs. It has calendar-based flow restrictions for protection of the CSSS as follows:

- 500 cfs (July 15 to December 31)
- 325 cfs (January 1 to January 31)
- 250 cfs without the use of S-332DX1 or 375 cfs with S-332DX1 discharge of 125 cfs (February 1 to July 14)

As it has in the past, the Service requests the Corps and other State, Local and Tribal partners work closely to monitor and adaptively manage the entire detention area from the 8.5 SMA south to the Frog Pond, to ensure it is being used efficiently to meet the goals and objectives of the COP. The order of S-332B, S-332C and S-332D pumping should be prioritized, in real-time, based on coordination with the Service, SFWMD, ENP and other partners. Local rainfall

patterns, antecedent conditions, operations and other parameters should be discussed at the weekly multi-species meetings and at the Periodic Scientist Calls to determine pumping prioritization. For more detail on the evolution of S-332 detention area operations and their relation to the Frog Pond detention area see the ERTP 2016 Biological Opinion (Service 2016).

1.3.5 Periodic Scientist Calls

The purpose of the Periodic Scientist Calls (PSC) are for the Corps to gather input regarding ecological, hydrological, and meteorological conditions from various governmental and Tribal agencies to make future water management decisions. The monitoring and reporting of ecological, hydrological, and meteorological conditions were critical to achieving the ERTP objective of managing WCA-3A water levels and water releases for the protection of multiple endangered species and their sensitive habitats. The PSC occur on an as needed basis with the frequency of the calls determined based upon ongoing or anticipated conditions within the WCAs, SDCS, and ENP. The PSC focus on both the status of individual species (*e.g.*, Everglade snail kite nesting status) and the status of a suite of species and habitat conditions to allow for adaptive management of the system based upon the needs of multiple species and their habitats. Under the COP, the Corps will continue to implement the PSC.

1.3.6 Multi-Species Transition Strategy

Another interagency group created as a result of the ERTP 2010 planning process, which included the Multi-Species Transition Strategy, is the Ecosystem Based Management Group (EBM). This group consists of staff from the Corps, ENP, FDACS, FWC, Service, SFWMD and others who meet weekly during the dry season transition and seasonally three times annually. Discussion topics usually include climate conditions and weather forecasts, current water management conditions, pertinent species reports and typically culminates in a set of recommendations for water managers to consider in the coming weeks. The focus of the EBM group is currently on the WCAs, more specifically on WCA-3A. The Service suggests these meetings become a permanent fixture in the COP. The scope of the group would need to expand to include areas like ENP and Florida Bay. Additionally, there would need to be timely input mechanisms for the groups' recommendations to both Corps and SFWMD water managers so that they could be implemented if necessary.

1.3.7 Operational Flexibility

Examples of operational flexibility, such as preemptive releases, were proposed by the Corps during ERTP 2016 and were used to create storage within WCA-3A when large adjustments to inflow into WCA-3A or large regional rainfall events were forecast. It is unclear how many times these type of releases were used. The more efficient TTFF may reduce the need for these types of releases. The Corps should continue to explore the use of operational flexibility to improve the timing of flow deliveries throughout the system. The Adaptive Management and Monitoring Plan (AMMP) is intended be able to capture areas where additional operational flexibility can be incorporated into the COP. This flexibility will assist in maintaining target

stages within WCA-3A and allow for further flexibility in discharges through the S-12 and S-333 structures.

1.3.8 Temporary Emergency Deviations During 2017

The Corps initiated a Temporary Emergency Deviation to Alleviate High Water Levels in WCA-3A during June 2017. The intent of this deviation was to address high water concerns related to a series of early wet season storms that occurred during the month of June 2017. These rainfall events caused hydrologic conditions within the C&SF Project to change rapidly from very dry conditions to very wet conditions within South Florida, with the WCAs and EAA accumulating most of the rainfall. The Corps' BA for the temporary deviations, dated July 2017, outlined four major components of the deviation which included (1) opening of the S-12A, S-12B, S-343A, S-343B and S-344 structures prior to the official opening date of July 15, 2017; (2) opening of S-152 structure of the Decompartmentalization Physical Model (DPM) to discharge water from WCA-3A and WCA-3B; (3) increasing discharges at S-332D from 250 cfs to 500 cfs to increase discharge from WCA-3A to the South Dade Conveyance System via S-333 to S-334, if needed; and (4) increasing discharge at S-197 from 400 cfs to 2,400 cfs to accommodate additional flows from WCA-3A to South Dade via S-334. They anticipated these actions would continue until the WCA-3A 3-gauge average (3AVG) (gauges 3A-3, 3A-4 and 3A-28 also known as sites 63, 64 and 65) fell below Zone A of the regulation schedule.

By letter dated June 27, 2017, the Service responded to the Corps' request for emergency consultation and the associated deviations outlined in Corps letters dated June 22, 2017; June 26, 2017; and email dated June 26, 2017. Our recommendation to the Corps was to proceed with all the emergency deviations and actions described in the BA and other correspondence; however, we requested that to the extent practical, that early release of water through the S-12A and S-12B structures be minimized. CSSS were actively nesting immediately downstream of these structures and allowing those nests to succeed would benefit the species. The Service concurred with the Corps' determinations that the emergency actions may affect, but would not adversely affect the wood stork and snail kite but we did not concur with the same determination for the sparrow because there was documented nesting in CSSS-A. However, the Service determined that the emergency actions would not result in jeopardy to the CSSS because their population had slightly increased and the minimum target of 90 dry nesting days had been met in all subpopulations.

The S-343A and B opened on June 28 and the S-12A and B structures were opened on June 29, 2017. CSSS-Ax was displaying 6.5 percent (roughly 5,340 acres) dry with mean water depth of 22.8 cm (8.97 inches) at the time the structures opened. This small dry area was near the upper and lower meadow study plots where ground researchers had identified active nesting. Water depths increased throughout the next two weeks until July 14 when no available dry habitat remained. Field crews confirmed 4 active nests in CSSS-Ax after visits on June 23, 27 and 30. On July 6, the three nests observed on June 27 had failed due to unknown predators. One new juvenile was banded on that trip. On July 11, no nests were seen, and breeding activity had subsided.

On September 10, around 3 pm EDT, Hurricane Irma made landfall near Marco Island as a category-3 storm with 115 mph winds. While it was not a direct hit to CSSS-Ax, strong winds and rains resulted in a maximum stage of 8.29 feet NGVD (water depth of 2.3 feet) at NP-205 which is believed to have negatively impacted sparrows (Virzi and Tafoya 2020). The Service had planned to mobilize crews during the non-nesting season to assess impacts to sparrows in the area but was unable to secure funding to do so. The estimated population size in CSSS-Ax, based on the helicopter surveys, was reported as 16 birds in 2017, 32 in 2018 and 0 in 2019.

1.4 Action Area

For consultation purposes, the Action Area is defined as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" (50 CFR §402.02). The COP defines operations for the constructed features of the MWD and C-111 Projects. The major project components of the MWD and C-111 Projects are shown in Figure 1 (Figures referenced in this BO are included at the end of the document in section 12). The Action Area for the COP encompasses approximately 2,374,782 acres (See Figure 2).

The primary areas in which these projects directly affect water flows and levels are (listed in north-south order):

- Water Conservation Areas (WCAs) 3A and 3B;
- Western and Eastern Shark River Slough (SRS);
- 8.5 Square Mile Area (8.5 SMA) and Rocky Glades;
- Private and public lands served by the South Dade Conveyance System (SDCS); and
- Taylor Slough.

The dominant project features addressed in the COP are the massive wetland expanses of WCA-3A and increased flow from it into Northeast Shark River Slough in Everglades National Park. The management of WCA-3A affects adjacent areas hydrologically both upstream and downstream but primarily to the south. Effects of WCA-3A management can be felt as far north as Lake Okeechobee and WCAs 1 and 2. Likewise, the COP may affect Big Cypress National Preserve, Biscayne Bay, and Florida Bay through its modification of freshwater flow in south Florida. The Action Area spans: (a) the entire range of the CSSS; (b) the range of the Everglade snail kite south of and including Lake Okeechobee; and (c) all wood stork nesting colonies within 18.6 miles of WCA-3 or Everglades National Park (ENP) that have been active during the past 10 years (Figure 2).

The Action Area is comprised of a series of hydrologically interconnected wetlands that include some of the largest remaining expanses of Everglades marshes and many man-made features, including canals, levees, and artificial impoundments. Water movement through this system is managed with a variety of water control structures and pumps. The man-made infrastructure

influences large volumes of water received via rainfall, which varies seasonally and annually, and which establishes the general hydrologic regime for wetlands in southern Florida.

Historically, the entire Action Area was known as the Everglades; a mosaic of sloughs, tree islands, long-hydroperiod marshes, shorter-hydroperiod marl prairies, sawgrass marshes, and coastal mangrove fringe habitats. Much of this land has been converted to urban development; active agriculture composed of fruit tree groves, row and field crops, and plant nurseries; and abandoned agricultural areas that a variety of native and invasive plant species have colonized. It is estimated that less than half of the historic Everglades remains (Corps 1999).

2.0 CAPE SABLE SEASIDE SPARROW

2.1 Status of the Species

This section summarizes the effects of all past human and natural activities or events that have led to the current status of the CSSS and are relevant to formulating the biological opinion about the proposed action.

2.1.1 Legal Status

The CSSS was one of the first species listed on March 11, 1967, under the Endangered Species Preservation Act of 1967 (32 FR 4001). The subspecies' limited distribution and small population size, along with threats to its habitat, resulted in its listing under the Endangered Species Preservation Act in 1967. Protection for the sparrow was continued under the Endangered Species Conservation Act of 1969. The sparrow and all the other species listed under the Endangered Species Conservation Act of 1969 were also listed as endangered under the Act of 1973.

2.2 Species Description

The Cape Sable seaside sparrow (CSSS) is one of eight extant subspecies of seaside sparrow in North America. Its distribution is limited to the short-hydroperiod wetlands, or marl prairies, located at the southern end of the greater Everglades ecosystem, on the southern tip of mainland Florida. The CSSS is a medium-sized bird, 5.1 to 5.5 inches in length (Werner 1975). Unlike most other subspecies of seaside sparrow, which occupy primarily brackish tidal systems (Post and Greenlaw 1994), this sparrow currently occurs primarily in the short-hydroperiod wet prairies, also referred to as marl prairies. The sparrow is generally sedentary, secretive, and non-migratory, although sparrows are known to disperse between subpopulations (Lockwood et al. 2008; Virzi et al. 2009).

From its initial discovery in the cordgrass (*Spartina* spp.) marshes on Cape Sable in 1918 (Howell 1919), followed by reports in what is now Everglades City (Nicholson 1928) as well as Ochopee (Anderson 1942), CSSS have experienced hurricanes, fires, and habitat transitions.

These historic populations have since been extirpated, but in 1972, sparrows were discovered near Taylor Slough (Ogden 1972). Subsequent investigation revealed that a sparrow had been reported in this area in 1958, but the observation was never verified (Werner 1975; Pimm et al. 2002). Werner conducted helicopter surveys in 1974 and 1975 to characterize the distribution and abundance of sparrows in this region. These initial surveys revealed that sparrows were widely distributed and abundant (Werner 1975). A subsequent 1981 survey (Kushlan and Bass 1983) delineated the six subpopulations that are currently monitored.

2.3 Life History

2.3.1 Breeding and Nesting Behaviors

CSSS are thought to be generally monogamous (Post and Greenlaw 1994), with a single female occurring within a male's breeding territory. However, there are indications that sparrows may be polygamous under some circumstances, such as within small populations; it is unknown whether the sparrows are simultaneously or sequentially polygamous (Lockwood et al. 2006).

During the breeding season, typically considered March 1 through July 15, but which can extend through August, male sparrows establish and defend territories that are variable in size, ranging from 0.7 to 16.8 acres (Werner 1975), with reported average sizes ranging from 2.2 to 8.9 acres (Werner and Woolfenden 1983; Pimm et al. 2002). Throughout the breeding season, the majority of a sparrow pair's activities occur within this territory, including breeding, feeding, and sheltering. Within an area of suitable habitat, territories do not appear to be tightly packed (Werner 1975), and there are gaps between defended boundaries of adjacent males. Even when sparrows occur at high densities, small areas usually remain between adjacent territories, though some territories do appear to overlap (Cassey et al. 2007). Therefore, some gaps that appear to be suitable habitat may remain unclaimed by territorial sparrows (Werner 1975). It is likely that sparrows venture into these "unclaimed areas" during the breeding season. In many cases, areas that appear to be suitable for sparrow occupancy may not be suitable during certain environmental conditions and this may cause sparrow territories to appear to be widely separated from neighboring territories (Cassey et al. 2007).

Outside of the breeding season (August to February), sparrows generally remain sedentary in the general vicinity of their breeding territories but expand the area that they use compared to the breeding season territory (Dean and Morrison 2001). The average non-breeding season home range is approximately 42 acres, with a range of 14.1 to 137.1 acres (Dean and Morrison 2001). Some individuals make exploratory movements away from the area of their territories and may occasionally relocate their territories and home ranges before resuming a sedentary movement pattern (Dean and Morrison 2001).

Sparrows generally begin nesting in early March (Lockwood et al. 2001), but may begin territorial behavior, courtship, and nest-building in late February (Werner and Woolfenden 1983; Lockwood et al. 1997). This timing coincides with the dry season, and most areas within the marl prairies are either dry or only shallowly inundated at the beginning of the breeding season.

During the dry portion of the breeding season (March to May), sparrows build nests above the ground, but relatively low in the vegetation (6.7 to 7.1 inches) (Werner 1975; Lockwood et al. 2001). Nests are woven into clumps of dense vegetation and are well-concealed (Werner 1975; Post and Greenlaw 1994). Nest cups are consistently concealed from above (Post and Greenlaw 1994), either through construction of a domed cover or through modifying vegetation in the vicinity (Werner 1975; Post and Greenlaw 1994). During the wet portion of the sparrow breeding season (June to August), sparrows build their nests higher in the vegetation than during dry periods, an average of 8.3 inches above the ground surface (Lockwood et al. 2001). Wet-season nests probably occur in taller prairie grass vegetation than during the dry season because there must be sufficient height and density of vegetation remaining above the nest to cover and conceal nests.

Pimm et al. (2002) suggest that nesting will not be initiated if water levels are at a depth greater than 4 inches during the breeding season. For many years, rising water levels resulting from the onset of summer rains were thought to end the breeding season (Werner 1975). While these statements are generally true, the sparrows may respond to changes in hydrologic conditions as long as water levels are not prohibitively high. Large rainfall events early in the wet season may cause some nest failure and sparrows generally cease breeding when water levels rise above the mean height of the nests above the ground (Lockwood et al. 1997; Basier et al. 2008; Cade and Dong 2008). However, if water levels subsequently drop, sparrows may again initiate breeding activity. The initiation of molt, which usually occurs in early September, is probably the best indicator of the true end of the breeding season.

CSSS lay three to four eggs per clutch (Werner 1978, Pimm et al. 2002) with a hatching rate ranging between 0.66 and 1.00 (Boulton et al. 2009). The sparrow nesting cycle, from nest construction to independence of young, lasts between 30 and 45 days (Werner 1975; Lockwood et al. 2001; Pimm et al. 2002), and sparrows may re-nest following both successful and failed nesting attempts (Werner 1975; Post and Greenlaw 1994; Lockwood et al. 2001). A three-clutch breeding season necessitates an uninterrupted period of 90 to 120 days of maximally favorable conditions (Lockwood et al. 2001; Elderd and Nott, 2008). Both parents rear and feed the young birds and may do so for an additional 10 to 20 days after the young fledge (Woolfenden 1956, 1968; Trost 1968). Sparrows are incapable of flight until they are about 17 days old; when approached, flightless fledglings will freeze on a perch until the threat is less than approximately 3 ft away, and then run along the ground (Werner 1975; Lockwood et al. 1997).

Because of the long breeding season in southern Florida (March – August), optimal conditions may allow sparrows to nest several times within a year, and they may be capable of successfully fledging two to four clutches. Few sparrows probably reach this level of success (Lockwood et al. 2001) since second and third nesting attempts may occur during the early portion of the wet season. Nests initiated later in the season usually occur over water and result in reduced success rates.

Nest success rates vary among years, and range from 12 to 60 percent, depending upon time within the breeding season (Lockwood et al. 2001; Baiser et al. 2008; Boulton et al. 2009; Slater

et al. 2014). Substantially higher nest success rates occur within the early portion of the breeding season (prior to June 1) followed by a decline in success as the breeding season progresses to a low of about 20 percent after June 1. Nest predation is the primary documented cause of nest failure (Pimm et al. 2002; Baiser et al. 2008; Boulton et al. 2009; Virzi et al. 2009; Slater et al. 2014), accounting for more than 75 percent of all nest failures (Lockwood et al. 1997; Baiser et al. 2008). A complete array of nest predators has not been determined, however, raccoons (*Procyon lotor*), rice rats (*Oryzomys palustris*), and snakes, including exotic pythons may be the predominant predators (Lockwood et al. 1997; Post and Greenlaw 2000; Dean and Morrison 2001). It is also possible that as exotic tegus continue to expand their range, they may become a significant predator for CSSS (Mazzotti 2015). As water levels begin to rise above ground surface with the onset of the summer rains in May to June, nest predation rates also rise. Nests that are active after June 1, when water levels are above ground, are more than twice as likely to fail as nests during drier periods (Lockwood et al. 2001; Baiser et al. 2008; Cade and Dong 2008). This effect appears to be the result of both increased likelihood of nests being flooded and an increased likelihood of predation (Lockwood et al. 1997, 2001; Pimm et al. 2002).

CSSS are generally short-lived, with an average individual annual survival rate of 66 percent (Lockwood et al. 2001). The average lifespan is probably 2 to 3 years. Consequently, a sparrow population requires favorable breeding conditions in most years to be self-sustaining and cannot persist under poor conditions for extended periods (Lockwood et al. 1997, 2001; Pimm et al. 2002).

2.3.2 Feeding Behavior

While detailed information about the diet of CSSS is not known, invertebrates comprise most of their diet, though sparrows may also consume seeds when they are available (Werner 1975; Post and Greenlaw 1994). Howell (1932) identified the contents of 15 sparrow stomachs and primarily found remains of insects and spiders, as well as amphipods, mollusks, and plant matter. Primary prey items that are fed to nestlings during the breeding season include grasshoppers (*Orthoptera*), moths and butterflies (*Lepidoptera*), dragonflies (*Odonata*), and other common large insects (Post and Greenlaw 1994; Stevenson and Anderson 1994; Lockwood et al. 1997; Pimm et al. 2002). Adult sparrows probably consume the same species during the nesting season. Sparrows may consume different proportions of different species over time and among sites, suggesting that they are dietary generalists (Pimm et al. 2002). During the non- breeding season, preliminary information from evaluation of fecal collections suggests that a variety of small invertebrates, including weevils and small mollusks are regularly consumed (Dean and Morrison 2001). Evidence of seed consumption was only present in 4 percent of samples (Dean and Morrison 2001). These non-breeding season samples may not be representative of the foods most frequently consumed during that season and may only represent a portion of the items ingested.

While the sparrow appears to be a dietary generalist, an important characteristic of sparrow habitat is its ability to support a diverse array of insect fauna. In addition, these food items must be available to sparrows both during periods when there is dry ground and during extended

periods of inundation. The specific foraging substrates used are unknown, but they probably vary throughout the year in response to hydrologic conditions.

2.4 Habitat

CSSS subpopulations require large patches of contiguous open habitat. The minimum area required to support a population has not been specifically determined, but the smallest area that has remained occupied by sparrows for an extended period is about 4,000 acres. Individuals are area-sensitive and generally avoid the edges where other habitat types meet the marl prairies. They will only occupy small patches (less than 100 acres) of marl prairie vegetation when they occur within large, expansive areas and are not close to forested boundaries (Dean and Morrison 2001). Large expanses of deep water or wooded habitat may act as barriers to long-range movements (Dean and Morrison 2001). Once sparrows establish a breeding territory, they exhibit high site fidelity, and each individual sparrow may only occupy a small area for most of its life (Warner 1975). Although sparrows are generally sedentary, research has revealed occasional movement between subpopulations east of SRS (Lockwood et al. 2008; Virzi et al. 2009). However, sparrow dispersal probability declines greatly over longer distances and thus the likelihood of sparrows immigrating from other subpopulations decreases as distances increase (Gilroy et al. 2012). CSSS most consistently occur and are most abundant near the center of the patch of habitat in which they occur.

CSSS occur mostly within the short-hydroperiod freshwater marl prairies of the southern Everglades that flank the deeper Shark River and Taylor Sloughs. The most commonly associated vegetation species in occupied freshwater habitat is muhly grass (*Muhlenbergia filipes*) (Werner 1975; Kushlan and Bass 1983; Werner and Woolfenden 1983; Post and Greenlaw 1994; Stevenson and Anderson 1994), but CSSS also occur in freshwater marl prairies where *Muhlenbergia* is absent (Ross et al. 2006). Other dominant species that occur in these prairies include sawgrass (*Cladium jamaicense*), south Florida bluestem (*Schizachyrium rhizomatum*), black-topped sedge (*Schoenus nigricans*), and beak rushes (*Rhynchospora* spp.) (Werner and Woolfenden 1983; Ross et al. 2006).

CSSS occupy these marl prairie communities year-round during all life stages. During the dry season, usually coinciding with the late winter and early spring (November to May), sparrows traverse the ground surface beneath the grasses, and only occasionally perch on the vegetation. During the wet season (June to October), the ground surface is inundated, with peak water depths occasionally exceeding 2 ft (Nott et al. 1998). Sparrows travel within the grasses, perching low in the vegetation, hopping among the bases of dense grass clumps, walking over matted grass litter, and flying more frequently than during the dry season, but generally remain inconspicuous (Dean and Morrison 2001).

Hydrologic conditions have significant direct and indirect effects on sparrows. First, water depth or depth of inundation within sparrow habitat is directly related to the sparrow's ability to move, forage, nest, find shelter, and avoid predators and harsh environmental conditions. Average annual rainfall in the Everglades is approximately 56 inches per year (ENP 2005), with the

majority of this falling within the wet season months (June-October), which coincides with the latter half of the sparrow nesting season. This rainfall drives hydrologic characteristics in the marl prairies; however, throughout southern Florida, water management actions also influence hydrologic conditions. The operation of a system of canals, levees, pumps, and other water management structures affects much of the remaining marl prairies (Johnson et al. 1988; Van Lent and Johnson 1993; Pimm et al. 2002).

At water depths greater than 2 ft above ground surface, the majority of the vegetation in sparrow habitat is completely inundated, leaving sparrows with limited refugia. Conditions such as these may result in significant impacts to sparrow survival, and if they occur during the breeding season, can cause loss of sparrow nests (Nott et al. 1998; Pimm and Bass 2002). Even more moderate water levels, in the range of 6 inches above ground surface, may inundate enough habitat that sparrows cannot find shelter and are restricted in their movements. These water levels, when they occur during the breeding season, result in increased rates of nest failure (Lockwood et al. 1997; Baiser et al. 2008). While topographical variation within the remaining Everglades is relatively small, differences in elevation as little as 1 ft are associated with substantial differences in habitat characteristics.

The composition and structure/density of plant communities in the Everglades are strongly influenced by the rise and fall of annual water levels, which is measured as the number of days of inundation per year, or annual hydroperiod. Water quality has the potential to influence vegetation communities in sparrow habitat, but the literature summarized below highlights the more dominant role of hydroperiod and fire. Hydroperiods that range from 60 to 270 days support the full variety of vegetation conditions that are generally suitable for sparrows (Ross et al. 2006), though the vegetation composition and structure may vary significantly. Persistent increases in hydroperiod may alter vegetation communities from marl prairies or mixed prairies to sawgrass-dominated communities resembling sawgrass marshes (Nott et al. 1998). Detailed studies relating hydroperiod characteristics to sparrow habitat have concluded that an average annual discontinuous hydroperiod range (average number of days in a year that water level or stage is above ground surface) of 60 to 180 days in most years is optimal for the plant species that support sparrow nesting and otherwise maintain sparrow habitat (Olmsted and Loope 1984; Kushlan et al. 1982; Kushlan 1990; Wetzel 2001; Ross et al. 2006, Sah et al. 2013).

Average hydroperiods that extend much beyond 240 days per year are associated with sawgrass marsh communities (Ross et al. 2006, Sah et al 2013) which are unlikely to support sparrows in the long term. Conversely, areas that are frequently subjected to short hydroperiods generally have higher fire frequency (Lockwood et al. 2003; Ross et al. 2006) and are readily invaded by woody shrubs and trees (Werner 1975; Davis et al. 2005). Both an increased incidence of fire and an increased density and occurrence of woody shrubs reduce the suitability of an area as sparrow habitat.

Small tree islands and individual trees and shrubs occur throughout the areas occupied by the sparrows, but at a very low density. Sparrows do not appear to require woody vegetation for any aspect of their normal behavior, and generally avoid areas where shrubs and trees are either

dense or evenly distributed. However, the small tree islands and scattered shrubs and trees may serve as refugia during extreme environmental conditions and may serve as escape cover when fleeing from potential predators (Dean and Morrison 2001). Because of their general aversion to dense trees and woody vegetation, encroachment of trees and shrubs quickly degrades potential sparrow habitat. However, a heterogeneous arrangement of different vegetation conditions provides habitat for sparrows under variable environmental conditions. A complex relationship between hydrologic conditions, fire history, and soil depth determine the specific vegetation communities at a particular site, and variation in these characteristics may result in a complex mosaic of vegetation (Taylor 1983; Ross et al. 2006). Kushlan and Bass (1983) conclude that a combination of hydroperiod and periodic fire events is critical in the maintenance of suitable mixed marl prairie communities for the sparrow. CSSS are generally not found in communities dominated by dense sawgrass, cattail (*Typha* spp.) monocultures, long-hydroperiod wetlands with tall, dense vegetative cover, spike rush (*Eleocharis cellulosa*) marshes and sites supporting woody vegetation (Werner 1975, Bass and Kushlan 1982). Sparrows also avoid sites with permanent year-round water cover (Curnutt and Pimm 1993).

Sparrows do not regularly occupy burned areas for 2 to 3 years following fires (Pimm et al. 2002; Lockwood et al. 2005), though they can re-occupy areas after only 1-year post-fire under some conditions (Taylor 1983; Werner and Woolfenden 1983). This is probably because of the sparrow's dependence on a level of structural complexity in the vegetation, which is absent after a fire, to provide cover, support nests, and allow individuals to move through the habitat during wet periods. Fire is common within the areas occupied by sparrows, and nearly all areas where sparrows currently occur have been burned within the past 10 to 20 years (Lockwood et al. 2003; LaPuma et al. 2007; Sah et al. 2013). A combination of naturally ignited and human-ignited (both prescribed and arson/accidental ignition) fires have resulted in different fire frequencies in different portions of the sparrow's range. Most of the species of vegetation that occur within sparrow habitat are fire-adapted and respond quickly following fire (Snyder 2003). Several of the dominant grass species, including *Muhlenbergia*, also flower following fires during the growing season (Main and Barry 2002). Under normal conditions, fires do not kill the individual plants that make up the dominant species in sparrow habitat, and fires remove only the aboveground growth and leaf litter (Snyder and Schaeffer 2004). Many of the dominant grasses may grow more than 15 inches after only a few weeks (Steward and Ornes 1975; Snyder 2003). For this reason, the species composition and even the general structural characteristics of the vegetation may be nearly indistinguishable from unburned areas only 2 to 3 years after burning (Lockwood et al. 2005).

The interaction of fire and flooding strongly influence the suitability of habitat for sparrows. In the most extreme case, vegetation that burns and is subsequently flooded within 1 to 3 weeks, either because of a natural rainfall event or water management operations, may not recover for up to 10 or more years (Ross 2006). If water levels overtop sprouting grasses after a fire, the grasses may die, resulting in an absence of vegetation. Recovery of vegetation from these circumstances is via seed germination, which requires a longer time than recovery via vegetative growth and may result in a different plant species community (composition and structure) than was present prior to the fire. Under more suitable conditions, vegetation may recover more

quickly following fire when water levels are near the soil surface, providing ample water for the plants to grow, without changing the plant community species composition.

2.5 Population Dynamics

2.5.1 Population Size and Variability

The use of helicopters to facilitate larger spatial-scale surveys for the sparrow was first accomplished in 1974 (Werner 1975). The first comprehensive, range-wide sparrow population survey was conducted in 1981 but was not repeated until 1992. Since that time, surveys have been conducted annually including twice in 1999 and 2000 (Pimm et al. 2002). The number of survey locations has changed through time, from a high of over 850 sites in 1992 to a low of 250 sites in 1995 (Cassey et al. 2007). The results of these annual helicopter surveys are used to estimate the CSSS population. An assumption of the annual population estimate calculations based on the range wide helicopter surveys (Pimm et al. 2002) is that every male detected calling also accounts for one female in the population (*i.e.*, they are paired), resulting in a sex ratio of 50:50. To estimate the total number of sparrows from the number observed on helicopter point counts, a correction factor is needed. Bass and Kushlan (1982), used a value of 15.87 (rounding it to 16) based on the range at which they could detect the sparrow's song (detection distance of a singing sparrow [200 m] resulting in a census coverage of 12.6 ha at each site visited), and on the assumption that each singing male was accompanied by one female ([100 ha/km^2 ÷ 12.6] x 2).

Over the period that range wide helicopter surveys have been performed, there have been substantial demographic changes in most of the six subpopulations (Table 1) (Tables referenced in this BO are included at the end of the document in section 11). The 1981 and 1992 sparrow surveys provided a baseline of the distribution and abundance of sparrows at that time, though there is no information available about how the populations may have changed during the intervening 11 years. In 1981, there were an estimated 6,656 sparrows distributed across six subpopulations, with the majority (86 percent) of the sparrows occurring within subpopulations A, B, and E. By comparison, the last complete CSSS population survey for all the subpopulations (2019) resulted in an estimate of 2,688 sparrows, with most birds occurring within subpopulation B (57 percent) and subpopulation E (33 percent). Survey results for 2019 indicate a drop in the estimated population of sparrows, from 3,184 in 2018 to 2,688 in 2019. To better understand the variability in the annual population estimates, the total number of birds has fluctuated between a high of 6,576 in 1992 to a low of 2,416 in 1994 and 2016 (Table 1). Several subpopulations were not surveyed during 1994.

Subpopulation A inhabits the marl prairies west of SRS in ENP and eastern Big Cypress National Preserve (BCNP), (Figure 3). In 1981 and 1992, subpopulation A supported over 40 percent (2,600 sparrows) of the total CSSS population (Table 1). Subpopulation A experienced the most dramatic population decline observed, dropping from more than 2,600 birds in 1992 to 432 birds in 1993 a decrease of 84 percent (Curnutt et al. 1998, Pimm et al. 2002). It is likely that Hurricane Andrew, in August 1992, caused mortality within most subpopulations but details suggest that Andrew was not the major cause of the overall population

decline (Curnutt et al. 1998, Nott et al. 1998). Andrew was followed by several wet years and high discharges of water through water control structures which caused several years of poor conditions for the CSSS, reducing its ability to recover from the impact of the hurricane (Curnutt et al. 1998, ENP 2005, Nott et al. 1998). The sharp decline in sparrow subpopulation A corresponds to a change from four drier than average years prior to 1992 to four wetter than average years between 1993 and 1996 when only limited breeding was possible and vegetation changes were documented (Nott et al. 1998, Jenkins et al., 2003). Lockwood et al. (2001) demonstrated that after experiencing three years of poor breeding conditions in quick succession, CSSS populations will decline sharply. Subpopulation A has subsequently remained at a low level, ranging from a high of 448 sparrows in 2000 to a low of 16 sparrows in 2017.

The most recent population estimate for CSSS-A was 0 sparrows in 2019. While male sparrows were not heard singing during the helicopter surveys, 3 adults and 2 fledglings were observed by researchers during one of their intensive demographic monitoring trips to this subpopulation. Prior to 2019, Subpopulation A accounted for only 6 percent of the total CSSS population. The continued low population numbers in subpopulation A are a major concern due to this subpopulation historically providing over 40 percent of the total population. Researchers have previously hypothesized that subpopulation A could be approaching a minimum threshold necessary to promote settlement of breeding sparrows and that local recruitment and dispersal rates alone will likely be insufficient to enable this sparrow subpopulation to persist (Virzi and Davis 2013, Slater et al. 2014). This seems more likely to be the case as we await survey results for the 2020 nesting season. Additional management measures including prescribed fire and translocation of sparrows from other subpopulations may be needed to ensure recovery of this critical subpopulation and are being considered by the Service at this time.

Subpopulation B, inhabiting the marl prairies southeast of SRS near the center of ENP, has remained relatively stable over time. When first surveyed in 1981, subpopulation B contained an estimated 2,352 sparrows (35 percent of the total population). Subpopulation B remains one of the most abundant subpopulations, with the estimated population size from 1981 to 2019 ranging from 1,536 to 3,184 sparrows (Table 1). Even though subpopulation B is the largest remaining subpopulation, a general downward trend in the estimated population has been noticed over the period of record. The subpopulation averaged 2,320 birds between 1992 and 2007. However, the average estimated population of subpopulation B since that period has been 1,958 birds. In 2019, subpopulation B recorded its lowest estimate on record 1,536 birds. Since this has been one of the most abundant subpopulations, regularly comprising 60 percent or more of the total population, this recent downturn is cause for concern and will be watched closely for a rebound in 2020.

In 1981, subpopulation C, located in the vicinity of Taylor Slough and along the eastern boundary of ENP, contained an estimated 432 sparrows (6 percent of the total population). By the 1992 survey, subpopulation C had declined nearly 90 percent, to 48 sparrows (Table 1). The population has remained very low since 1992, with two years where no sparrows were detected (1993 and 1995). There were only 48 sparrows estimated in this area in 1996 and 1997, and 80 sparrows estimated in 1998. Between 2007 and 2010, the population declined to an estimated

32 to 48 sparrows. However, since 2010, the sparrow population in subpopulation C has increased slightly and has been hovering around an estimated average of 104 sparrows (24 percent of its 1981 estimated population size).

Subpopulation D, just to the southeast of subpopulation C, supported an estimated 400 sparrows in 1981 (approximately 6 percent of the sparrow population), but declined to approximately 96 sparrows in 1993 (Table 1). High water levels likely led to the decrease in population since 1999 (Slater et al. 2009) with 32 sparrows estimated in 2000. No sparrows were identified within subpopulation D in 1995, 2002, 2003, 2004, 2006, and 2007. When birds have been detected, the number of males consistently exceeded the number of females (Virzi et al. 2011, Virzi and Davis 2012, Virzi and Davis 2013). Lockwood et al. (2008), observed that the continued population decline, since its estimate of 400 sparrows in 1981, had possibly left this subpopulation functionally extirpated. Surveys from 2008 through 2015 documented a few sparrows in this subpopulation with an estimated population range of 16 to 64 sparrows, except for 2012 when the estimate was 224 sparrows. Recent population estimates in 2018 and 2019 have indicated a significant increase in sparrows with 2018 registering 256 sparrows, the most since 1981, while 2019 estimated 176 (Virzi et al. 2018, Virzi and Tafoya 2020). Additionally, intensive ground surveys observed and banded 64 fledglings during 2019. Prior to 2018 and 2019, which saw significant increases in production, intensive ground monitoring activities in this subpopulation were indicating that the actual number of birds in this subpopulation may be far fewer than what was being estimated by the helicopter surveys. This area, like subpopulation A, has suffered from persistent high water levels that may have precluded sparrows from nesting in many of these years (Virzi at al. 2018).

Subpopulation E, north of subpopulation B and east of SRS, contained over 10 percent of the total population (approximately 672 sparrows) in 1981. Following Hurricane Andrew, subpopulation E declined by about 50 percent to 320 sparrows (Curnutt et al. 1998). However, due to the presence of suitable conditions, this subpopulation, like subpopulation B, has remained relatively stable even though it has experienced wide interannual fluctuations (Table 1). Between 2010 and 2019 the estimated population ranged from 384 to 1,200 sparrows with the most recent survey in 2019, estimating a population of 880 sparrows (T. Dean pers. comm.).

Subpopulation F, located between SRS and the western edge of the Atlantic coastal ridge along the eastern boundary of ENP, was the smallest subpopulation in 1981, containing an estimated 112 sparrows or just 2 percent of the total population. Population estimates for subpopulation F declined from 1981 to 1992, from 112 sparrows to 32 sparrows (Table 1). In several years (1993, 1995, 1999, 2000, 2007, 2008, and 2009) no birds were detected during the surveys. Only 16 sparrows were estimated for each year from 1996 to 1998, 2002, 2004, 2010, 2013, and 2014. Since 2010 the estimated population has ranged between 16 and 64 sparrows, with 16 sparrows estimated in 2019 (T. Dean pers. comm.).

Subpopulations A, C, D and F are currently the smallest in terms of number of sparrows. Since subpopulations A, B and E have consistently held sparrows over all survey years they are

considered “core” subpopulations and essential to the survival of the species. Subpopulation A has a large amount of previously occupied habitat which has the potential for restoration given the proper hydrologic regime. During the 2006-2008 nesting seasons, intensive ground surveys were conducted in subpopulations C, D, and F to better understand these small subpopulations (Lockwood et al. 2006; Boulton et al. 2009). Data collected in these surveys included territory size, fecundity, nest success and survival rates. Results indicate that the small subpopulations exhibit: 1) suppressed breeding, 2) an excess of unpaired males, 3) nest survival comparable to larger subpopulations, 4) low hatch rate, and 5) larger territory sizes than birds in the larger subpopulations. Boulton et al. (2009) concluded that the small subpopulations are demographically dynamic and subject to the negative effects of low densities (*e.g.*, allee effects). Allee effects often make it difficult 1) for breeding adults to find each other to mate, 2) to assess the condition of potential breeding habitat and 3) to ward off predators of adults and nests (Reed 1997, Etterson 2003).

Recent surveys in subpopulation D, prior to 2018 and 2019, have revealed results demonstrating the effects of small population size (Virzi and Davis 2013, Slater et al. 2014). In addition to C and D, subpopulation A was intensively surveyed beginning in 2009 (Virzi et al. 2009). Nineteen male sparrows holding territories and 15 nests were detected in CSSS-A during intensive ground surveys in 2009, and the subpopulation exhibited similar traits to the larger subpopulations such as the presence of few unmated males, and comparable clutch sizes, adult return rates, and proportion of early to late nests (Virzi et al. 2009). The subpopulation was reported as extant and functional. However, recent surveys between 2011 and 2019 found that the number of breeding pairs within subpopulation A has decreased, leading to concerns that subpopulation A could be approaching, or is already below, a minimum threshold necessary to promote settlement of breeding sparrows, perhaps due to a lack of conspecific cues (Virzi et al. 2018, Virzi and Tafoya 2020). No males were heard singing during the 2019 helicopter surveys which resulted in a population estimate of zero for the first time on record. Additionally, past low nest success rates and current low return rates raise the concern that this subpopulation may face extirpation unless the cause of the lower demographic rates can be identified and managed (Slater et al. 2014).

There have been large population declines recorded among most of the subpopulations and relatively few large population increases since 1981, especially in the smaller subpopulations and specifically CSSS-A. These population changes suggest that while declines can occur rapidly, it may take many years of favorable conditions to return a sparrow population to its previous status (Jenkins et al. 2003; Cassey et al. 2007; Lockwood et al. 2008). The continued population decline is a major concern. Since the significant decline in sparrow numbers in 1993, the overall population has varied from a low of 2,416 birds in 1994 to a high of 4,048 birds in 1997. Since 2001, the population estimates have ranged from a high of 3,584 in 2004 to a low of 2,416 in 2016. Understanding these population changes, especially in small subpopulations, is often complicated by discrepancies between population estimates based on range wide helicopter survey results and intensive ground monitoring. For example, based on intensive ground surveys in selected areas, the number of sparrows in CSSS-A dropped between 2010 and 2011, largely due to a reduction in females. Between 2010 and 2011 the number of males decreased from

24 to 16 while the number of females decreased from 19 to 6 within the study plot. The numbers dropped again between 2012 and 2014 due to a reduction in single males (Slater et al. 2014). Population estimates based on helicopter counts do not closely follow these trends. This can be partially explained by the fact that helicopter surveys only detect males and that they are conducted on a much larger range wide subpopulation level scale than intensive ground monitoring which concentrates on intensive data collection within a much smaller area, usually within optimal habitat conditions.

2.5.2 Population Stability

Current information suggests that sparrow subpopulations C, D, and F may support fewer sparrows than previously estimated, and the demographics of these subpopulations may differ from the larger subpopulations (Lockwood et al. 2006, Virzi and Davis 2013, Virzi and Tafoya 2020). Because sparrows typically experience low nest survival, low juvenile survival, and have a relatively short life span, we cannot expect sparrow recovery to be rapid (Lockwood et al. 2001). The demographic attributes of sparrows preclude them from rapid recovery particularly when consistently faced with poor conditions (*i.e.*, high water levels and frequent fires) (Lockwood et al. 2008). This affects assessment of the likelihood of the persistence of these subpopulations and the overall probability of persistence for the species.

With smaller population sizes in subpopulations C, D, and F, the relative importance of subpopulations A, B and E is increased with respect to maintaining a viable overall sparrow population. Similarly, potential contributions of the small subpopulations to maintaining the overall sparrow population and buffering it from potential catastrophic events such as widespread fire and hurricanes are reduced (Lockwood et al. 2006). Pimm et al. (2002) and Walters et al. (2000) suggested that three breeding subpopulations are necessary for the continued long-term survival of the sparrow. However, Slater et al. (2009) emphasize the need to recover all subpopulations, noting that with a vast majority of sparrows concentrated within subpopulations B and E, the species' vulnerability to stochastic events is particularly acute.

Slater et al. (2009) observed that even though the overall sparrow population has remained somewhat stable since the massive decline it experienced in the early 1990s, the population has shown minimal signs of recovery. The Sustainable Ecosystems Institute (SEI), an independent scientist review panel (2007a) also concluded:

> *"More important than trying to delineate populations, is recognizing that protecting the subspecies from catastrophic events will require maintaining sparrows over as wide an area as possible. This recognition provides a more compelling rationale for maintaining subpopulation A than the need to maintain three populations did, since subpopulation A is the only subpopulation west of SRS. It also suggests more emphasis should be placed on maintaining subpopulation D as the southeastern-most subpopulation".*

2.6 Distribution

The CSSS was first discovered in the cordgrass (*Spartina* spp.) marshes on Cape Sable in 1918 and was originally thought to be limited in distribution to Cape Sable (Howell 1919). On September 2, 1935, a severe hurricane struck the Keys and southern Florida, with the hurricane's center passing within a few miles of Cape Sable (Stimson 1956). Post-hurricane observations in the vicinity of Cape Sable suggest that water levels resulting from the storm surge rose about 8 ft above normal water levels, and the sparrow was thought to have been extirpated from the area due to habitat degradation as a result of the storm surge. Between 1935 and the 1950s, searches on Cape Sable failed to locate sparrows, however there were occasional reports of sparrows that could not be verified (Stimson 1956). Despite the fact that sparrows were again reported on Cape Sable in 1970 (Kushlan and Bass 1983; Werner and Woolfenden 1983), the habitat in the area had changed significantly from cordgrass marshes to mangroves and mud flats since the 1935 hurricane, and sparrows were considered to have been extirpated from this area since 1981 (Kushlan and Bass 1983).

In 1928, CSSS were reported to the northwest of Pinecrest, along the mainland coast of Florida, near what is today Everglades City (Nicholson 1928). The location of this mainland record was improperly reported, and the true location, Lostmans Pine Islands area approximately 5 miles southwest of Pinecrest, was not accurately reported until 1954 (Sprunt 1954). Stimson conducted extensive searches on the Florida mainland in the vicinity of the corrected 1928 sparrow observation and found sparrows to be very widespread throughout both coastal cordgrass marshes (Werner and Woolfenden 1983) and freshwater prairies along the western edge of the Everglades (Stimson 1956). However, by 1968, Stimson (1968) concluded that widespread fires in this region had severely impacted the sparrows in that area, and he expected them to be extirpated from the area as a result.

In the early 1940s, Anderson (1942) reported sparrows in the coastal cordgrass marshes near Ochopee. Subsequent searches revealed that sparrows occurred south of Ochopee along the coastal marshes landward of the mangrove zone (Stimson 1956). Werner (1975) reported that habitat occupied by sparrows in the Ochopee area was changing from cordgrass marshes to other species, and mangroves were encroaching into the area. Werner's searches in the area from 1970 through 1975 revealed a decline in the number of sparrows and the amount of habitat available in the area (Werner 1975). Sparrows were extirpated from this area by 1981 (Kushlan and Bass 1983), and there is little or no suitable habitat remaining in the area.

In 1972, CSSS were discovered near Taylor Slough (Ogden 1972). Subsequent investigation revealed that a sparrow had been reported to ENP in this area in 1958, but the observation was never verified (Werner 1975; Pimm et al. 2002). Surveys conducted by Werner in 1974 and 1975 with the use of a helicopter, sought to characterize the distribution and abundance of sparrows in this region. These initial surveys revealed that sparrows were widely distributed and abundant (Werner 1975). They occupied an area of about 21,745 to 31,629 acres, and the number of sparrows occurring within this area was estimated to range from 1,500 to 26,300 individuals (Werner 1975). Because of the magnitude of the area occupied and the

large estimates of population size, ecologists concluded that sparrows probably occurred within this area for many years. The difficulty in accessing the areas and the vastness of the areas (Kushlan and Bass 1983), as well as the secretiveness of the sparrow, all contributed to the failure to document the sparrow's occurrence in the area previously. The sparrow populations within these areas probably fluctuated over time in response to changes in habitat suitability resulting from fires and hydrologic conditions (Taylor 1983; Kushlan and Bass 1983). These fluctuations may have also contributed to the lack of sparrow detections in these areas.

The 1981 sparrow survey provided a good baseline on the distribution and abundance of sparrows at that time, and the 1992 survey results were remarkably similar, though there is no information available about how the population may have changed during the intervening years.

The overall sparrow population has declined since 1992, and there has been no evidence of significant improvements (Table 1). In addition to the decline in overall numbers, the distribution has decreased. Several of the sparrow subpopulations have contracted toward the center of the remaining habitat patches (Cassey et al. 2007).

2.7 Factors Affecting the Species

2.7.1 Hydrology

The C&SF Project is a system-wide network of canals and water-control structures. The Corps and District operate the C&SF Project to achieve a variety of local and regional objectives including flood protection, water supply, and environmental benefits. Operations of the C&SF Project affect the hydrologic conditions of nearly all the wetland systems within south Florida to some degree, including the habitat supporting the CSSS.

The most critical issue facing the sparrow today is altered hydrology in what was once the largest and most productive subpopulation, CSSS-A. Since 1992, and coincidental with Hurricane Andrew, the numbers of dry nesting days and average annual discontinuous hydroperiod in this area have been inadequate to maintain suitable habitat conditions. This altered hydrology resulted from implementation of the C&SF Project which re-routed the main flow through the Everglades from an eastern flow path within SRS to a more western one below the S-12 structures. The restoration of flow through the Everglades has been studied for decades and is a prominent part of the CERP, which has yet to be completed.

The Service's 1999 Biological Opinion required immediate emergency management actions to reduce the amount of flow through the S-12 structures onto western marl prairies. Later, in 2002, the Corps requested that the Service consider IOP as an RPA with a requirement that included a hydrologic management regime to protect sparrow breeding by reducing water deliveries in western marl prairies which were too wet and increasing water deliveries to the eastern marl prairies that had been over drained (Service 2002).

Many areas of sparrow habitat have experienced vegetation change since monitoring was initiated. These changes in vegetative composition have resulted from changes in hydrologic conditions, fire frequency, and management actions. Over drying within CSSS habitat is a result of maintaining artificially low water levels within areas of sparrow habitat, such as those that occur along the eastern boundary of ENP, increasing the potential for woody vegetation encroachment, and reducing the suitability of the habitat for sparrow occupancy. Extended hydroperiods and deep water depths occur as a result of managed water releases in combination with wet-season rainfall which can lead to the marl prairie vegetation changing to marsh species, also reducing habitat suitability.

Under IOP, hydrologic management provided reduced flows to sparrow habitat located in the western marl prairies during the breeding season. Construction and operation of several detention areas adjacent to sparrow habitat in the eastern subpopulations increased hydroperiods by an average of approximately 40 days in some over-drained habitats such as CSSS-C. Many other routine hydrologic operations that occur throughout the C&SF system have resulted in changes to hydrologic conditions in and adjacent to sparrow habitat. Pre-storm and post-storm operations, testing of hydrologic management operations, and other similar activities conducted by the Corps and District also affect hydrologic conditions within sparrow habitat, mainly through alteration of the natural timing of wetting and drying events.

In November 2019, the Corps released its report entitled, 2016 Everglades Restoration Transition Plan Biological Opinion: Evaluation of Western Flows Assessment (Corps 2019b). A draft preliminary report was summarized in the ERTP 2016 BO and can be found in Appendix C of that report (Service 2016). The current report, summarized below, contains similar hydrologic modeling analyses to those produced for the COP and utilizes nesting days, annual hydroperiod days and the marl prairie suitability index. Key points from this report include:

1. Areas within the southeastern corner of BCNP and the western marl prairies of ENP are receiving more water quantities than the historical pre-drainage condition. The source of this water is the L-28 borrow canal receiving inflows from S-344, S-343A and S-343B and shunting it south (along with BCNP basin runoff from south of the Jet Port), to the Tamiami Trail borrow canal which then discharges through Tamiami Trial bridges and Loop Road bridges into ENP near the western marl prairies. Seepage may also be occurring through and around the S-343A and S-343B structures and ending up near the western marl prairies.

2. In accordance with the ERTP 2016 BO, the Corps has provided their assessment summarizing planning efforts under WERP and potential effects to CSSS-Ax (Corps 2019a). Model results for the WERP alternatives WALT1R, WALT3R, W3RNL and ALTH were observed to better re-distribute water across the existing landscape through modifications of the L-28 Tieback and L-28 Canal relative to the WECB and WFWO model runs, with WALT3R and W3RNL better re-distributing water away from areas within southeastern BCNP and ENP's western marl prairies which are currently deemed too wet and further into the central and southern interior of BCNP.

3. The Corps concluded that, implementation of WERP would be expected to influence wetland hydroperiods causing changes in nesting and marl prairie suitability for the CSSS primarily within the western marl prairies. Those alternatives (*i.e.*, WALT3R and W3RNL) that included pump stations at the bottom of the L-29 Canal to direct water toward the interior of BCNP were more aggressive in reducing potential water depths in CSSS-Ax. Each WERP alternative slightly increased the average percentage of habitat within CSSS-Ax that experienced >90 dry nesting days over the period of record relative to the WECB (48.1 percent) and WFWO (43.1 percent). On average, CSSS-Ax experienced >90 dry nesting days 48.7, 52.1, 52.6, and 49.7 percent under WALT1R, WALT3R, W3RNL, and ALTH respectively, showing a minor beneficial effect.

4. Each WERP alternative also slightly increased the average percentage of habitat within CSSS-Ax that experienced a four-year running average discontinuous hydroperiod between 90 and 210 days over the period of record relative to the WECB (27.3 percent) and the WFWO (23.3 percent). On average, CSSS-Ax experienced a four-year running average discontinuous hydroperiod between 90 and 210 days 30.1, 33.7, 34.3 and 31.0 percent, under WALT1R, WALT3R, W3RNL and ALTH, respectively, showing a minor beneficial effect. Potential effects to the eastern marl prairies between each alternative and each baseline were not as great.

Western Water Flows are driven by the hydraulics of the L-28 Levee and L-28 Interceptor infrastructure (*i.e.*, levees, canals, and structures). When the L-28 was constructed, BCNP was privately owned. The L-28 was designed to protect those areas from flooding and impound water in WCA-3A. This infrastructure has not been substantially changed since it was installed in the 1960s, the result of which has been over-drainage of water around and away from BCNP in favor of channeling the surplus water south (into WCA-3A and the western marl prairie). The CSSS-Ax has been negatively affected as a result. Absent changes to the L-28 system, Western Water Flows will continue to pose hydro-ecological impacts to the western marl prairie and CSSS-Ax. The Service looks forward to working closely with the Corps during renewed WERP planning to ensure the western marl prairies remain suitable for sparrows.

Prior to ERTP 2016, the discontinuous hydroperiod and dry nesting window analyses were based on data that were available from gauges situated within and in the vicinity of individual subpopulations. A single water-level gauge (in the case of NP-205, R3110 or EVER4) or several gauges within or in the vicinity of a subpopulation were used to estimate water depths in one or more subpopulation areas. In 2015, several water-level gauges used to estimate water depths in CSSS habitats (MRSHOP-B1, MRSHOP-C1, MRSHOP-C2, and MRSHOP-C3 in CSSS-F and MRSHOP-D1 in CSSS-C) were discontinued following a reduction in funding. With the removal of these gauges and questions arising about the use of individual gauges to estimate hydrology over large areas, the Service worked with the USGS to develop an improved method for estimating and evaluating water depths and their spatial extent. EDEN has provided daily water-level and water-depth surfaces for the freshwater Everglades for the period 1991 to present. The Sparrow Viewer tool (http://sofia.usgs.gov/eden/csss) was developed by the USGS

in coordination with the Service, to use these surfaces to estimate and evaluate water levels, depths, and durations in CSSS habitat on a near-real-time basis. CSSS Water-Depth Maps containing daily water depths based on the EDEN water-level surfaces, water-level gauge data, and ground elevation data are generated each day. The data have the same 400 meters by 400 meters grid resolution as other EDEN data.

The animated viewer shows changes in water levels and provides calculations of the percent area that is dry along with other statistics relating to CSSS biology on a daily basis. Scientists and water managers can use the Sparrow Viewer data to spatially analyze and assess past and present impacts of hydrology on sparrow habitat and nesting success and develop management strategies for the future. Another tool developed by the USGS for use in analyzing EDEN data is the EDEN Transect Plotter tool, which facilitates the plotting of water levels from the EDEN daily water-level surfaces and ground elevations along transects located at key locations along water management features for specified periods such as the CSSS breeding season. This tool can be used to assess past events as well as providing a real time evaluation of hydrologic conditions. The tool has been used to evaluate conditions as a substitute for the MRSHOP gauges which were discontinued. The analysis contained in this document will only rely on data produced by EDEN and the Sparrow Viewer. For more detailed information on the relationship between individual gauge stations and EDEN, see ERTP 2016 biological opinion (Service 2016).

The requirement to provide suitable conditions over 40 percent of the habitat within CSSS-Ax, equating to approximately 24,000 acres, was originally established to ensure that sufficient habitat was properly maintained to support pre-1993 sparrow populations. Over time, the western CSSS-A habitat has declined in condition due to extended hydroperiods. However, the Sparrow Viewer analysis has indicated that areas to the east of CSSS-A (Figures 7 and 8) appear to provide suitable breeding season dry periods, indicating that habitat management actions may provide benefits in that area. Given the currently diminished condition of both optimal CSSS habitat and population numbers compared to historical levels, and the need to identify what improvements in habitat would be possible to facilitate its recovery, it is appropriate to extend the analysis to determine the feasibility of expanding suitable habitat beyond the original boundary of CSSS-A. For purposes of analysis throughout this document we will only be looking at the CSSS-Ax delineated area. For more detailed information on the origin of CSSS-Ax see the ERTP 2016 BO (Service 2016).

2.7.2 Dry Nesting Days

While provision of the quality and quantity of viable habitat for all phases of the CSSS life cycle is vital, conditions during the March 1 to July 15 breeding season that favor successful rearing of young, and ideally multiple broods, are essential for maintenance of healthy and sustainable sparrow populations. This has been the subject of considerable study, and development of metrics and trigger levels in an attempt to foster these conditions. This metric has evolved over time since 1999 and the target, in use since 2016, is worded as follows: To produce multiple broods each year, the CSSS requires at least 90 consecutive dry days (water below ground surface) over 40 percent of each subpopulation during the nesting season (March 1 – July 15).

1. Subpopulation A - At least 24,000 acres of suitable habitat within and adjacent to CSSS subpopulation A must have 90 consecutive dry days between March 1 and July 15 (CSSS breeding season) every year.

2. Subpopulations B through F – At least 40 percent of each designated CSSS critical habitat unit must have 90 consecutive dry days between March 1 and July 15 (CSSS breeding season) every year.

While the average nest cycle for sparrows is estimated to be 34 to 44 days (Pimm et al. 2002), a minimum of two successful nesting periods, in the majority of years is considered essential to maintain a stable and viable CSSS population (Pimm et al. 2002). A nesting window of at least 90 days provides additional time to account for delays in nest initiation due to weather conditions, possible reversals of water levels, and other factors which may delay or interrupt breeding attempts. For a more detailed version of how this metric has evolved over time see the Service's ERTP 2016 Biological Opinion (Service 2016).

With the development of the Cape Sable Seaside Sparrow Viewer (Sparrow Viewer) tool in 2016 (http://sofia.usgs.gov/eden/csss), it is possible to assess the performance of this metric across all subpopulations from 1991-2019 (Table 2). This data indicates that CSSS-Ax and CSSS-D miss the target more frequently and have more occurrences of consecutive years outside the target range. CSSS-Ax only met the target in 8 out of 29 years and averages just 25 percent of its total area achieving 90 or more consecutive dry nesting days. CSSS-D meets the target in 14 of 29 years with an average of 39.7 percent of its total area meeting the 90-day criterion. Consecutive years of not providing ideal nesting windows for sparrows increases the likelihood that multiple broods will not be achieved, and population numbers will not increase. CSSS-Ax had 13 instances where conditions were not met in two consecutive years. CSSS-D had 7 instances where this occurred. These results indicate that the current level of breeding habitat has not been sufficient to aid in the recovery of the population within CSSS-Ax and is only minimally adequate to maintain the subpopulation at a precariously low level.

By contrast, CSSS-B the largest and most consistent performing subpopulation met the target 21 of 29 years with an average of 56.4 percent of the area meeting the 90 consecutive dry day target. Only twice did CSSS-B not meet the target in consecutive years. CSSS-E which is located closer to NESRS and is not protected by the main Everglades National Park road met the target 19 of 29 years with an average of 54.3 percent of the area meeting the target. It only exhibited one instance of consecutive years missing the target.

2.7.3 Discontinuous Hydroperiod

The timing and extent of dry habitat during the Cape Sable seaside sparrow breeding season has been the subject of extensive research and analysis in an attempt to determine key periods and relationships to ensure successful breeding. However, equally if not more important, is the provision of optimal depth and duration of above ground surface water levels throughout each

year (known as the discontinuous hydroperiod). Additionally, this hydroperiod should have an optimal occurrence frequency over the long-range period of years to maintain enough suitable sparrow habitat capable of supporting a healthy sparrow population. Walters et al. (2000) observed that if water management produces long hydroperiods in CSSS habitat frequently enough to alter its vegetation, as has occurred in CSSS-AX and CSSS-D, sparrow survival and reproductive rates will be moot because the habitat will be unable to support successful reproduction regardless of how many birds might be in the area.

The discontinuous hydroperiod for the marl prairie habitat type favored by CSSS has been determined to be in the range of 90 to 210 days (Ross et al. 2003, Beerens et al. 2016). Habitat in the lower end of this range or with less than a 90-day discontinuous hydroperiod tends to be more prone to fire and has more woody vegetation encroachment. Habitat in the upper range or with more than a 210-day discontinuous hydroperiod tends to quickly convert to habitat dominated by species such as sawgrass and cattail. Research has shown that habitat degradation, whether by changes in available habitat or increases in water level, had a much larger impact on final population size and quasi-extinction risk compared to changes in demography and behavioral parameters (Elderd and Nott, 2008).

The marl prairie habitat that the CSSS requires for its survival and recovery persists under a hydrologic regime of 90 to 210 wet days (water above ground; discontinuous). In order to maintain and restore enough area of suitable marl prairie habitat for each CSSS subpopulation, water management should be implemented in a manner aimed at meeting the following:

1. Subpopulation Ax – At least 24,000 acres of suitable habitat within and adjacent to CSSS subpopulation Ax must show a 4-year running average discontinuous hydroperiod range of 90 to 210 days, with no 2 consecutive years failing to meet this target.

2. Subpopulations B through F – At least 40 percent of each designated CSSS critical habitat unit must show a 4-year running average discontinuous hydroperiod range of 90 to 210 days, with no 2 consecutive years failing to meet this target.

With the development of the Cape Sable Seaside Sparrow Viewer (Sparrow Viewer) tool in 2016 (http://sofia.usgs.gov/eden/csss/index.php), it is possible to assess the performance of this metric across all subpopulations from 1991 to 2019 (Table 3). First, with regards to the percent area meeting the target, table 3 shows the percentage of each subpopulation that falls into the 0 to 89, 90 to 210 and greater than 210-day annual hydroperiod for the period of record 1991-2019. The target hydroperiod range is between 90 and 210 days over 40 percent of each subpopulation. The metric above calls for 4-year running average hydroperiod. However, it is beneficial to look at percentages by year to see how many years in the period of record the annual target is met and the percentage of area that is too dry or too wet outside of the target.

CSSS-Ax

It is evident from table 3 that CSSS-Ax is too wet compared to the other subpopulations and has been so since 1993. This subpopulation only met the 90 to 210-day discontinuous hydroperiod target in 2 of 29 years, has the least amount of area meeting the target on average (16 percent) and has the highest percentage of area, on average, with a hydroperiod greater than 210 days (83 percent). During the period 1991-2019, CSSS-Ax only exhibited comparable conditions to the larger subpopulations in two years, 2001, when 40.6 percent of available habitat was in the optimal discontinuous hydroperiod range and 2008 when the percentage was 48.6 (Table 3). In 72 percent of the years it failed to meet the 90 to 210-day threshold over even 20 percent of the habitat.

CSSS-B

CSSS-B is presently the largest subpopulation in terms of numbers of sparrows and the second largest in area. The Sparrow Viewer analysis demonstrates that CSSS-B has been able to achieve the 90 to 210-day discontinuous hydroperiod threshold over 35 percent of its habitat. However, recently it appears that CSSS-B may have experienced a decline in habitat meeting the threshold with 38 percent of the habitat meeting the threshold between 1992 and 2008 and 28 percent meeting it between 2009 and 2019. The area experiencing greater than 210-day hydroperiod for the same time period indicates an increase of 13 points, from 25.3 to 48.2 percent, indicating that CSSS-B has become wetter. The decline from 2009 to 2019 is possibly due to wetter than average dry season conditions between 2012 and 2019 and/or the still to be determined effects of water management operations. The latter is unlikely because CSSS-B is surrounded by the Main Park Road and is not susceptible to management actions like some of the other subpopulations.

CSSS-C

CSSS-C is presently maintaining a very low population level and represents only a small portion of all delineated CSSS habitat. The eastern portion of this subpopulation has been subjected to over drainage due to adjoining canal infrastructure resulting in the invasion of non-native woody vegetation and a frequent fire return rate. The western portion of this subpopulation has remained mostly unimpacted, except for occasional fires. Since the implementation of IOP in 2002, portions of this subpopulation have been affected to varying degrees by the construction and operation of infrastructure designed to retain more water in Taylor Slough and adjoining marshlands. The Sparrow Viewer analysis (Table 3) demonstrates that between 1992 and 2008, CSSS-C had an average of 63 percent of its acreage in the optimal 90 to 210-day discontinuous hydroperiod range with 53 percent of the years achieving it over more than 60 percent of the habitat (Table 3). However, between 2009 and 2019 there has been a 13 percent decrease in the area of habitat achieving the optimal range, possibly attributable to wetter meteorological conditions during the dry season (2012 through 2019) and/or the effects of water management operations (Table 3).

CSSS-D

CSSS-D is also at a very low population level and represents only a small portion of all delineated CSSS habitat. The Sparrow Viewer analysis demonstrates that between 1992 and 2008, CSSS-D had an average of 45 percent of its acreage in the optimal 90 to 210-day discontinuous hydroperiod range (Table 3). However, the amount of habitat achieving the optimal range has decreased from 45 percent between 1992 and 2008 to just 21 percent between 2009 and 2019 (Table 3). This is possibly attributable to wetter meteorological conditions during the dry season (2012 through 2019) and/or effects of water management operations. Percentages in the 90 to 210-day discontinuous hydroperiod category have remained low since 2016 with less than 4 percent of the area meeting the target during the exceptionally wet years of 2016 and 2018. As noted earlier, despite these wet years, productivity increased significantly in 2018 and 2019. This further demonstrates the complexity of factors affecting this species and highlights the importance of maintaining interannual variability to ensure continued success.

CSSS-E

CSSS-E is presently the second largest population of CSSS. Since the early 1990s, CSSS-E has consistently been within the target discontinuous hydroperiod needed to maintain CSSS habitat and its persistence is evidence of this. The Sparrow Viewer analysis demonstrates that between 1992 and 2008, CSSS-E had an average of over 41 percent of its acreage in the optimal 90 to 210-day discontinuous hydroperiod range (Table 3). However, the amount of habitat achieving the optimal range has decreased from 41 percent between 1992 and 2008 to 29 percent between 2009 and 2019 (Table 3). This is possibly attributable to wetter meteorological conditions during the dry season (2012 through 2019) and/or the effects of water management operations.

CSSS-F

CSSS-F has maintained a very low population level and has the smallest subpopulation area. In this case it appears that the over drained state of this subpopulation is the problem, frequently resulting in a discontinuous hydroperiod of less than 90 days. This subpopulation has been subjected to over drainage due to adjoining canal infrastructure which has resulted in invasion of non-native woody vegetation, and an increased frequency of fire. The Sparrow Viewer analysis demonstrates that CSSS-F has had an average of 25 percent of its acreage in the 90 to 210-day discontinuous hydroperiod range over the period from 1992 to 2008 (Table 3). But more recently (2009-2019) there has been an increase in habitat in the optimal range. In seven of the last eleven years, conditions have improved such that this subpopulation has regularly met the discontinuous hydroperiod criteria with an average of over 52 percent of the habitat within the optimal range (Table 3), possibly as the result of wetter meteorological conditions during the dry season (2012 through 2019) and/or the construction of the Tamiami Trail Modifications 1-mile bridge completed in 2013. Additionally, in the last three years, the Corps has implemented Increments 1.1, 1.2 and 2 which have put more water into NESRS presumably increasing flows at the 1-mile bridge which sits directly north of CSSS-F.

All Subpopulations

In contrast to CSSS-Ax, the other subpopulations have a higher percentage of area falling within the 90 to 210-day window ranging from 35 percent in CSSS-B to a high of 56 percent in CSSS-C. They also meet the target in more years over the 29-year period of record, ranging from 9 in CSSS-E to a high of 20 in CSSS-C. Previous characterizations of the eastern subpopulations have been that they were too dry, however, the observed data in table 3 (1991-2019) indicates that CSSS-C is not as dry as was previously thought with an average of 29 percent of the area in the 0 to 89-day hydroperiod range. CSSS-F is perpetually too dry and records an average of 59 percent in the 0 to 89-day range. CSSS-D and E tend to be on the wetter side when outside of the target range with averages of 57 and 49 percent respectively in the greater than 211-day hydroperiod category.

Table 4 shows the one-year and four-year rolling average hydroperiod in each subpopulation from 1991-2019. The trends discussed earlier are evident in these metrics as well where CSSS-Ax has an average annual hydroperiod of 286 days. This is 76 days beyond the target (210 days) and 111 days beyond the average annual hydroperiod for CSSS-B at 175 days (Table 4). CSSS-D is the only other subpopulation to exceed the target with a long-term average of 225 days and CSSS-F averages drier than the target with an 81-day hydroperiod on average. CSSS-C reports an average of 135 days and CSSS-E, located just east of SRS, stays within the target range at 199 days. Since 2016, averages have remained steady except for the wet year of 2018 when all subpopulations except CSSS-F exceeded the target. Tracking of the four-year rolling average hydroperiods was initiated in 2016 to account for some of the annual variability in hydroperiod and because it has been estimated that there is a lag period of around 4 years for the vegetation to shift with hydrologic changes (Ross et al. 2006).

2.8 Population Dynamics

The methodology used to estimate Cape Sable seaside sparrow population levels has remained consistent since 1981 (Bass and Kushlan 1982). Analyses conducted as part of the ERTP development resulted in a population trigger level that was documented in the Service's ERTP Biological Opinion (Service 2010a) that, when exceeded, required the Corps to reinitiate consultation. This reinitiation trigger was based on an average total population estimate of 3,145 birds over the 2001 to 2009 period, and specified that if the annual estimated population fell below one standard deviation (-230) of the average total population (3,145 - 230 = 2,915 birds) reinitiation of consultation under the Act was required. During the period of 2001 to 2016, the population estimate fell below the trigger level of 2,915 birds four times (2002, 2011, 2014, and 2016) (Table 1). Since this criterion was developed as part of the ERTP BO which was issued in 2010 with operations commencing after the ROD was signed in October 2012, only the exceedance that occurred in 2014 was considered as a trigger for reinitiation. The Service and Corps did reinitiate formal consultation and though it was found that the project did not cause the population estimate to fall below the trigger level, a new Biological Opinion was produced (Service 2016). In the 2016 BO the reinitiation trigger was slightly modified by taking one half of a standard deviation from the 2007 – 2016 mean population estimate and subtracting that from

the 2016 population estimate (2,416 – 135 = 2,281). This meant that if the population estimate fell below 2,281, reinitiation should occur. This has not happened in the intervening years since the ERTP 2016 BO was submitted. The closest was in 2019 when the population estimate was 2,688.

While it is true that the currently proposed action (COP) was a part of the RPA in the previous BO and is anticipated to benefit sparrows in the long-term, it is possible that further exceedances could occur. This species is highly sensitive to hydrologic change and the transition into a completed MWD and C-111 SD Project operating plan and future transitions into CERP operations coupled with influences from other factors including weather events, El Nino, and potential sea level rise could cause fluctuations in the population estimate.

An additional indication of the declining sparrow status can be seen in the decline in annual peak levels of the estimated population in CSSS-B and the total CSSS population from 1981 to present (Figure 5). Since sparrow population numbers are cyclic, often over a period of 3 to 4 years, related to both the average life span (Service 1999; Pimm et al. 2002), weather, and hydrologic conditions, a repeating pattern of high and low years can be discerned within the data. The high years are indicative of conditions that have been favorable for sparrow reproduction and survival when the population has been able to recover from previous poor years. If, as indicated by the declining peak population numbers, those favorable conditions are not resulting in substantial population increases, it is an additional indicator that the species needs additional management actions. Of further concern is that this decline also appears to be occurring in the largest remaining healthy subpopulation CSSS-B. Since 1992, the estimated populations in CSSS-Ax, CSSS-C, CSSS-D, and CSSS-F, have trended lower and remain at extremely low levels, an indication that little to no improvement is occurring in these subpopulations.

The South Florida Multispecies Recovery Plan (Service 1999), identified one of the recovery criteria components for the Cape Sable seaside sparrow as when the 3-year running average intrinsic rate of increase (*r*) for the total population is equal to or greater than 0 for at least 10 years. When *r* is greater than 0 it indicates an increasing population, and when *r* is less than 0 it indicates a declining population. From 1994 to 2004, the three-year running average of *r* was greater than 0 in 6 years, and less than 0 in 4 years. Within the period of 2005 to 2015, the three-year running average of *r* was greater than 0 in 2 years, and less than 0 in 8 years (Figure 11). In the four years since the ERTP 2016 BO was submitted, the three-year running average of *r* was greater than 0 in 2 years and less than 0 in 2 years. This metric is significant in that the calculation of the three-year running average considers the complexity that is often introduced in trying to correlate yearly relationships. This metric provides additional evidence that population changes are connected to habitat effects which often occur over a period of years.

Pimm and Bass (2002), in their population viability analysis (PVA) of the sparrow offered the following tentative conclusions:

> *"…the Cape Sable sparrow will survive only if it has at least three healthy subpopulations. To implement this requirement, the breeding areas west of Shark River*

Slough must not be flooded in the breeding season, and water levels should be raised in the northeast of Shark River Slough to reduce the incidence of fires."

"…the population declines towards extinction within fifty years in the "plausible" scenario. It even goes to extinction in the "optimistic one". What if water were not released? The population dips below its population ceiling periodically but persists indefinitely even in the plausible scenario."

"We predict that the Cape Sable sparrow subpopulation west of Shark River Slough will decline to extinction if the pattern of managed flows over the S-12 structures for the last 20 years is repeated."

Their study concluded that during the previous 20 years sparrow population levels had failed to recover from documented declines, and if similar water management operations were continued, their PVA analysis indicated that extinction was inevitable. The Service concluded in its 2016 BO that:

"In reviewing the progress in Everglades restoration, the status of the species since this analysis, and the effects of water management changes that have been implemented to date with consideration for the sparrow, the Service can find minimal justification to refute that conclusion."

With the implementation of the currently proposed action (COP) in 2020, it is anticipated that we will significantly and permanently begin the redistribution of flows to their historic flow path and benefit sparrows, as well as other wildlife resources in the Everglades.

A biased sex ratio has been observed by researchers conducting intensive ground surveys for the CSSS (Lockwood et al. 2006; Lockwood et al. 2007; Boulton et al. 2009; Virzi and Davis 2013; Slater et al. 2014). The number of males observed in intensive ground surveys frequently exceeds the number of females observed, resulting in an increase in the sex ratio up to a maximum of 1.0 (*e.g.*, when only males are observed in the population, this type of ratio is expressed as the number of males divided by the total number of adults in the population). A male biased sex ratio is most often observed in smaller subpopulations (Slater et al. 2014) and may be a function of several factors such as habitat quality and increased female vulnerability to predation (Virzi and Davis 2013; Gruebler et al. 2009). Highly skewed adult sex ratios increase a species' risk of extinction (Dale 2001; Donald 2007) and were observed during the extinction of the Dusky seaside sparrow, when ultimately all the remaining sparrows in the wild were males (Delany et al. 1981). With this in mind, it is critical that the skewed sex ratio in small subpopulations be monitored closely to assess the range wide status of the CSSS (Slater et al. 2014) and that actions be taken to address this issue.

Since the current population estimator assumes that there is a one to one ratio of males and females in the population and that they are paired and successfully reproducing, the resulting population estimate may be overestimating the total population. Further research is currently

underway to increase the accuracy of the range wide survey methodology as well as the validity and statistical power of the current population estimate. For additional detail on biased sex ratios and their affects on the population estimator refer to the ERTP 2016 BO (Service 2016).

2.8.1 Territory Size

Another metric that has been used to evaluate the health of the CSSS population is the acres of suitable habitat available for each individual (Table 13). The larger, more stable subpopulations have fewer suitable acres per bird in the 90 to 210-day discontinuous hydroperiod range, meaning either the larger subpopulations have smaller territories covering the majority of the suitable habitat, and/or that the less stable subpopulations have a large amount of underutilized habitat. CSSS-B, the subpopulation with the largest population, had the lowest value for suitable acres per bird at 5.9 acres (2.4 ha) followed by CSSS-E, the second most populous, at 19.7 acres (7.9 ha). The number of suitable acres per bird in CSSS-Ax was substantially larger at 46 acres (18.5 ha), even though it has only averaged 9 percent of its potential acreage in the optimal target range. In 1992, the last year CSSS-Ax had a large population (2,608 birds), the average number of acres per bird in the target 90 to 210-day discontinuous hydroperiod range was 5.2 acres, comparable to CSSS-B. The smaller subpopulations, CSSS-C, CSSS-D, and CSSS-F, average 33 to 62 percent of their acreage within the target discontinuous hydroperiod range but account for very few birds which results in a high range of potentially suitable acres per bird (72 to 124 acres).

The average of the annual total number of suitable acres per bird across all subpopulations is 11.4 acres (4.60 ha), or 22.8 acres per pair. This is larger than the territory size documented in Pimm et al. 2002, of 3.0 to 11.1 acres (1.2 to 4.5 ha) based on observations of known breeding pairs. This could be a further indicator of the current underutilization of the less optimal habitat by sparrows compared to usage in more optimal habitat areas studied by Pimm.

If 40 percent of the maximum acreage in CSSS-Ax were to exhibit the target discontinuous hydroperiod, this would provide approximately 24,000 acres of suitable habitat. This optimal habitat acreage area, at a theoretical average of 11.4 acres per bird, would result in a potential estimated population for CSSS-Ax of 2,100 birds. For comparison, the estimated population in CSSS-Ax in 1981 was 2,688 birds and as late as 1992 was 2,608 birds. Based on this analysis, 24,000 acres of habitat meeting the target 90 to 210-day discontinuous hydroperiod would provide enough habitat to begin restoring the overall population of CSSS-Ax to its previous level.

2.8.2 Vegetative Community Changes

Another factor affecting sparrows is the loss of suitable habitat due to extended flooding or high water levels. Sah et al. (2007) documented a conversion of habitat type from shorter hydroperiod plant species (less-flood tolerant) to those indicative of longer hydroperiod conditions (more flood-tolerant) not preferred by sparrows, in particular, vegetation in the wet prairies along the eastern edge of CSSS-E, the central part of CSSS-A, and the southern part of

CSSS-B were indicative of wetter conditions. Based on vegetation studies within sparrow habitat, researchers concluded that the direction and magnitude of vegetation change within marl prairie depends on whether the vegetation is located along the fringes near either wetter or drier areas, and the magnitude of the hydrologic change that is influencing them (Ross et al. 2003, 2004, 2006; Sah et al. 2007, 2010, 2013; Elderd and Nott 2008). The transition from one vegetation type to another (*e.g.*, prairie to marsh) in response to hydrology may take place in as little as 3 to 4 years (Armentano et al. 2006); however, the transition from marsh back to suitable prairie may take longer (Ross et al. 2006; Sah et al. 2010; Sah et al. 2013).

Vegetation change is also influenced by the interaction of fire and hydrology. Studies by Sah et al. (2010) revealed that not only did post-fire flooding delay the vegetation recovery process, but also caused it to follow a different trajectory in terms of species composition. This could potentially impede recolonization of previously burned areas by the sparrow (Sah et al. 2010).

Vegetation studies within sparrow habitat (Ross et al. 2004) showed that sparrows occupy prairies with a hydroperiod ranging between 90 and 240 days. In sites with hydroperiods ranged between 150 and 240 days, CSSS occupancy was over 40 percent, while at shorter and longer hydroperiods occupancy was 20 percent or less (Ross et al. 2004). This Biological Opinion, like the ERTP 2016 BO, uses 210 days as the upper limit of the discontinuous hydroperiod metric for the analysis of effects. However, solely attaining this hydroperiod requirement may not be enough to promote a transition from marsh to prairie habitat, as this process likely requires a fire frequency regime in the landscape defining process (Ross et al. 2006; Sah et al. 2010).

Water management operations associated with IOP and ERTP have not resulted in an adequately shortened annual hydroperiod sufficient to maintain suitable marl prairie habitat throughout the historical expanse of subpopulation Ax. This is especially evident in the lower-elevation peripheral portions of subpopulation Ax (*e.g.*, at the P-34 gauge) where the average annual hydroperiod ranges from 235 to 320 days. The extended hydroperiods and associated habitat degradation are likely contributing to the decline of the sparrow in CSSS-Ax and suggests a source of water to the west of the S-12s which has recently been investigated (Corps 2019b). It is not precisely known where, when, or how this “additional” water reaches the P-34 gauge but it has been hypothesized that it may be coming from the infrastructure associated with the L-28 Borrow Canal, or may be the early impacts of sea level rise. Consequently, CSSS-Ax has not recovered under IOP or the subsequent ERTP, nor has it been extirpated, but the estimated population has remained extremely low compared to the level that existed in 1981 and 1992.

Recent sampling by Sah et al. (2018), as part of their long-term study of marl prairie vegetation, indicates that vegetation on the eastern side of CSSS-Ax has experienced an increase in vegetation composition consistent with longer hydroperiods. The reported trend in this location had been towards the drier side with the annual closures of the S-12 structures, however the reverse was evident from the 2016 sampling and thought to be due to high water conditions in the spring of 2016 (Sah et al. 2018). Several wetter than average years have occurred since 2016 so this trend has probably continued, however, it is anticipated that with the COP the trend will be reversed again as more flow is restored to NESRS. As anticipated, the same sampling picked

up the positive trend in the eastern marl prairies of shifting vegetation towards the wetter side. This is due in part to the the C-111 South Dade detention areas receiving water from the S-332 B and C structures. This is achieving the goal of rehydrating the eastern marl prairies located in the Rocky Glades.

2.8.3 Construction, Maintenance and Human Disturbance

Since the COP represents the next iteration of water management operations, and no construction is proposed, there will not be any direct impact due to project related construction. While direct physical disturbance to sparrow habitat and disturbance resulting from construction activities has occurred in the past, it has been limited because nearly all available sparrow habitat occurs within ENP and other conservation lands. Indirect effects of construction activities have included noise and vibration disturbance from heavy earth moving equipment and a general increase in human presence in the project area. Construction and maintenance of roads, canals, and levees near sparrow habitat have likely resulted in some localized effects to sparrows through loss or degradation of habitat or disturbance. However, maintenance and human disturbance is an ongoing issue that the Service has been attempting to address with its partner agencies. Maintenance of monitoring gauges has resulted in the destruction of habitat through the creation of paths between access points and the gauges. These paths can disrupt surface flow and may aid in spreading invasive plants or providing trails for exotic animals to access parts of the habitat.

2.8.4 Fire

Fire is a natural or human-related factor that affects marl prairies occupied by the sparrow and most sparrow habitat has burned at some point during the past 30 to 40 years. ENP, BCNP, SFWMD, and the FWC have all conducted prescribed burns within sparrow habitat on lands within their respective jurisdictions. Fire management on Department of the Interior (DOI) land (ENP and BCNP) combines fire operations, prescribed fire, and fire ecology in order to maintain fire in the natural ecosystems while considering impacts on nearby human population centers as well as threatened and endangered species habitat. The Service has consulted with ENP and BCNP on several fire management plans and has issued a biological opinion on ENP's 2015 Long-Term Fire Management Plan (NPS 2014). The Service also participates in the annual sparrow/fire symposium held at ENP by their fire management staff. In addition, these agencies and the Florida Division of Forestry conduct wildfire suppression and management within sparrow habitat.

In the short-term, fire typically renders sparrow habitat unsuitable for occupancy, because it removes the vegetation that sparrows rely upon for cover and refugia especially during the breeding season. Following fire, vegetation normally begins to regenerate rapidly and reaches pre-burn density and species composition about 2 years later. Sparrows do not regularly occupy burned areas for 2-3 years after fire (La Puma et al. 2007). ENP has conducted prescribed fires in former sparrow habitat within the western marl prairies to facilitate habitat restoration and has conducted wildfire suppression within CSSS-B, with the intent to reduce potential impacts to

sparrows and sparrow habitat. Additionally, prescribed burns have been conducted along the eastern ENP boundary to reduce the likelihood of human-ignited fires spreading into sparrow habitat near subpopulations C, E, and F. Prescribed, natural, and human-ignited fires have occurred within and in the vicinity of CSSS-D. Because fires reduce habitat suitability for up to 3 years, it can have adverse effects on sparrow populations, but also may be necessary in the long-term for the maintenance of habitat (Taylor 1983; Pimm et al. 2002; Lockwood et al. 2003, 2005; LaPuma et al. 2007).

Several fires burned within sparrow habitat during the 2008 dry season. Among these were the West Camp Fire (CSSS-Ax) and Mustang Corner Fire (CSSS-E and CSSS-F), which was the largest fire to have burned in ENP since the Ingraham Fire in 1989. Unlike previous burned areas, pre-fire vegetation data were available for these fires and Sah et al (2010) provide a preliminary evaluation of one year after the fire. Post-fire hydrology in these areas was favorable for normal recovery with a gradual increase in water depth. This is in contrast to a subset of sites burned in 2005 that were flooded within 7 to 14 days of the fires and remained significantly different from pre-burn vegetation composition even four years post fire. More recently in 2015, the Dogwood, Otter, and 10 Mile Fires burned a total of approximately 3,350 acres, and in 2014 ENP conducted the River of Grass NW prescribed burn, which covered approximately 8,750 acres. These fires were within or near CSSS-Ax habitat. The 10 Mile Fire burned occupied sparrow habitat in southwestern CSSS-Ax during 2015 and subsequently no sparrows were detected in that area during the 2016 surveys. Based on previous experience with burned areas, we would expect that conditions would be unsuitable for CSSS for the next 2 years in this area. This further increases the importance of providing hydrologically suitable areas in the northern part of CSSS-Ax which are most directly impacted by S-12 flows. Although habitat changes caused by these fires have not been monitored closely, they are part of a revised ENP fire management strategy that is structured to protect sparrows and improve sparrow habitat conditions.

Small populations are particularly at risk from a catastrophic event or series of events, such as fire or major rainfall during the breeding season. About two-thirds of the total CSSS population currently occur within subpopulation B, which has remained relatively stable. However, if a large fire or other catastrophic event were to occur in this subpopulation, there is a possibility the entire remaining CSSS population could be reduced by 60 percent or more. The Keyhole Hammock Fire was a lightning strike fire that started on August 14, 2017, in CSSS-B just east of Main Park Road. The extent of the burn was approximately 1,708 acres and covered roughly 75 percent (210 acres) of the Dogleg study plot (Virzi and Tafoya 2020). Sparrow numbers were declining prior to the fire with a total population of 34 in 2015, 16 in 2016 and 9 in 2017 but fell off sharply post-fire with only 2 reported in 2018 and 0 in 2019 (Virzi and Tafoya 2020). So far this season, a couple of singing males have been sighted in the more recovered parts of the Dogleg plot (T. Virzi pers. comm.). Most of the birds in this area pre-fire dispersed to surrounding suitable habitat as the field crews have observed color-banded birds across Main Park Road in the Alligator Hammock study plot in the first-year post-fire as well as south of the Dogleg in an area known as South Mahogany. CSSS habitat depends on periodic fire to

maintain its suitability and sparrows will likely move back into this area once the habitat is fully recovered.

2.8.5 Introduced Predators

The introduction of exotic species has been problematic in South Florida for many years. The Burmese python (*Python molurus bivittatus*) is found widely throughout South Florida and especially concentrated in ENP, Southern Glades, and the Model Lands where it is having major adverse effects on those ecosystems. Burmese pythons now number in the thousands if not tens of thousands in ENP and are known to consume a wide variety of prey (Snow et al. 2007), including small birds. There is documented overlap of Burmese python populations and sparrow subpopulations (Hart et al. 2015).

A more recent introduction, the Argentine black and white tegu (*Salvator merianae*), is also a concern. The tegu is a large omnivorous lizard which has been experiencing a population explosion in the Model Lands located to the east of ENP. Sightings of this species, as well as other tegu species, have been made within the critical habitat designated for CSSS-C and CSSS-D. As tegus outgrow their juvenile state, they begin to move towards a higher protein diet, frequently scavenging eggs from other reptiles, and even eating small birds. It is possible that as this exotic species continues to expand its range it may become a significant predator for CSSS (Mazzotti et al. 2014; Mazzotti 2015). While neither species has yet been documented depredating the CSSS, both species represent major threats as a predator, and are now an established part of the environmental baseline.

2.8.6 Climate Change

Climate change and sea level rise represent significant short- and long-term threats to the environmental baseline of CSSS and their habitat (Miller and Traxler 2018). Sea level rise has been estimated by various sources to potentially increase by as much as 12 to 48 inches by the end of the century (National Climate Assessment [NCA] 2014; Rahmstorf 2007; Pfeffer et al. 2008). Because the entire population of CSSS occurs in low lying areas in south Florida, the population may experience changes in habitat conditions or availability due to climate change and sea level rise over the next several decades (Figures 14, 15, 16).

Modeling scenarios provided by the Corps for South Florida at the +1, +2, and +3 ft above mean higher high water (MHHW) levels indicate that subpopulations A, B, and D are particularly vulnerable, even in the lower end of these scenarios. The baseline model scenario indicates that these areas may already be experiencing detrimental habitat effects due to sea level rise. Based on the Corps' model projections, a sea level rise of only 1-foot MHHW could result in a loss in area of approximately 40 percent of subpopulation Ax and 60 percent of subpopulations B and D. If sea levels were to rise 2-feet MHHW, it could result in a loss of almost 60 percent of subpopulation Ax and nearly 100 percent of subpopulations B and D. In the long term, all subpopulations could potentially experience major flooding effects, and if the CSSS is to be

saved as a species, accommodations for expanded habitat or relocation of individuals will need to be considered.

The Service will continue to monitor sea-level rise and other effects of climate change closely under the Strategic Habitat Conservation (SHC) paradigm. SHC is an adaptive, science-driven process that begins with explicit species population objectives in a framework for adjusting management strategies in response to monitoring, data, and assumption-driven research, including new data about climate change (Service 2006b).

2.8.7 Water Quality

The Everglades was historically an oligotrophic system, lacking plant nutrients such as phosphorus, but having high levels of dissolved oxygen. Due to anthropogenic sources of phosphorus and nitrogen (cultural eutrophication), portions of the Everglades have become rich in nutrients that promote excessive plant growth and deplete dissolved oxygen. Degradation of water quality, particularly runoff of phosphorus from agricultural and urban sources, is a concern because it can cause encroachment of cattail (*Typha* sp.) and other undesirable invasive and exotic species. Sah et al. (2013) observed; "In the Taylor Slough basin, surface water entering ENP typically has low average phosphorus content (10µg/l), (Sutula et al. 2001), *i.e.*, within the range considered to be protective of oligotrophic Everglades habitats. However, the cumulative effects of phosphorus loading in outflows from the canal (L-31N/C-111) seem to have enriched adjacent soils in Taylor Slough (Surratt et al. 2012), resulting in a change in plant species composition."

Increased production and changes in the periphyton (freshwater organisms clinging to plants and other objects projecting above the bottom sediments) result from increasing water levels, longer hydroperiods (Browder et al. 1994), or from nutrient enrichment (McCormick and O'Dell 1996). During high water events, submerged periphyton mats can become floating mats and shade out submerged macrophytes (Van Meter-Kasanof 1973). Field observations suggest that as heavy floating periphyton mats dry they can flatten and kill the aboveground portion of muhly grass and other vulnerable species. In contrast, sawgrass can penetrate this thick mat. Pimm et al. (2002), noted that an area spanning several kilometers dominated by mixed prairie was covered by such a mat after waters receded in 1996, which left few places for sparrows to nest during the following breeding season, and thereafter supported a smaller breeding population.

Implementation of the COP may affect water quality at certain times of the year in some locations. For example, the COP is designed to move more water into NESRS during the dry season when poor water quality is more prevalent. A monitoring plan has been developed for the COP which includes a water quality component. While anthropogenic effects on water quality are unlikely to be eliminated, water quality is expected to slowly improve. This is based on trends in the data indicating that Best Management Practices (BMPs) are continuing to reduce nutrient loading to the system.

2.8.8 Methylmercury

Since the late 1980s, researchers have documented mercury (Hg) contamination in the upper trophic-level biota of the Everglades with concentrations found in feather samples of longer-lived wading birds such as anhinga, ibis, and egrets (Frederick et al. 2004, Herring et al. 2009). Fish consumption advisories have been issued for the Everglades due to high Hg levels within species such as largemouth bass (*Micropterus salmoides*). In wetland systems, mercury contamination is particularly harmful as inorganic mercury under certain conditions is microbially converted to methylmercury (MeHg), which can accumulate as it moves up the food chain. Hign mercury concentrations have been hypothesized as one reason for documented declines of bird species in the Everglades. Cleckner et al. (1998) found spatial variability with higher concentrations of MeHg occurring in the southern portions of WCA-2 and WCA-3. Their studies also found that fish and hemipterans had the most MeHg and the magnitude of accumulation in biota varies seasonally and often independently of water concentration.

Monitoring of Hg levels has been conducted in birds based on blood, feather, and egg samples. Mercury concentrations can vary widely depending on the sample source material. Herring et al. (2009) found that feather growth influences blood mercury levels, and that nestlings were buffered to some degree against the adverse effects of mercury during early growth periods, because mercury is sequestered in growing feather tissues. Upon completion of feather growth, this elimination pathway is closed. Condon and Cristol (2009) found that the highest risk period for mercury intoxication in young songbirds may occur during the vulnerable period after fledging, when rapidly growing feathers no longer serve as a buffer against dietary mercury. Interestingly, Brasso et al. (2010), found that when female tree swallows lay eggs, some of the body burden of mercury was eliminated into each egg, potentially leading to declining mercury across the clutch.

Jackson et al. (2011) found up to 34 percent reduction in nesting success in Carolina wrens along the forest floodplain of two mercury contaminated rivers in Virginia. This study also reported a range of effects concentrations associated with various levels of reproductive impairment. A 10 percent reduction in nest success corresponded with 0.7 µg/g mercury in the blood, 2.4 µg/g mercury in body feathers, 3.0 µg/g mercury in tail feathers, and 0.11 µg/g mercury in eggs. This study showed that songbirds can suffer negative reproductive effects at relatively low mercury concentrations. Krabbenhoft (pers. comm. 2008), reported mercury concentrations for Cape Sable seaside sparrows in the Everglades, based on juvenile and adult feather and egg samples collected in all subpopulations, as 0.7 to 2.5 µg/g in feathers and 0.1 to 0.45 µg/g in eggs, consistent with the levels Jackson et al. (2011) observed to reduce nest success.

More recently, Virzi et al. (2018) reported preliminary results of their study measuring methylmercury concentrations in CSSS tissue samples collected from 2016-2017. Researchers collected breast feather samples, a less invasive sampling technique than drawing blood, from 128 sparrows in 5 subpopoulations A, B, C, D and E. Mainly adult males were sampled as they are more easily caught, however, female and free roaming juvenile sparrow samples were also collected. Reported methylmercury concentrations were highest in the eastern subpopulations,

where known methylmercury hotspots have previously been identified, with CSSS-C reporting a mean concentration of 8.83 mg/kg (n=29, SE=0.84) and CSSS-D reporting 10.11 mg/kg (n=5, SE=4.57). The other subpopulations, located further west in the Everglades reported lower concentrations of Hg with CSSS-A reporting a mean of 3.25 mg/kg (n=19, SE=0.46), CSSS-B 4.61 (n=58, SE=0.34) and CSSS-E 3.83 mg/kg (n=12, SE=0.85). While Virzi et al. (2018) and other researchers such as Jackson et al. (2011) conclude that these levels are high enough to cause sublethal impacts to reproductive success, it is interesting to note that the sparrow with the highest concentration of methylmercury in the study successfully fledged three young in a single nest. However, in general, those birds showing the lowest concentrations of methylmercury had the highest reproductive success (Virzi et al. 2018). It is believed that Hg levels in blood samples will provide the strongest correlation to impacts on reproductive success, so researchers are currenly planning for this study in the near future.

2.8.9 Conservation Actions by Others

The DOI (NPS, USGS and Service) developed a Memorandum of Understanding (MOU) outlining actions that are intended to benefit the CSSS (Service 2015). The MOU includes actions such as habitat management, research on population trends and estimates, improved information on genetics, and preparing for the potential need for captive breeding and translocation. Actions completed or ongoing since inception of the MOU are summarized by agency below. This list may not be complete but demonstrates progress towards completing priority actions.

Service

- Continue providing annual funding, barring any constraints, for intensive demographic monitoring.
- Working closely with USGS and ENP on model development and surveys.
- Working with researchers on draft population estimator and translocation studies.
- Coordinating with SFWMD on CSSS-D burn plan. Burn took place this year.

ENP

- Provides annual funding for helicopter range-wide surveys.
- Conducting a 5-year marl prairie vegetation study.
- ENP long term fire management plan.
- Providing funds to USGS for model development.
- Provided funding for a project to measuring fine scale microtopography throughout CSSS habitat with LIDAR.
- Continued woody vegetation control near CSSS-E.
- Funded mercury and DNA studies.
- Coordinating with SFWMD on CSSS-D burn plan.

USGS

- Maintaining the Sparrow Viewer and Sparrow Helper applications.

- Providing modeling support.
- Developing HSI criteria for CSSS habitat.
- Measuring fine scale microtopography throughout CSSS habitat with LIDAR.

The SFWMD is making progress on the removal of the old Tamiami Trail between S-12B and S-12D. Contractors have begun clearing the old Tamiami Trail roadway and removed the S-346 Bridge on March 12, 2020. Road removal will begin in earnest once Florida Power and Light relocates the overhead powerlines. Completion of this project is scheduled for January of 2022. This action is expected to protect CSSS-Ax from backwater effects caused by flows from S-12C/D. The ERTP 2010 BO evaluated replacement of the existing culvert in the old Tamiami Trail borrow canal with a plug. CEPP evaluated removal of the old Tamiami Trail roadway but did not include backfill of the adjacent canal.

Since 2016, the SFWMD has completed several habitat enhancement actions in and around CSSS-D as part of their commitments under the C-111 Spreader Canal Project. From 2015 to 2018 they treated approximately 4,200 acres for invasive woody vegetation (primarily cypress) that was encroaching into sparrow critical habitat. Between 2018 and 2019, an additional 1,200 acres surrounding the CSSS-D core nesting area underwent woody vegetation removal. In addition to these actions, the District has reduced ponded surface water in and around CSSS-D by gapping remnant roads formerly associated with the Aerojet missile facility. This is believed to have aided in the movement of water south and away from the core nesting area, however, it has not been confirmed though an analysis of available hydrologic gauge data. The District, in coordination with other State and Federal agencies, has also conducted prescribed fires in and around CSSS-D that benefit the habitat in this area.

The Service, in conjunction with its State and Federal partners, would like to consolidate what we've learned from the projects above and focus efforts on establishing suitable marl prairie habitat in areas that have either been formerly occupied by sparrows or in those areas where hydrologic modeling indicates a shift towards appropriate hydrology (*e.g.*, CSSS-Ax and areas east of CSSS-E). Much of the recent focus has been on restoring the hydrology in these areas, which remains the biggest driver in shifts in CSSS suitable habitat, however, habitat management via other means is also important. Several aspects of this approach have already been implemented by ENP, SFWMD and others (*e.g.*, woody vegetation removal, prescribed fire close to but not in core CSSS nesting areas, etc.) so the framework and tasks may vary. In general, the Service would like to see increased vegetation monitoring in these areas, if necessary, to establish a baseline and means of monitoring vegetation shifts. Once the baseline is defined, and in conjunction with existing hydrologic monitoring, mechanical means of habitat management such as prescribed fire and 'seeding' vegetation species which define optimal sparrow habitat (*i.e.*, Muhlenbergia) should be employed. Combining a more habitat-based management plan with restoration projects designed to correct unnatural shifts in hydrology could greatly improve habitat conditions in the upcoming years and thereby improve the outlook for the sparrow.

2.9 Environmental Baseline – Cape Sable Seaside Sparrow

The environmental baseline is an analysis of the effects of past and ongoing human and natural factors leading to the current status of listed species, their habitat (including designated critical habitat), and ecosystem within the action area. It is a "snapshot" of the species' health and critical habitat conditions in the action area at the time of the consultation and does not include the effects of the action under review.

Since the action area includes the entire range of the CSSS there is no difference between the status of the species in the action area and the status of the species. Refer to section 2.1 for details.

2.10 Summary and Analysis of Effects of the Action

Effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (50 CFR 402.02).

The evaluation method used to assess the effects of ERTP 2016 on the CSSS in the 2016 BO was different than that outlined in the preceding ERTP 2010 BO which was similar to the 1999 Biological Opinion on the MWD Project, the Experimental Program, and the C-111 Project and the 2002 BO on IOP. The ERTP 2016 BO used the Sparrow Viewer to provide regional and subpopulation-specific views of hydrologic conditions in close to real time. The Sparrow Viewer reduces the reliance on single gauges, such as NP-205, and displays results based on extrapolated hydrologic surfaces over the entire range of the species. One example of how this new evaluation method has improved our understanding of the effects of the project on the species can be seen by comparing the NP-205 output with the Sparrow Viewer output. It was previously believed that a stage of 6.01 ft NGVD at NP-205 would result in 40 percent of CSSS-Ax being dry. The Sparrow Viewer demonstrates that this stage only provided dry conditions over approximately 25 percent of the habitat, much less than what was expected. This BO will continue to use the Sparrow Viewer in its evaluation of hydrologic benefits and/or impacts to sparrows. RSM model runs of the various alternatives for the COP were run through the sparrow viewer utility for the first time providing consistent post-processing for observed data as well as model output.

The proposed action being evaluated in this Biological Opinion is the Combined Operational Plan (COP) which is the next iteration of operational plans for the completed MWD and C-111 SD Projects. Hydrologic conditions predicted by the model for the previous ERTP Biological Opinions were expected to maintain the CSSS population, but the species has continued to have low population numbers. The Service has reviewed the Corps' annual assessments (Corps 2016, 2017, 2018 and 2019) in analyzing the effects of the currently

proposed action. Hydrologic impacts to sparrow nesting and sparrow habitat have been documented as part of the analyses in these reports and are expected to continue with slight improvements while shifting locations of suitable habitat within the subpopulations. It is likely that some impacts will continue until proposed CERP projects are implemented and additional system-wide restoration is complete. The implementation of the COP is anticipated to decrease the frequency and intensity of previously documented impacts in northern CSSS-Ax and CSSS-F while increasing the chances of impacts in southern CSSS-Ax, CSSS-E and CSSS-D.

Managed water releases through the S-12 structures and the S-343A and B structures have a direct effect on the hydrologic condition within CSSS-Ax, which is located immediately downstream from these structures. These structures have varying effects on the hydrology in sparrow habitat which is reflected in the hydrologic modeling as well as in actual practice. As an example, the S-12A structure gates were partially opened due to high water in WCA-3A during the 2016 CSSS breeding season to prevent overtopping of the structure. The S-12A gate was opened to allow the equivalent amount of water that would have otherwise been released by overtopping in accordance with the 2012 Water Control Plan. Uncontrolled overtopping of the structure could have resulted in risk to the integrity of the structure. A noticeable increase in groundwater and surface water was detected five days later at NP-205. However, the individual effects of each structure on hydrologic conditions in the area have not been well established through field measurements. The S-12A structure is assumed to have the greatest direct influence on hydrologic conditions within sparrow subpopulation A due to its location immediately upstream of CSSS-Ax, followed by S-12B, C and D to a lesser extent.

Additionally, it is clear that construction and operation of the C&SF Project has diverted the historic flow path to the west, significantly increasing the amount of water in the vicinity of the S-12 structures and CSSS-Ax. The most significant difference between ERTP and the COP is the latter's ability to redistribute large amounts of water east into its historic flow path. This is anticipated to have beneficial effects in CSSS-Ax and drier subpopulations to the east while also impacting southern CSSS-Ax and western portions of CSSS-E. For these reasons, and because the shift of flow away from the S-12s, we have concentrated much of our evaluation on the effects of the proposed project on CSSS-Ax and CSSS-E.

2.11 Cape Sable Seaside Sparrow Evaluation Criteria

The South Florida Water Management District (SFWMD) in conjunction with Corps hydrologic modelers produced an extensive set of modeling results for an array of project alternatives using the iModel and Regional System Model (RSM). For purposes of this evaluation, consistent with the Corps Biological Assessment (Corps 2019a), performance of the preferred alternative ALT Q+ is compared to the Existing Condition Base (ECB19RR). While ALT Q+ was not independently modeled its performance is expected to be very close to the performance of ALT Q while including a few minor adjustments that were modeled in sensitivity runs. The previously described nesting and habitat criteria ware evaluated using the Sparrow Helper tool which runs the RSM model output through the same post processing routine that the Sparrow

Viewer does on observed or real time data. The Marl Prairie Habitat Suitability model produced and run by the USGS and its Joint Ecosystem Modeling lab was also used.

One issue with the ECB19RR that was identified by the Service and others after the first round of modeling, is that it contains features and operations associated with the Modified Water Deliveries (MWD) projects Increments 1.1, and 1.2, which already move half of the water east that is intended to be moved under the COP. This has the effect of masking the benefits and/or impacts of this water movement by the project alternative because it is already in the ECB19RR run. While the increments did undergo NEPA analysis they were not modeled, so the lift they provide above the ERTP existing condition is not quantifiable. Where appropriate in the following analysis we will compare the ECB19RR to 'observed' data to provide a better idea of the range of benefits or impacts which may be observed.

2.11.1 General Hydrology

The primary goal of the COP is to define an operating plan for the constructed elements of the Modified Water Deliveries to Everglades National Park project and the C-111 SD projects to enhance the delivery of water from WCA-3A into Northeast Shark River Slough. The COP utilizes both constructed features, such as the bridges and road raising in the Tamiami Trail Modifications (which allows increased stage in the L-29), as well as operational features like the Tamiami Trail Flow Formula to achieve a large part of the goal to redistribute flows eastward and restore Northeast Shark River Slough.

On average, ALT Q will move an additional 229,000 acre-feet per year (more than enough to cover Manhattan with 9 feet of water) into NESRS above that in the ECB19RR (Table 5). This includes a 142,000 acre-feet per year increase during the dry season (November to May) and an 87,000 acre-feet per year increase during the wet season (June to October) for a total flow amount crossing Transect 18 (Figure 9) of 561,000 acre-feet per year on average. This achieves about 40 percent of the restoration flows compared with flow estimates under the CERP of 1.4 million acre-feet per year. Once the rest of the Tamiami Trail is modified and water levels in the L-29 can be raised from 8.5 feet NGVD to 9.7 feet NGVD, more capacity will be available. Observed flows across this transect had averaged 105,000 acre-feet per year from 2012 to 2015. This increased to an average of 300,000 acre-feet per year during the period between 2016 and 2019 when Increments 1.1, 1.2 and 2 emergency high water actions were implemented. The ECB19RR, which includes Increments 1.1 and 1.2, estimates a similar flow volume of 332,000 acre-feet per year.

Research on flows in the pre-drainage Everglades, using the "Natural System Model" developed for CERP, showed that the eastern half of the Shark River Slough, including NESRS, had originally carried 65 percent of the Everglades flows, with only 35 percent going to the western half. Conversely, the routing under the C&SF Project put 78 percent of flows to the west, and only 22 percent through NESRS (Corps 1999). According to the modeling, the COP is expected to reverse this trend by shifting flow to the east and creating a flow distribution of 76 percent to the east and 24 percent to the west across the Tamiami Trail. The resulting flow across Transect

17 (western transect) will be a decrease of 67,000 acre-feet per year from 239,000 acre-feet per year in the ECB19RR to approximately 172,000 acre-feet for ALT Q (Table 5). Transect 17 flows will become 80,000 acre-feet per year during the dry season and 92,000 acre-feet per year during the wet season under the COP. This results in flow reductions at the S-12A structure (Table 5) from 29,800 acre-feet per year under ECB19RR to 21,400 acre-feet per year under ALT Q (reduction of 8,400 acre-feet). S-12B will see a reduction in flow of 10,000 acre-feet per year from 34,900 to 24,900 acre-feet per year under the COP.

This change in flow distribution is what the Service and other agency and Everglades scientists have been asking for since 2000. Not only will this benefit sparrows and other threatened and endangered species but all the natural resources in ENP and Florida Bay. This movement of water is expected to result in benefits to sparrows in CSSS-Ax by lengthening the duration of nesting season conditions and reducing hydroperiods that have significantly impacted the suitability of nesting habitat in this area. Similarly, it should help the drier areas in the eastern prairies like CSSS-F by making them wetter. CSSS-E, located in the middle of ENP just east of Shark Slough, will see the most impact from the COP as its western edge has been densely populated by sparrows. Close monitoring of this subpopulation will need to continue to see how the sparrows react to the changes in hydrology resulting from this project. The leading hypothesis is that habitat conditions will shift with changing hydrology and that the sparrows in CSSS-E will follow this shift in their habitat eastward to areas that will have improved hydrology resulting from the COP. The following sections will assess the model output to quantify the benefits/impacts from the movement of water outlined above. Reference the Corps Biological Assessment (Corps 2019a) and other species sections of this Biological Opinion for estimated changes in hydrology in WCA-3A, 3B and other areas north of ENP.

2.11.2 Nesting Criteria

Sparrows nest close to the ground surface with an average early season height of 6.3 inches and 8.3 inches later in the nesting season when water levels begin to rise (Lockwood et al. 2001). Water levels that rise above ground surface within occupied sparrow habitat, as a result of natural rain events or water management operations, may cause nest flooding and failure, increased predation, and a period of mating inactivity (male sparrows stop singing) which may reduce nesting success (Nott et al. 1998; Boulton et al. 2007; Baiser et al. 2008).

One important hydrologic measure of the potential for CSSS nesting success is the number of consecutive days between March 1 and July 15 (total of 137 days) that water levels are near or below ground surface. The range of dates used for the nesting season incorporates roughly 84 percent of the time between the earliest and latest recorded nests (Pimm et al. 2002) and is an indirect measure of the number of days potentially available for sparrow courtship and nesting (Van Lent et al. 1999). Pimm et al. (2002) estimates the nest cycle, including the number of days required for all the nesting stages (nesting, egg laying, incubation, and fledging), of CSSS to range from 34 to 44 days.

This metric has evolved over the years along with the science and analytical methodologies used to evaluate it. The Sparrow Viewer analysis proved that the NP-205 trigger stage of 6.01 feet NGVD was not providing 40 percent dry habitat rather it was closer to 25 percent (Service 2016). Additionally, previous research has indicated that a minimum of two successful nesting periods (at least 80 days), during the majority of years was considered essential to maintain a stable and viable CSSS population. A target for subpopulation Ax of at least 80 consecutive nesting days in all years until sparrow numbers have increased to at least 1,000 individuals has also been suggested by researchers (Walters et al. 2000; Pimm et al. 2002).

Considering the current status and past performance of CSSS reproduction, the Service has determined that nesting conditions provided previously were not sufficient to provide for increasing population numbers. In order to keep CSSS-Ax extant and to begin recovery of the species as a whole, water management actions should strive to provide nesting conditions which include at least 90 consecutive dry nesting days (equivalent to at least two, and possibly three broods) over 24,000 acres of the CSSS-Ax in every year until there are enough birds to sustain yearly population growth. The Sparrow Viewer analysis indicates that CSSS-Ax only met the target of 90 consecutive dry days over 40 percent of the habitat in 8 out of 29 years from 1991 to 2019. The reduction in nesting durations and amount of breeding habitat that have been provided throughout the period of record have not allowed the subpopulation to recover from the precariously low level which began in 1993. If these poor conditions continue, we can be expected to see further diminishment of the sparrow's numbers, reproduction, or distribution. The currently proposed action, with its shift of flow eastward into the historic flow path, is anticipated to improve hydrologic conditions in the western marl prairie and provide benefits to CSSS breeding success in CSSS-Ax.

CSSS-Ax

Performance of the nesting criteria under the COP as compared to the ECB19RR by subpopulation and for the period of record (POR) 1965 to 2005 is in the Corps' Biological Assessment (Corps 2019a). The number of years in which the target of 40 percent of the habitat experienced 90 or more dry nesting days is 20 of 41 years for the ECB19RR and 18 of 41 years for ALT Q. The average percentage of habitat across the POR that meets the target is 46.2 percent for ECB19RR and 44.2 percent for ALT Q a decrease of 2.0 percent. If either of these modelled alternatives performed similarly in the field as they do in the model, this would represent a significant benefit to areas within CSSS-Ax.

Table 6 is a partial reproduction of the Corps' table from their BA (Corps 2019a) with an additional column of years with overlapping POR from the EDEN Sparrow Viewer observed data (1991-2005). It is not standard practice to compare observed data with model data, however, in this case it is important to see the difference between modeled ECB19RR and observed existing condition because there may be more benefit from ALT Q than is visible in its comparison to the modeled ECB19RR. The average percentage of CSSS-Ax that meets the 90 continuous dry days over 40 percent of the area criteria drops to just 20.7 percent from 1991 to 2005 for the observed condition, a decline of 19.3 percent from the modeled ECB19RR during

this same time (40 percent). The benefit of ALT Q could be much higher if it were compared to the observed existing condition. This could be due to the issue discussed earlier where the modeled ECB19RR already includes a large amount of flow to the east.

CSSS-E

The number of years in which the target of 40 percent of habitat in CSSS-E experienced 90 or more continuous dry nesting days within 40 percent of the area is 27 of 41 years for the ECB19RR and 23 of 41 years for ALT Q. The average percentage of habitat meeting the requirement across the POR is 57.7 percent for ECB19RR and 50 percent for ALT Q which is a difference of -7.7 percent (Corps 2019a). While the average difference in the areal extent this metric is met across the POR is a reduction of 7.7 percent, there are 8 years when it is more than a 20 percent reduction (1966, 1967, 1969, 1986, 1992, 1996, 2000, and 2002). In four of these years the reduction causes the target to be missed. There are an additional four years with greater than 10 percent reduction in the area in which this target is met (range is 0.0 to 28.2 percent reduction). To put this into perspective, 20 percent of CSSS-E is 5,045 acres. Pimm et al. (2002) documented territory size range of 3.0 to 11.1 acres (1.2 to 4.5 ha) based on observations of known breeding pairs. A significant change in hydrology across 5,045 acres of currently occupied habitat in CSSS-E could disrupt and displace many nesting attempts.

Table 7 is a partial reproduction of the Corps' table for CSSS-E from the BA (Corps 2019a) with an additional column of years with overlapping POR from the EDEN Sparrow Viewer observed data (1991-2005). It is evident that the ECB19RR already contains a large portion of the redistributed flows eastward. The observed data shows the average area in which this target is met is 61.3 percent vs the modeled ECB19RR which shows 51.4 percent. If the observed data were used as the baseline, ALT Q would show a reduction of 17.2 percent in the area of CSSS-E where the target is met instead of the modeled 7.3 percent. This is not to say that the observed data is more accurate and should be substituted for the model base, however, it illustrates that the model may be over or underestimating the impacts/benefits of ALT Q.

CSSS-D

From the table in the Corps BA (Corps 2019a), the number of years in which the target of 40 percent of CSSS-D experienced 90 or more continuous dry nesting days over 40 percent of the area is 24 out of 41 years for the ECB19RR and 21 of 41 years for ALT Q. This is the second worst performing subpopulation at 53 percent of the years meeting target, second to CSSS-Ax which meets the target 45 percent of the time. CSSS-E meets the target in only 58 percent of years under ALT Q. Similar to CSSS-E, the average difference in the areal extent this metric is met across the POR for CSSS-D is a reduction of 7.2 percent. However, in 11 of the years the average reduction in areal extent meeting the target was 23.4 percent with a range of 14.7 - 41.9 percent; 23.4 percent of CSSS-D is equal to 2,275 acres.

In reviewing the overlapping observed data for this metric from 1991 to 2005 (Table 8) the ECB19RR run increases the average areal extent in which the target is met by 12 percent. The

ECB19RR also meets the target in more years out of the period of record. These indicate a sizeable benefit to CSSS-D but it is unclear why the performance drops again under ALT Q (a reduction of 11.9 percent). For the period 1991 to 2019 the sparrow viewer shows that this target has been met 48 percent of the time which is similar but slightly lower than the 41-year POR modeled percentage of 53 percent.

Subpopulations B, C and F meet the target 88, 90 and 73 percent of the POR respectively and ALT Q performs similarly to the ECB19RR with regards to the percentage of area meeting the target. As compared to the ECB19RR, ALT Q indicates that CSSS-C and F will experience increases in the areal extent in which the target is met in most years.

In summary, performance for this metric was as expected with a slight reduction in performance in CSSS-Ax for ALT Q versus the ECB19RR, however, both the ECB19RR and the alternative perform much better than the observed data from Sparrow Viewer from 1991 to 2019. CSSS-E exhibits moderate impacts when comparing ALT Q to ECB19RR and these may be underestimated due to the ECB19RR already containing flow eastward from Increments 1.1 and 1.2. Later, in this analysis, the marl prairie suitability index is used to determine the areal extent of benefit/impact in and around CSSS-Ax and CSSS-E. The ECB19RR performs the best for CSSS-D, however performance of the project falls off considerably to levels closer to the observed data from 1991 to 2005. The Corps, State, and other Federal partners should continue to monitor CSSS-D closely to see if the project makes conditions worse, per the modeling, or if conditions stay relatively the same.

2.11.3 Habitat Criteria

The average annual discontinuous hydroperiod required to maintain the wet prairie habitat where the CSSS currently resides is an important measure used to determine the effects of water management scenarios on the sparrow. Studies by Sah et al. (2007), confirm reports by Pimm et al. (2002), that sparrow habitat can remain suitable after experiencing hydroperiods up to 210 days, however, extended periods with annual hydroperiods of more than 210 days will shift the habitat from short hydroperiod marl prairie to wetter marsh habitat types unsuitable for sparrows. After review of the pertinent research, the target discontinuous hydroperiod for ERTP 2016 and future Biological Opinions was designated to be 90 to 210 days (Service 2016).

Consistent with past evaluations, maintaining and restoring sparrow CSSS-Ax is essential to maintaining the overall sparrow population. CSSS-Ax has the potential to contribute to improved population resiliency more than any other subpopulation because it is the most isolated and geographically separated from the other sparrow subpopulations, thereby providing the greatest protection from risks associated with local catastrophic events. Additionally, because of the amount of potential habitat available it has the potential to support large numbers of sparrows. The extirpation of CSSS-Ax would represent a significant reduction in the distribution of the CSSS and given its location and current condition, would be a challenging area in which to reestablish a self-sustaining subpopulation if it were lost. Walters et al. 2000, stated "Recolonization of Population A is most problematic because of its isolation from the other

populations by distance and barriers, especially Shark River Slough." Walters et al. 2000 goes on to conclude that, "…under the current water management strategy, near-term extinction of Populations A and D are real possibilities." As predicted in 2010, ERTP has not improved the status of this subpopulation but has kept it viable in anticipation of improved hydrologic conditions resulting from the MWD, C-111 SD and the COP.

Since 2016, the Service has been working closely with the Corps within the bounds of Increments 1, 1.1, 1.2 and 2 water management operations to provide improved hydroperiods within the marl prairies through movement of water eastward to the head waters of Shark River Slough under the Tamiami Trail Modifications 1-mile and 2.6-miles bridges. Additional inter-agency coordination has occurred during periodic scientist calls and weekly operations calls with SFWMD. ENP (2005) stated that "hydrologic processes, such as the timing, depth and distribution of water, are the primary drivers of CSSS habitat suitability and a primary resource that can be managed in Everglades restoration." It is evident that a major shift in how water flows through the Everglades is necessary to continue protection of the CSSS. The COP is anticipated to provide that shift.

The proposed implementation of the COP is expected to significantly change the hydrologic pattern provided by previous operational plans across all of sparrow habitat. With the average annual movement of 229,000 acre-feet of water to the east (in addition to the roughly 200,000 acre-feet per year from the Increments), hydroperiods in CSSS-Ax should be reduced. Analyses following in this document will determine how many acres in northern CSSS-Ax may be improved versus the acreage in the southern portion that may be negatively impacted by Shark River Slough flow moving westward toward this area. Additionally, areas in the eastern marl prairies which have been impacted by too little flow are expected to benefit. These areas include CSSS-F and the areas in between CSSS-E and C. The second largest subpopulation CSSS-E will see the most impacts from the COP where restoration of flow through Shark River Slough will cause the western edges of this subpopulation to become wetter and less suitable for sparrows. The following analysis assesses the impacts, as well as the benefits, each area is expected to experience as a result of the COP.

Modeled performance of the habitat criteria under the COP, compared to the ECB19RR, for each subpopulation during the period of record (POR) 1965 to 2005 is in the Corps' Biological Assessment (Corps 2019a). The Corps analyzed this metric as the percent of the habitat within the subpopulation (target is 40 percent) that meets a four-year running average discontinuous hydroperiod between 90 and 210 days and does not miss the target in two consecutive years.

CSSS-Ax

The observed 1-year and 4-year hydroperiods for CSSS-Ax during the period of record 1991 to 2020 is presented in Table 4. The averages for the 1-year and 4-year hydroperiods are generally within a day or two of each other so on occasion the following analyses will be looking at the 1-year hydroperiods depending on availability. The results of this metric are similar to that of the nesting metric in that CSSS-Ax only meets the target in 14 out of 41 years for the ECB19RR

and ALT Q and the average area in which the target is met is 26 percent for ECB19RR and 25 percent for ALT Q. The results of the model indicate that the target of 90 to 210 days is not met in the majority of years. The ECB19RR and ALT Q report a modeled average annual hydroperiod of 242 ± 56 and 243 ± 57 days respectively (Corps 2019a). For comparison, the observed average annual hydroperiod as reported by the Sparrow Viewer from 1991 to 2019 is significantly higher (286 ± 37) (Table 9). This could mean a reduction in 43 days on average of hydroperiod in CSSS-Ax which would significantly increase the area meeting the target of 210 days in areas with higher ground surface elevation. The marl prairie habitat suitability index analyzed later in this section will quantify the areas where this benefit may be realized.

Comparison between ECB19RR and ALT Q shows no difference, however, when the observed data for the POR 1991 to 2005 is added, there is a significant improvement in performance (Table 10). The percent area meeting the 90 to 210-day discontinuous hydroperiod target from 1991 to 2005 in the observed data is only 12 percent versus the ECB19RR's 21 percent and ALT Q's 22 percent. This represents a potential 10 percent increase in the area of CSSS-Ax that meets the target (roughly 8,215 acres). It is difficult to determine the magnitude of difference between observed data and the modeled ECB19RR, however, since the Increments have demonstrated their ability to move water east and with the COP predicting additional flow to the east, it is reasonable to assume that ecological lift in CSSS-Ax is possible. However, the reverse of this trend could also be true for the western portions CSSS-E on the eastern side of Shark Slough.

CSSS-E

Results of the habitat metric in CSSS-E as reported in the Corps BA (2019) demonstrate that the 90 to 210-day discontinuous hydroperiod target is met in 28 of 41 years for the ECB19RR but drops to 24 of 41 years in ALT Q. The average area within CSSS-E that the metric is met with ECB19RR is 44 percent for the 41-year POR. It drops to 39 percent of the area on average (a decrease of 5 percent) for ALT Q. While the POR indicates an average reduction of 5 percent, individual year differences range from +3 to -16 percent. Eleven years in the POR show an 8 to 16 percent reduction in area where the target is met. For perspective, 5 percent of CSSS-E equals 1,261 acres.

The ECB19RR and ALT Q report a modeled average annual discontinuous hydroperiod of 204 ± 64 and 217 ± 65 days respectively (Corps 2019a). This is compared to the observed average annual hydroperiod as reported by the Sparrow Viewer from 1991 to 2019 of 199 ± 53 days (Table 9). The difference between the observed data, ECB19RR and ALT Q is not as drastic in this area, however, ALT Q could increase the average hydroperiod in CSSS-E by 18 days, pushing the average outside the target range of 90 to 210 days. Additionally, Table 11 shows the side by side comparison of the observed data from Sparrow Viewer, ECB19RR and ALT Q with regards to the percentage of area within CSSS-E that meets the target. It is not common to compare observed data to model data, however, in this instance it is given to demonstrate the possible range of impacts in CSSS-E. Observed conditions from 1991 to 2005 in CSSS-E showed an average of 40 percent of the area meeting the target. During this same

period (1991-2005), the ECB19RR only met the target in 32 percent of the area and the project alternative ALT Q lowers it further to 29 percent.

CSSS-D

Results of the habitat metric in CSSS-D as reported in the Corps BA (2019a) show that the target 90 to 210-day discontinuous hydroperiod is met in 34 of 41 years for the ECB19RR but drops to only 18 of 41 years for the ALT Q. The average percentage of area meeting the target also drops from 57 percent in the ECB19RR to 37 percent in ALT Q. The difference in the percent area meeting the target for individual years range from +6 to –47 percent. Nearly half of all years in the 41-year POR show a reduction of 20 percent or more in the area meeting the target for ALT Q when compared to ECB19RR. Twenty percent of CSSS-D equals 1,945 acres. This is a concerning result for one of the smaller subpopulations that has been plagued by long hydroperiods for years.

Table 9 shows that CSSS-D has an average annual hydroperiod of 188 ± 46 days for the ECB19RR, 214 ± 50 for ALT Q, and 225 ± 46 for the observed data. This shows ECB19RR as the best performing alternative while ALT Q increases the average annual discontinuous hydroperiod to 214 days which is slightly outside the target range of 90 to 210 days, but ALT Q still performs better than the observed condition. Table 12 shows the percent area of CSSS-D that meets the 90 to 210-day hydroperiod for the ECB19RR, ALT Q and observed data from the sparrow viewer during the years 1991 to 2005. In this case the observed data and ECB19RR perform similarly with 43 and 44 percent of the area in the target window respectively, however, the performance of ALT Q falls off with only 28 percent of the area meeting the target. The model results indicate that ALT Q becomes wetter with 67 percent of the area experiencing hydroperiods ≥211 days.

CSSS-B, C, and F

Subpopulations B, C and F meet the target across 50 percent of their respective areas for ALT Q during the POR. ALT Q also performs similarly to the ECB19RR with regards to the percentage of area meeting the target in these subpopulations. CSSS-C experiences an increase of 4 percent areal extent in which the target is met under ALT Q, while CSSS-F sees a slight decline by 2 percent compared to ECB19RR. CSSS-B shows no change in areal extent the target is met between the ECB19RR and ALT Q (50 percent). This, however, is an increase from observed data in CSSS-B between 1991 and 2019 that shows the average area meeting the target was 35 percent.

Summary

In summary, the model does not show the anticipated lift ALT Q will provide as compared to the ECB19RR. This is assumed to be due to ECB19RR already including several major components of the COP which were initiated under Increments 1, 1.1, and 1.2. When compared to the observed data from the Sparrow Viewer there is potential for a significant increase in the area of

CSSS-Ax that will meet the target of 90 to 210-day average annual hydroperiod. CSSS-E exhibits moderate impacts when comparing ALT Q to ECB19RR and these may be underestimated due to the ECB19RR already containing flow eastward from Increments 1.1 and 1.2. As compared to observed data, within the overlapping period of record (1991-2005, Table 11) ALT Q could reduce the area meeting the target in CSSS-E by 11 percent. CSSS-D displays a significant reduction in years meeting the target as well as a reduction in areal extent in which the target is met. Monitoring of this subpopulation during the next several years will need to continue to make sure the hydrology is not shifted so far as to make it unsuitable for sparrows.

2.11.4 Marl Prairie Indicator

The Joint Ecosystem Modeling lab which is a part of the USGS Wetland and Aquatic Research Center produces several decision support tools that help relate hydrologic change, as predicted by models, to effects on species and habitats within the Everglades ecosystem. One of these tools, incorporated into the analysis below, is the Marl Prairie Indicator which is different than the two hydrologic metrics discussed previously. This model combines several hydrologic attributes such as maximum dry days, wet season water depth, and dry season water depth, with CSSS occupancy data to provide a more holistic visualization of how the proposed action may affect marl prairie habitat (Pearlstine et al. 2014). For more detailed information on this ecological model visit https://jem.gov/Modeling.

Figure 10 shows the results of the Marl Prairie Indicator through three maps; the habitat suitability of the ECB19RR (upper left), the habitat suitability of the project alternative ALT Q (lower left) and a map of the difference between ALT Q and ECB19RR in the lower right corner. Table 14 summarizes the acreage of differences within each subpopulation. The results of this tool generally track the changes we see from the previously analyzed hydrologic metrics in that it shows that northern CSSS-Ax is expected to exhibit slight improvements while southern CSSS-Ax, CSSS-D and CSSS-E will see moderate to high impacts.

As evidenced by the ALT Q - ECB19RR difference map, located in the bottom right of figure 10, the northern half of CSSS-Ax will see an increase of 1 to 20 percent towards meeting the marl habitat suitability target while the southern half of CSSS-Ax will see a 1 to 20 percent reduction in target met. In order to put these differences in perspective it is beneficial to look at the ALT Q map to see what the percent to target in these areas is under the project. Some of the most suitable habitat in CSSS-Ax is located in the northeast section and this area will be made slightly better.

The lower half of CSSS-Ax, where the ECB19RR and ALT Q show marginal habitat in the 30 to 40 percent category on averageis expected to experience habitat degredation. The difference map shows that about 27,480 acres (33.4 percent of total CSSS-Ax) will see a reduction in marl prairie suitability between 1 and 20 percent. This could shift this habitat out of reach for restoration in the future. Another hydrologic metric that may help explain the increase in hydrology in southern CSSS-Ax is east to west flows across transect 20 (Figure 9). Modeling

shows that this transect will see an average annual increase in flow under ALT Q, compared to ECB19RR, of 127,000-acre feet per year.

Approximately 18,402 acres or 83 percent of the total area in CSSS-E will see a decline in marl prairie habitat suitability of between 1 and 20 percent but the majority of this area will remain as suitable habitat and should remain occupied. This decline in suitability shows the general wetting trend that will occur in this subpopulation. An additional 523 acres in the northeast tip will see a reduction of 21 to 40 percent. This is currently occupied habitat with a high suitability score that could see damaging hydrologic shifts. ECB19RR and ALT Q show a large portion of the western edge of CSSS-E, adjacent to Shark River Slough, as already poor habitat. This poor-quality habitat will likely become unsuitable as a result of increased flows due to the project. It is encouraging to see that 1,557 acres of eastern CSSS-E are expected to have an increase of 1 to 20 percent in habitat suitability and the map shows additional acreage east of this, between CSSS-E and CSSS-C, which is also expected to see increased habitat suitability. Even though the model indicates improvements to habitat suitability, the area between the two subpopulations is not currently suitable for sparrows and management actions are necessary to make this area suitable. The Marl Prairie Indicator model already shows this area as 50 percent or more suitable in the ECB19RR and ALT Q maps, but it remains unoccupied indicating that there are more factors at play than what is considered in this model.

Results of this metric also for CSSS-D indicate that 9,506 acres, or 88 percent of this area, will see a decrease in percent of marl prairie suitability of 1 to 20 percent. CSSS-D also shows about 513 acres with a reduction of habitat suitability of 21 to 40 percent in the southeast corner. The southeast area is already poor quality habitat that is currently unoccupied by sparrows and will likely remain unsuitable with the COP. CSSS-D has been historically wet which has led to the core nesting area shrinking towards the highest points of the area just north and west of the center point. The model indicates that much of this area is already in the 50 – 60 percent habitat suitability range and substantial shifts towards wetter conditions could result in further losses in occupied habitat. Close monitoring and habitat maintenance in this area should continue in order to ensure it maintains the reproductive success seen in 2018-2019.

The majority of CSSS-F and CSSS-C will see slight increases in the marl prairie habitat suitability (1 to 20 percent). With the increase in flow to NESRS, as a result of the COP, the western and southwestern edges of CSSS-B outside of the main park road will see a decrease in marl prairies habitat suitability of between 1 and 20 percent. Field researchers and ENP scientists visit these areas frequently while monitoring CSSS so close observation of habitat conditions will continue in conjunction with standard hydrologic monitoring and vegetation surveys. The timing and volume of flows to NESRS, especially during the dry season will need to be monitored closely for effects to the shorter hydroperiod marl marsh on the flanks of SRS and Taylor Slough.

While it is expected that some currently suitable habitat will become wetter under the COP and future CERP projects, we must ensure through monitoring and habitat restoration actions that other portions of the sparrow’s habitat simultaneously become more suitable.

2.12 Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the Action Area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. Most of the lands in the Action Area for the CSSS are federally owned and managed. Therefore, the majority of impacts to CSSS and their habitat are anticipated to be related to future Federal actions that will require a separate consultation under the Act.

2.13 Conclusion

Research involving CSSS biology, population levels, demographics and habitat conditions have been conducted since the species was first described (Howell 1919) and more extensive research has been conducted since the first systematic population surveys in 1981. Beginning in 1993, the rapid decline in the CSSS population began to be documented, causes investigated, and its perilous status recognized.

Previous releases of water into habitat occupied by subpopulation Ax and the current inability to effectively manage water levels south of the S-12 structures have posed a significant risk to that subpopulation's continued existence. Additionally, frequent lack of sparrows within subpopulations D and F along with the increase in discontinuous hydroperiods experienced within subpopulation D since the construction of the C-111 Spreader Canal Project has resulted in an increased urgency to achieve substantial benefits for the species in order to avoid the possible near-term extinction of these subpopulations. The risk of extinction of the CSSS is substantially increased by the reduction of viable subpopulations from three to two and the decrease in distribution across the landscape.

Starting with the Service's jeopardy biological opinion in 1999, emergency actions were implemented to reduce the amount of water crossing western Tamiami Trail at the S-12 structures. In 2002, the Corps implemented its hydrologic equivalent to the Service's RPA which introduced the seasonal closures of the S-12 A/B/C, S-343 A/B and S-344 structures. The intent of these actions was to keep CSSS-A extant until MWD and components of CERP could be implemented. S-332D pumping restrictions were also incorporated during the sparrow nesting season to help protect CSSS-C. These actions have proved successful over the past 18 years while planning has progressed on CERP and the MWD and C-111 SD Projects are nearing completion through the COP. The Service is encouraged that the Corps will maintain these closures in COP (except the agreed upon removal of S-344 closure and relaxation of S-332D pumping prior to the nesting season). However, CSSS-Ax has experienced a significant decline in population as evidenced by the fact that zero birds were surveyed there during ENP's 2019 range-wide helicopter surveys for the first time since the surveys began. This is a possible indication that emergency protections enacted under the previous projects are not sufficient to prevent the extirpation of CSSS-A. The COP is anticipated to shift the paradigm for sparrows by

redistributing flows across Tamiami Trail with a majority going east into NESRS. With reduced hydroperiods in northern CSSS-Ax, increased hydroperiods in the eastern marl prairies (CSSS-C and F) and careful monitoring and adaptive management of CSSS-E and CSSS-D, the COP may move us one step closer in the process of recovery for the CSSS.

2.13.1 Summary of hydrologic metrics

Nesting window

Performance for this metric (provide at least 90 consecutive dry nesting days per year over 40 percent of each subpopulation) was as expected with a slight reduction in performance in CSSS-Ax for ALT Q versus the ECB19RR, however, both the ECB19RR and the alternative perform much better than the observed data from the Sparrow Viewer from 1991-2019. CSSS-E exhibits moderate impacts when comparing ALT Q to ECB19RR and these may be underestimated due to the ECB19RR already containing flow eastward from Increments 1.1 and 1.2. The ECB19RR performs the best for CSSS-D, however, modeled performance of the project falls off considerably to levels closer to the observed data during 1991 to 2005. The Corps, and State and other Federal partners should continue to monitor CSSS-D closely to see if the project makes conditions worse, per the modeling, or if conditions stay relatively the same. Subpopulations B, C and F meet the target 88, 90 and 73 percent of the POR respectively and ALT Q performs similarly to the ECB19RR with regards to the percentage of area meeting the target. CSSS-C and F experience increases in areal extent in which the target is met in most years under ALT Q as compared to ECB19RR.

Habitat Criteria

The model does not show the lift anticipated for ALT Q compared to the ECB19RR but when compared to the observed data from the Sparrow Viewer there is potential for a significant increase in the area of CSSS-Ax that will meet the target of 90 to 210 day average annual discontinuous hydroperiod. Similarly to the nesting criteria, CSSS-E exhibits moderate impacts when comparing ALT Q to ECB19RR and this may be underestimated due to the ECB19RR already containing flow eastward from Increments 1.1 and1.2. As compared to observed data, ALT Q could result in an 11 percent reduction in the area meeting the target. CSSS-D results in a decrease in the number of years meeting the target as well as a reduction in the areal extent in which the target is met. Monitoring of this subpopulation during the next several years will be necessary to make sure the hydrology is not shifted so far as to make it unsuitable for sparrows.

Marl Prairie Indicator

The Marl Prairie Indicator generally mirrors the hydrologic changes expected under the COP which shifts a significant amount of flow into NESRS and also increases flows to Taylor Slough especially during the dry season. The southern half of CSSS-Ax and nearly all of CSSS-E and CSSS-D will see declines in the percent to target met of between 1 and 20 percent. Some of the habitat that is shifting to a wetter regime was already poor habitat and could become completely

unsuitable for sparrows. The northern half of CSSS-Ax and areas northeast of this subpopulation and areas between CSSS-C and CSSS-E could see an increase in percent of target met between 1 and 20 percent. Most of the area outside of the currently delineated sparrow subpopulations already shows marginal habitat that could be improved with the project; however, these areas are currently unoccupied and there is considerable uncertainty as to whether they can be made suitable for sparrows to occupy without significant management actions. Work is continuing on the Marl Prairie Indicator to strengthen the relationship between changes in the index and response by sparrows through density and duration of occupancy. It is currently being interpreted as a general trend analysis to relate shifts in hydrology to potential habitat suitability changes.

Cape Sable seaside sparrows have a short life history (low annual survival and high fecundity), therefore they can be affected very quickly by anthropogenic changes that adversely affect sparrow breeding habitat. Given its short lifespan (2 to 3 years), the CSSS can experience rapid population declines over a short period of time if conditions severely limit or do not permit annual reproduction over several consecutive breeding seasons (Virzi et al. 2011).

The previous operational plans such as ISOP, IOP, and ERTP, have not been able to achieve substantial increases in desired dry days during the nesting season, improved discontinuous hydroperiod throughout the rest of the year, improved habitat conditions within the CSSS subpopulations, or reverse the decline in overall population numbers. The entire Everglades restoration community has been anticipating the implementation of the COP which is the culmination of the MWD and C-111 SD projects. This project will begin to remove major impediments to flow through the historic Everglades by restoring flow to NESRS and benefitting the entire Everglades ecosystem.

The continuing decrease in sparrow population in CSSS-Ax, with zero birds recorded there during the 2019 range-wide helicopter surveys, is a major concern. A few adults and two fledglings were observed during intensive demographic monitoring by field crews, but the outlook is troubling. The importance of recovering CSSS-Ax to a self-sustaining population can not be understated and several of the leading avian ecologists and sparrow researchers have published statements to this effect. A few are reproduced below. For a more complete list see the ERTP 2016 BO.

Walters et al. 2000, in The AOU Conservation Committee Review of the Biology, Status and Management of Cape Sable Seaside Sparrows: Final Report emphasized the following conclusions at that time relating to the status and vulnerability of CSSS subpopulations, especially CSSS-A;

> *"Continued releases of water into habitat occupied by Population A pose a significant risk to that population's continued existence. We conclude that under the current water management strategy, near-term extinction of Populations A and D are real possibilities. We further believe that retaining water in WCA-3A rather than releasing it west of Shark*

River Slough and into Taylor Slough in wet years will substantially reduce the risk of extinction of Populations A and D."

"The best available means to reduce the risk of extinction of the Cape Sable seaside sparrow is to retain and recover Population A. Population E should be monitored carefully while interim water management remains in place, because the persistence of this population also is important to the future of the sparrow."

"The risk of extinction of the total population obviously is increased by the reduction of the number of large populations from three to two." (*i.e.,* the loss of A, and persistence of B and E).

Ten years later, Slater (2009), as part of the preparation of an Emergency Management Action Plan for the Endangered Cape Sable Seaside Sparrow, observed;

"The sparrow population has shown no signs of recovery and we see little of the habitat restoration deemed necessary for their recovery. Therefore, we must emphasize that, without amending the conditions that led to the bird's initial decline, any implementation of emergency actions are prone to failure."

The Reasonable and Prudent Alternative to avoid jeopardy to the continued existence of the Cape Sable seaside sparrow described in the 2016 ERTP Biological Opinion had as its main component to finish the planning and implementation of the COP. The Service still believes, based on the best available scientific information, that this project will provide the greatest long-term benefit for all natural resources in the project area. There will be impacts to sparrow habitat on the eastern side of Shark River Slough, which were anticipated, but the Service feels that a concerted effort to monitor and adaptively manage the COP will reduce these impacts. After reviewing the current status of the CSSS, the effects of the proposed action and the cumulative effects, it is the Service's biological opinion that the Corps' proposed action is not likely to jeopardize the continued existence of the CSSS.

3.0 CAPE SABLE SEASIDE SPARROW CRITICAL HABITAT

3.1 Status of the Critical Habitat

This section summarizes the effects of all past human and natural activities or events that have led to the current status of designated critical habitat for the Cape Sable seaside sparrow and are relevant to formulating the biological opinion about the proposed action.

3.1.1 Critical Habitat Description and Status

Critical habitat for the CSSS was initially designated on August 11, 1977 (42 *FR* 42840). The critical habitat designation was revised on November 6, 2007 (Service 2007c; 72 FR 62736) and

the revised habitat included the following primary constituent elements (PCE), which are those physical and biological features essential for the conservation of the species:

1. Calcitic marl soils characteristic of the short-hydroperiod freshwater marl prairies of the southern Everglades. These soils support the unique vegetation community and probably many of the food items upon which sparrows depend. They also result from specific hydrologic conditions that are characteristic of the marl prairies. These soils are an integral component of sparrow habitat.

2. Herbaceous vegetation that includes greater than 15 percent combined cover of live and standing dead vegetation of one or more of the following species (when measured across an area of greater than 100 ft^2): muhly grass, Florida little bluestem, black-topped sedge, and cordgrass. These plant species are largely characteristic of areas where sparrows occur. They act as cover and substrate for foraging, nesting, and normal behavior for sparrows during a variety of environmental conditions. The species identified in the PCE consistently occur in areas occupied by sparrows (Sah et al. 2007), however, many other herbaceous plant species and low-growing forbs also occur within sparrow habitat (Ross et al. 2006), and some of these may have important roles in the life history of the sparrow.

3. Contiguous open habitat. Sparrow subpopulations require large, expansive, contiguous habitat patches with few or sparse woody shrubs or trees. This PCE provides the space for population and individual growth, and provides the open, contiguous habitat that sparrows prefer.

4. Hydrologic regime such that the water depth, as measured from the water surface down to the soil surface, does not exceed 7.9 inches longer than 30 days during the period from March 15 to June 30 more than 2 out of every 10 years.

The critical habitat designation, as amended in 2007 (Service 2007c; 72 FR 62736), designated five units as critical habitat for the CSSS. These critical habitat units represent the areas determined to be occupied at the time of listing that contain one or more of the characteristics that are essential for the conservation of the species (PCEs) and that may require special management (Figure 4). The units designated as CSSS critical habitat in the Action Area are: (Unit 1) marl prairie habitats that support sparrow subpopulation B and lie exclusively within ENP in the vicinity of the Main Park Road (State Road 9336), between SRS and Taylor Slough; (Unit 2) marl prairie habitat that supports sparrow subpopulation C within ENP along its eastern boundary in the vicinity of Taylor Slough; (Unit 3) marl prairie habitats that support sparrow subpopulation D in the state- owned and managed Southern Glades Wildlife and Environmental Area to the east of Taylor Slough and ENP; (Unit 4) marl prairie habitat that supports subpopulation E within ENP located on the eastern edge of SRS; and (Unit 5) marl prairie habitat that supports subpopulation F within ENP located just west of the S-332B pump station and detention area and L-31N canal.

Currently, critical habitat includes areas of land, water, and airspace in the Taylor Slough vicinity of Collier, Miami-Dade, and Monroe Counties. Much of this area is within the boundaries of ENP. The designated area encompasses about 84,865 acres and includes subpopulations B through F (Figure 3). Subpopulation A is not included as part of the critical habitat. It was excluded per the Secretary's discretion as described in 50 CFR 62736.

The following descriptions summarize baseline conditions in critical habitat Units 1, through 5.

Unit 1 (Subpopulation B)

Unit 1 consists of 39,029 acres of marl prairie and lies exclusively within ENP. The unit is bounded on the south by the long hydroperiod Eleocharis-dominated wet prairie and mangrove zone just inland of Florida Bay, on the west by the sawgrass marshes and deep water slough communities of SRS, on the north by the pine rockland vegetation communities that occur within ENP on Long Pine Key, and on the east by the sawgrass marshes and deep water slough vegetation communities of Taylor Slough. There is a continuous topographical gradient across the site, from the slightly higher elevated pine rocklands north of the unit down to the lower-lying mangroves in the south. The area is bisected by the Main Park Road, which serves as the primary public access route from Homestead to Flamingo and Florida Bay. It is also bisected by the Old Ingraham Highway, which is the original historical roadway that provides alternate access to Florida Bay. Much of the western portion of this roadway was removed and restored to grade, but the eastern portions of the road, with its associated borrow canal and woody vegetation encroachment, interrupt the continuity of the prairies within the eastern portion of this unit. Besides the road, borrow canal, and woody vegetation, which are not critical habitat, the area consists of one large, contiguous expanse of marl prairie that contains all the PCEs for the sparrow.

When sparrows were first recorded in the area during the 1974 to 1975 surveys, they were abundant and widespread (Werner 1975). Based on their limited mobility and dispersal capabilities and the presence and persistence of suitable habitat, the Service believes that the sparrows have occupied this locality since at least the time of listing. These same areas have remained occupied by sparrows since their discovery nearly 50 years ago. Consequently, the Service considered the unit to be occupied at the time of listing. The area is the largest contiguous patch of marl prairie east of SRS. It is currently occupied and has consistently supported the largest sparrow subpopulation ranging from an estimated 1,792 to 3,184 birds since 1992 (Pimm and Bass 2002, 2005; Pimm et al. 2002, 2007) (Table 1).

The natural characteristics of this area make it relatively immune to risk of flooding or frequent fires (Walters et al. 2000). Its location south of the higher-elevation pine rocklands provides it a degree of protection from high water levels compared to other units. Within the southern portion of the greater Everglades watershed, surface water generally flows from north to south, with most water moving through SRS, and to a lesser extent through Taylor Slough. The pinelands block the southward flow of water across this area such that the primary influences on water levels are rainfall and overflow from the flanking sloughs. In addition, portions of Unit 1 occur

on relatively high elevations and remain relatively dry. Consequently, this area is not easily flooded as a result of managed water releases or upstream events, and the high water levels that may occur within other sparrow subpopulations are dampened by its relative position and topographic characteristics.

Similarly, the area is not particularly vulnerable to fires. It is not over drained as a result of local hydrologic management actions, and the fire frequency is primarily influenced by natural ignition and managed prescribed fire. The public road that traverses the area could result in an increased likelihood of ignitions, but this has not occurred to date. In addition, the presence of both the Main Park Road and the Old Ingraham Highway within this unit provides human access greater than in any other unit and may allow better opportunities to manage both prescribed fires and wildfires such that they would pose a reduced risk to the persistence of the sparrow subpopulation.

Unit 2 (Subpopulation C)

Unit 2 consists of 8,304 acres of marl prairie habitat that lies exclusively within ENP in the vicinity of Taylor Slough, along the eastern edge of ENP. The unit consists of the prairies that flank both sides of the relatively narrow Taylor Slough. The area is bordered by the pine rocklands of Long Pine Key on the west and by isolated pine rocklands and the L-31W canal that runs along the ENP boundary to the east. It is bordered by an area of constriction in Taylor Slough that is closely flanked on both sides by forested habitats at the southern end and by the Rocky Glades, a region of thin marl soils and exposed limestone and sparse vegetation to the north. The area is bisected by the Main Park Road in the southern portion of the unit, but the remainder of the unit consists of contiguous marl prairies.

Sparrows were not discovered in the area until 1972 (Ogden 1972). At the time of discovery, sparrows were found to be widely distributed and abundant in this area (Werner 1975). Based on their limited mobility and dispersal capabilities and the presence and persistence of suitable habitat, the Service believes that sparrows have occupied this locality since at least the time of initial listing on March 11, 1967. Following its discovery, the site was the location of some of the first intensive study of the sparrow's biology and its relationship to its habitat (Werner 1975).

During the mid-1970s, sparrows were abundant at this site (Werner 1975), and surveys in 1981 estimated 432 sparrows in this area (Pimm et al. 2002). Since 1981, the sparrow subpopulation at this site has declined and estimates have ranged from 0 to 1,176 sparrows between 1992 and the present (Pimm et al. 2002; Pimm and Bass 2005) (Table 1). During intensive nest surveys in 2008, Virzi et al. (2009) documented four females and five males, nine nest attempts and reported nest survival as 22.8 percent and in 2009, 9 males and 5 females were documented. No additional intensive nest surveys have been conducted in this subpopulation to date. When sparrows were abundant in this area, the habitat was in a relatively dry condition, with average annual hydroperiods between 90 and 180 days (ENP 2005).

Beginning in 1980, a pump station (S-332), installed along the eastern boundary of ENP at the approximate location of the historic slough, was operated to increase hydroperiods in the area. This resulted in extended hydroperiods within the portions of the area downstream from the pump station and vegetation changed from suitable marl prairie to unsuitable sawgrass marsh due to altered hydrology as a result of the S-332 pump station operations (ENP 2005), and sparrows ceased to occur in this area. At the same time, the northern portions of Unit 2, north of pump station S-332, continued to be over drained as a result of pump station and adjacent canal stage operations which effectively lowered the water table in the surrounding agricultural lands immediately bordering ENP (Johnson et al. 1988; ENP 2005).

In these over drained areas, frequent fires impacted the habitat and resulted in reduced sparrow numbers (Pimm et al. 2002). A large fire occurred in March 2007 when the Frog Pond fire swept through this area. Sah et al. 2010 and Virzi et al. 2009, observed that the habitat then was beginning to recover.

Unit 2 provides a contiguous expanse of habitat that is largely separated from other nearby subpopulations in an area that is uniquely influenced by hydrologic characteristics. The Taylor Slough basin is a relatively small system, and much of the headwaters of the Slough are cut off by canals, agricultural land, and development to the east of ENP. Portions of this unit near the slough have deep soil (15.7 inches) (Taylor 1983) and support resilient vegetation that responds rapidly following fire (Taylor 1983; Werner and Woolfenden 1983).

Sparrows were reported to reoccupy burned sites in this region within 1 to 2 years following fire (Werner and Woolfenden 1983). The unit contains the vegetation characteristics upon which sparrows rely, and most of the area currently experiences hydrologic conditions that are compatible with sparrows use. However, the area along the eastern boundary of ENP remains heavily influenced by water management operations (ENP 2005). Portions of the area are also over drained, resulting in the possibility of high fire frequency. The location of this unit relative to other sparrow subpopulations is significant in that it occurs in the center of the five sparrow subpopulations that occur east of SRS in the vicinity of Taylor Slough (subpopulations B through F). The habitat in this area most likely plays an important role in aiding dispersal among the eastern subpopulations, acting as a ‘‘hub’’ that facilitates dispersal in the region and recolonization of local areas that are detrimentally impacted and locally extirpated.

Unit 3 (Subpopulation D)

Unit 3 consists of 10,806 acres of marl prairie vegetation in an area that lies on the eastern side of the lower portion of Taylor Slough. The majority of this area, 92 percent or 9,973 acres, is within the Southern Glades Wildlife and Environmental Area, which is jointly managed by the District and Florida Fish and Wildlife Conservation Commission (FWC). The remaining 8 percent (883 acres) occurs within the boundary of ENP. The area is bordered on the south by the long hydroperiod eleocharis vegetation and mangroves that flank Florida Bay, on the west by the sawgrass marshes and deepwater vegetation of Taylor Slough, on the east by long-hydroperiod eleocharis vegetation and over drained areas with shrub encroachment in the

vicinity of U.S. Highway 1, and on the north by agricultural lands and development in the vicinity of Homestead and Florida City.

When sparrows were discovered in this area, they were widespread (Werner 1975). Based on their limited mobility and dispersal capabilities and the presence and persistence of suitable habitat, the Service believes that the sparrows have occupied this locality since at least the time of listing. This is the easternmost area where sparrows occur and is the only subpopulation that occurs on the eastern side of Taylor Slough. It is consequently unlikely to be affected by the same factors (*e.g.*, large fires or extreme hydrologic conditions) that affect the other eastern subpopulations that lie primarily between SRS and Taylor Slough. This area is separated from other sparrow subpopulations by Taylor Slough and the agricultural and urban/suburban areas around Homestead and Florida City. These discontinuities in the landscape would tend to prevent potential fires from spreading from the area of sparrow subpopulations B, C, E, and F into the subpopulation D area.

Similarly, hydrologic conditions in this region are different than those that affect the other subpopulations because water levels are attenuated by Taylor Slough and influenced by flood protection and water supply infrastructure in the urban and agricultural areas to the north.

The 1981 comprehensive population survey estimated 400 sparrows within this region (Pimm et al. 2002). This was higher than any number of sparrows recorded in the area in recent years, and estimates have ranged from 0 to 256 sparrows since 1992 (Pimm et al. 2002; Pimm and Bass 2005) (Table 1).

The area contains all PCEs, but most of the area is dominated by sawgrass, which indicates a wetter-than-average condition within the spectrum of conditions that support marl prairie and sparrow habitat (Ross et al. 2006). There is a small portion of the subpopulation critical habitat area that is somewhat higher (0.5 to 0.75 ft.) in elevation and, depending on current ambient water level conditions, offers a variable core habitat area utilized by sparrows. The larger scale habitat in this area is divided by several canals that are part of the C–111 basin. This canal system results in altered hydrologic conditions in the region (ENP 2005) and causes extended hydroperiods during wet periods (Pimm et al. 2002). The C-111 Spreader Canal Phase 1 Project, adjoining this critical habitat area, was constructed and became operational in 2012.

Effects of the project were analyzed and documented in the Service's Biological Opinion (Service 2009). Operational constraints that limit the amount and timing of water that can be pumped through project features that may affect the sparrow, and monitoring are ongoing in the area to determine if planned conditions for the project are being realized or if adaptive management may be required.

Unit 4 (Subpopulation E)

Unit 4, subpopulation E, consists of 22,278 acres of marl prairie habitat in an area that lies along the eastern margin of SRS. This unit occurs entirely within ENP. The area is bordered to the

south by the pine rocklands of Long Pine Key and by an area dominated by dwarf cypress trees. The sawgrass marshes and deepwater slough vegetation communities of SRS comprise the western and northern boundary of the area, and the Rocky Glades comprise the eastern boundary.

When sparrows were discovered in this area, they were relatively widespread (Werner 1975). Based on their limited mobility and dispersal capabilities and the presence and persistence of suitable habitat, we believe that the sparrows have occupied this locality since at least the time of listing. These same areas have remained occupied by sparrows since their discovery over 40 years ago. The majority of this area was included in the 1977 critical habitat designation for the sparrow (42 FR 40685 and 42 FR 47840).

This area supports one of the large, relatively stable sparrow subpopulations. It is centrally located among the areas supporting other subpopulations, and its location probably plays an important role in aiding dispersal among subpopulations, particularly movements from the eastern subpopulations (Units 1 – 5) to the only subpopulation west of SRS, subpopulation A. Since 1992, this area has consistently supported the second largest sparrow subpopulation in most years, with estimates ranging from 112 to 1,200 individuals (Pimm et al. 2002; Pimm and Bass 2005) (Table 1).

The location of this subpopulation helps to protect it from being affected by managed hydrologic conditions because it is distant from canals, pumps, and water management structures that occur along the boundaries of ENP. The magnitude of managed water releases is generally dampened by the time their influence reaches this area. However, the proximity of this area to SRS will make the habitats and the sparrows that they support vulnerable to hydrologic effects during restoration activities that rehydrate SRS. The western portions of the area may become too deeply inundated at higher frequencies to provide good habitat for sparrows under some conditions such as what occurred during the 2016 nesting season. Large-scale hydrologic modifications, such as those proposed under the COP and future CERP, have the potential to influence habitat conditions in this area, and may require special management attention. Large-scale fires may detrimentally affect this area since there are no intervening features in the region that would aid in reducing the potential impacts on this subpopulation.

While the area is relatively distant from ENP boundaries and potential sources of human-caused fires, there is still concern that fires ignited on the eastern boundary of ENP may rapidly spread into the area. The 2001 Lopez fire was a human-caused fire that affected a portion of this unit (Lockwood et al. 2005). Risk from fire may also require management in this area to prevent impacts to this large sparrow subpopulation.

Unit 5 (Subpopulation F)

Unit 5, subpopulation F, consists of 4,883 acres of marl prairie that lies along the eastern boundary of ENP, and is the northernmost of the designated critical habitat units. Unit 5 is also the smallest of the five units. It is bounded on the north and west by ENP sawgrass marshes and deepwater slough vegetation communities associated with SRS, and on the east by agricultural

and residential development along the eastern boundary of ENP. Its southern boundary is defined and characterized by the sparse vegetation, shallow soils, and exposed limestone depressions and solution holes of the Rocky Glades. When sparrows were discovered in this area, they were relatively widespread (Werner 1975). Based on their limited mobility and dispersal capabilities and the presence and persistence of suitable habitat, we believe that the sparrows have occupied this locality since at least the time of initial listing. The majority of this area was included in the 1977 critical habitat designation for the sparrow (42 *FR* 40685 and 42 *FR* 47840).

The first comprehensive CSSS population survey conducted in 1981 resulted in an estimated population of 112 sparrows in this area, and most subsequent surveys have resulted in estimates lower than this (0 to 112), including several years (1993, 1995, 1999, 2000, 2007, 2008, 2009 and 2016), when no sparrows have been found (Pimm et al. 2002; Pimm and Bass 2005) (Table 1). Since 2010 sparrows have been found in the area, indicating that sparrows are consistently using the area, albeit at low numbers.

This area could serve to support or recolonize subpopulations C and E (Units 2 and 4). Loss of available habitat in this area would result in a reduction in the total spatial distribution of sparrows. Its position in the landscape results in a unique set of threats that differ from those in other subpopulations. Because of its proximity to urban and agricultural areas and its relative topographic location, this area has been consistently over drained in recent years and remains dry during the year for longer periods than other subpopulations (shortened hydroperiod). The relative dryness of the area may allow the site to remain suitable as habitat for sparrows under very wet conditions, when other subpopulations may become deeply inundated for long durations.

Due in large part to its relatively drier hydrologic condition and its proximity to developed areas, Unit 5 has been subjected to frequent human-caused fires during the past decade, resulting in periods of poor habitat quality. The PCEs within this unit may require special management consideration due to the threat from fire. In addition, the dry conditions have allowed encroachment of woody vegetation, including invasive exotic and native woody species. Invasive exotic trees, primarily Australian pine, melaleuca, and Brazilian pepper have become established in local areas often forming dense stands. These trees have reduced the suitability of some portions of the habitat for sparrows and have reduced the amount of contiguous open habitat. Aggressive management programs have been implemented by resource management agencies to address this issue, and control of woody vegetation will continue to be necessary.

3.1.2 Factors Affecting Critical Habitat

Hydrology of the area is the most important component of the habitat. In addition to directly affecting the sparrow and its ability to forage, move within habitat, and nest, hydrologic patterns largely dictate the plant community composition, and even the fire frequency. Persistent increases in hydroperiod may quickly result in changes in vegetation communities from marl prairies or mixed prairies to sawgrass-dominated communities resembling sawgrass marshes

(Nott et al. 1998). Average hydroperiods that extend beyond 210 days per year generally result in sawgrass marsh communities (Ross et al. 2006). The interaction of fire and flooding also strongly influences the suitability of habitat for sparrows. In the most extreme case, the vegetation in areas that burn and are subsequently flooded within 1 to 3 weeks after the fire, either as a result of a natural rainfall event or human-caused hydrologic changes, may not recover for a long period, possibly 10 years or more (Ross 2006). Conversely, areas that are subjected to short hydroperiods generally have higher fire frequency than longer hydroperiod areas (Lockwood et al. 2003, Ross et al. 2006), and are readily invaded by woody shrubs and trees (Werner 1975, Davis et al. 2005). Another factor affecting critical habitat is sea level rise which represents significant short- and long-term threats to the CSSS and their habitat. Sea level rise has been estimated by various sources to potentially increase by as much as 12 to 48 inches by the end of the century (National Climate Assessment [NCA] 2014; Rahmstorf 2007; Pfeffer et al. 2008). Because the entire population of CSSS occurs in low lying areas in south Florida, the population may experience changes in habitat conditions or availability due to climate change and sea level rise over the next several decades (Figures 14, 15, 16).

Unit 1

The natural characteristics of Unit 1 (subpopulation B) make it relatively less susceptible to risk of human-induced flooding or frequent fires (Walters et al. 2000). Its location south of the high-elevation pine rocklands provides it a degree of protection from high water levels that do not occur within any other units. Within the southern portion of the greater Everglades watershed, water flows from north to south, with most water moving through SRS, and to a lesser extent through Taylor Slough. The pinelands interrupt the southward flow of water across this area such that the primary influences on water levels are rainfall and overflow from the flanking sloughs. In addition, portions of the area occur on relatively high elevations and remain comparatively dry. Consequently, this area is not as easily flooded as a result of managed water releases or upstream events, and the high water levels that may occur within other sparrow subpopulations are dampened by its relative position and topographic characteristics. However, as demonstrated by various model scenarios, changes in water management actions do result in changes to habitat conditions within this unit.

Unit 1 is also not particularly vulnerable to fires. It is not over-drained as a result of local hydrologic management actions, and the fire frequency is primarily influenced by natural ignition and intensively managed prescribed fire. The public road that traverses Unit 1 could result in an increased likelihood of ignitions, but this has not occurred to date. In addition, the presence of both the Main Park Road and the Old Ingraham Highway within this unit provides greater human access than in any other unit and may allow better opportunities to manage both prescribed fires and wildfires such that they would pose a reduced risk to the persistence of the sparrow subpopulation.

Unit 2

Unit 2 (subpopulation C) contains the vegetation characteristics upon which sparrows rely, and most of the area currently experiences hydrologic conditions that are compatible with sparrow use. However, the area along the eastern boundary of ENP remains heavily influenced by hydrologic management (ENP 2005). Portions of the area are also over drained, resulting in the possibility of high fire frequency. The location of this unit relative to other sparrow subpopulations is significant in that it occurs in the center of the five sparrow subpopulations that occur east of SRS in the vicinity of Taylor Slough (subpopulations B through F). The habitat in this area most likely plays an important role in supporting dispersal among the eastern subpopulations, acting as a ‘‘hub’’ that facilitates dispersal in the region and recolonization of local areas that are detrimentally impacted.

Construction of the S-332B North and West Detention Areas and the associated pumps and operations schedule has resulted in wetter conditions and improved habitat quality in some areas and the desired water stage during the sparrow nesting window in subpopulation C critical habitat.

Unit 3

Unit 3 (subpopulation D) is the easternmost area where sparrows occur and is the only subpopulation that occurs on the eastern side of Taylor Slough. It is consequently unlikely to be affected by the same factors (*e.g.*, large fires or extreme hydrologic conditions) that affect the other eastern subpopulations that lie primarily between SRS and Taylor Slough. This area is separated from other sparrow subpopulations by Taylor Slough, and the area immediately north of this subpopulation consists of agriculture and urban/suburban areas around Homestead and Florida City. These discontinuities in the landscape tend to prevent fires from spreading into Unit 3.

Similarly, hydrologic conditions in Unit 3 are different than those that affect the other subpopulations because water levels are attenuated by Taylor Slough and influenced by flood protection and water supply infrastructure in the urban/agricultural areas to the north. The 1981 comprehensive population survey estimated 400 sparrows within Unit 3 (Pimm et al. 2002). This was higher than any number of sparrows recorded in the area in recent years when estimates have ranged from 0 to 256 sparrows between 1992 and the present (Pimm et al. 2002; Pimm and Bass 2005; Virzi et al. 2009).

Unit 3 currently contains all of the PCEs, but the majority of this unit is dominated by sawgrass, which indicates a wetter-than-average condition within the spectrum of conditions that support marl prairie and sparrow habitat (Ross et al. 2006). The habitat in Unit 3 is divided by several canals that are part of the C–111 basin. This canal system results in relatively altered hydrologic conditions in the region (ENP 2005) and causes extended hydroperiods during wet periods (Pimm et al. 2002).

CSSS Unit 3 critical habitat was affected when canal infrastructure for the SDCS was completed in the 1980s. The SDCS was originally constructed to meet agricultural water supply needs, flood control, and mitigate saltwater intrusion as part of the overarching C&SF Project. More recently the C-111 SD project (Corps 1994) was modified by adding a series of detention areas aimed at retaining water within ENP by reducing seepage out of ENP into the C-111. In addition, in the 1960s, Aerojet-General Corporation built a plant, other infrastructure, and the Aerojet Canal, which is now within the Unit 3 critical habitat boundary, to supply the National Aeronautics and Space Administration (NASA) with solid rocket fuel components. It was closed after NASA chose liquid fuel for the Saturn V program. When the Aerojet product was not selected for the Saturn project, the land and facilities were returned to the State, and are now managed by the SFWMD and FWC as a nature preserve.

Unit 4

The central location of Unit 4 (subpopulation E) helps to prevent it from being affected by managed hydrologic conditions because it is distant from canals, pumps, and water management structures that occur along the boundaries of ENP. The magnitude of any managed water release is generally dampened by the time their influence reaches this area. However, the proximity of this area to SRS may make the habitat and the sparrows that it supports vulnerable to hydrologic effects during wet periods. The western portions of Unit 4 may become too deeply inundated to provide good habitat for sparrows under certain conditions. Large-scale hydrologic modifications, such as those proposed under the COP, have the potential to influence habitat conditions in Unit 4, and may require special management attention (*e.g.*, attention to the timing and volumes of flows into NESRS). Large-scale fires may detrimentally affect Unit 4, and there are no intervening features in the region that would aid in reducing the potential impacts on this subpopulation. While this unit is relatively distant from ENP boundaries and potential sources of human-caused ignition, fires that are started along the eastern ENP boundary may rapidly spread into Unit 4. The 2001 Lopez fire was a human-caused fire that affected a portion of this unit (Lockwood et al. 2005). Risk from fire may also require management in this area to prevent impacts to this large sparrow subpopulation.

Unit 5

Because of its dryness and its proximity to developed areas, Unit 5 (subpopulation F) has been subjected to frequent human-caused fires during the past decade, resulting in periods of poor habitat quality. The PCEs within this unit may require special management consideration due to the threat from fire. In addition, the dry conditions have allowed encroachment of woody vegetation, including invasive exotic and native woody species. Invasive exotic trees, primarily Australian pine, melaleuca, and Brazilian pepper have become established in local areas (Werner 1975), often forming dense stands. These trees have reduced the suitability of some portions of the habitat for sparrows and have reduced the amount of contiguous open habitat. Aggressive management programs have been implemented by resource agencies to address this issue, and control of woody vegetation will continue to be required.

All Units

Habitat changes in the CSSS critical habitat appear to be impacting the survival and recovery of the sparrow. Marl prairie requires an annual discontinuous hydroperiod of between 90 and 210 days. PCE 2 outlined in the revised critical habitat designation for the Cape Sable seaside sparrow (Service 2007c; 72 FR 62736), specifies herbaceous vegetation that includes greater than 15 percent combined cover of live and standing vegetation comprised of one or more of Muhly grass, Florida little bluestem, black topped sedge, and cordgrass. These plant species are largely characteristic of areas where sparrows occur and act as cover for foraging, nesting, and normal behavior for sparrows during a variety of conditions. In areas where the annual discontinuous hydroperiod frequently approaches or exceeds the upper threshold of 210 days the habitat transitions to more wet tolerant species such as sawgrass and cattail. In those areas where the annual discontinuous hydroperiod frequently approaches or is less than the lower 90-day threshold, the habitat shifts toward woody vegetation and there is an increased risk of fire.

Inspection of annual discontinuous hydroperiod data from Sparrow Viewer for the eastern subpopulations (Table 4), indicates that for the period 1991-2019, CSSS-B, CSSS-C and CSSS-E on average have achieved the target of 90 to 210-day hydroperiod. CSSS-D has averaged wetter than the target by 15 days. CSSS-F has averaged drier than optimal hydroperiods at 81 days leaving it prone to fire and invasive woody vegetation encroachment. The period from 2009 to 2019 reflects much wetter conditions compared to the previous 1991 to 2008 period, in terms of average discontinuous hydroperiod days (Table 15).

Beginning in 2009 through present, the average annual discontinuous hydroperiod for CSSS-C has increased by 57 days but still remains in the target discontinuous hydroperiod. CSSS-D and E increased by 48 and 36 days respectively and fall out of the target range of 90–210 days. Average annual discontinuous hydroperiod has doubled in CSSS-F for the time period 2009–2019 putting it within the target range. CSSS-B has also increased during this wetter period by 21 days on average.

From 2009 through 2016 the EVER4 gauge, previously used before the Sparrow Viewer, average discontinuous hydroperiod has been 253 days and has consistently exceeded the target 90 to 210-day discontinuous hydroperiod. New gauges (CSSS-D1, CSSS-D2, and CSSS-D3) were installed in CSSS-D by the SFWMD as part of monitoring for the C-111 Spreader Canal Phase 1 Project in 2011 (Service 2009). Two of these gauges (CSSS-D1 and CSSS-D2) are in, or near a core habitat area for this subpopulation where sparrows have routinely nested or have been observed in recent years. The average annual discontinuous hydroperiod at these two gauges between 2011 and 2015 was 136 and 182 days respectively, well within the 90 to 210-day range, indicating that hydrologic conditions are appropriate for the maintenance of suitable habitat for this core area. However, the average at these two gauges from 2016 to 2019 increased to 219 days and 262 days respectively. During the period between 2011 and 2015, the average discontinuous hydroperiod at EVER4 was 248 days which is an increase of 33 days over the average for the period of record. This demonstrates that the discontinuous hydroperiod at EVER4 has increased since the completion of the C-111 Spreader Canal Project. The third

installed gauge, CSSS-D3, was installed at a location near habitat that is only used by sparrows for breeding during dry years. This gauge location appears to be heavily influenced by the headwater stage level at the S-18C structure on the C-111 canal. Between 2011 and 2016, the average annual discontinuous hydroperiod at CSSS-D3 was 310 days. It has increased to 348 days during the period 2016-2019.

Examination of the recent 2009 to 2019 data compared to the previous (1992 to 2008) record (Table 3) indicates that there has been some loss of habitat in the optimal 90 to 210 day discontinuous hydroperiod range in subpopulations B (10 percent), C (9 percent), D (25 percent), and E (13 percent), possibly attributable to either recent wetter meteorological conditions or the construction and commencement of operations of nearby MWD/C-111 SD components. This analysis also indicates that the amount of habitat in the optimal 90 to 210-day discontinuous hydroperiod range in subpopulation F has more than doubled from 24 to 52 percent over that same time period.

It is worth reiterating here the nesting window requirement of providing at least 90 dry nesting days between March 1 and July 15. While this metric is normally a species-level attribute it is directly relatable to the annual hydroperiod in that if the nesting window is shortened, the hydroperiod will likely be increased. The percent of acreage meeting the criteria of 90 dry days within all critical habitat areas (B, C, D, E, and F) has decreased from 61 percent to 48 percent in CSSS-B, 90 percent to 65 percent in CSSS-C, 47 percent to 27 percent in CSSS-D, 61 percent to 44 percent in CSSS-E, and 93 percent to 80 percent in CSSS-F when comparing the record from 1991 to 2008 to the more recent 2009 to 2019 record, this change is possibly attributable to wetter meteorological conditions or the construction and commencement of operations of nearby MWD/C-111 SD components.

3.2 Environmental Baseline

The environmental baseline is an analysis of the effects of past and ongoing human and natural factors leading to the current status of listed species, their habitat (including designated critical habitat), and ecosystem within the action area. It is a “snapshot” of the species’ health and critical habitat conditions in the action area at the time of the consultation and does not include the effects of the action under review.

Since the critical habitat of the CSSS is located entirely within the action there is no difference between the status of the critical habitat in the action area and the status of the critical habitat. Refer to the prior Status of the Critical Habitat section for details.

3.3 Summary and Analysis of Effects of the Action

The same hydrologic modeling used in the Effects of the Action section for the species was used to evaluate potential adverse impacts to PCEs and designated critical habitat for the Cape Sable seaside sparrow. The model was developed to simulate conditions within critical habitat for the sparrow for the baseline condition and with project operations for the 1965 through 2005 period

for each of the simulations. The PCEs for the Cape Sable seaside sparrow were described in the rule designating critical habitat (Service 2007c; 72 FR 62736) and discussed previously in this Biological Opinion. The PCEs include:

3.3.1 Calcitic marl soils

Marl soils are characteristic of the short-hydroperiod freshwater marl prairies of the southern Everglades and support the vegetation community on which sparrows depend. These soils result from specific hydrologic conditions that are characteristic of the marl prairie. Presently, soils in the marl prairie landscape within sparrow habitat vary in physical and chemical characteristics due to the variation in topography, hydrology, and vegetation (Sah et al. 2007). There currently are no methodologies upon which to evaluate the effects of project operations on soils; therefore, we rely on our hydrologic analyses that provide for marl prairies as surrogates for soils analyses.

3.3.2 Herbaceous vegetation

This PCE is characterized by greater than 15 percent combined cover of live and standing dead vegetation of one or more of the following species: muhly grass, Florida little bluestem, blacktopped sedge, and cordgrass. These plant species act as cover and substrate for foraging, nesting, and normal behavior for sparrows during a variety of environmental conditions. Many other herbaceous plant species also occur within sparrow habitat (Ross et al. 2006), and some of these play important roles in the life history of the sparrow (Sah et al. 2007).

Previous sections of the BO provided the Service's rationale for the 90 to 210 days discontinuous hydroperiod metric to measure effects on the plant community that provides marl prairie habitat detailed in this PCE. The average annual difference in hydrologic model simulations between the ECB19RR and ALT Q for Units 1-5 (subpopulations B, C, D, E, and F) are provided in the Corps BA (Corps 2019a). The annual differences in percent area meeting the 90 to 210-day discontinuous hydroperiod are discussed further in section 2.11.3.

Based on comparisons between ECB19RR and ALT Q for this metric, 0 acres (0.0 percent) of Unit 1 critical habitat, the largest and most populous CSSS critical habitat area, would be adversely affected by the proposed COP. The analysis indicates that Unit 2 critical habitat would experience an average annual increase of 336 acres (+4.0 percent) meeting the optimal 90 to 210-day discontinuous hydroperiod. Unit 3 critical habitat would experience an average annual decrease of 2,161 acres (-20.0 percent) meeting the optimal 90 to 210-day discontinuous hydroperiod. Unit 4 critical habitat would experience an average annual decrease of 1,114 acres (-5.0 percent) meeting the optimal 90 to 210-day discontinuous hydroperiod. Unit 5 critical habitat would experience an average annual decrease of 98 acres (-2.0 percent) meeting the optimal 90 to 210-day discontinuous hydroperiod.

In summary, the analysis of model results indicates that across all CSSS critical habitat there would be an average annual decrease of 3,037 acres (3.6 percent of the total 84,982 acres) meeting the 90 to 210-day discontinuous hydroperiod. These acres are likely to experience a

reduction in optimal vegetation communities due to changes in hydrology caused by the proposed project. However, the Service has determined that since the effects of the project as indicated by this metric will be minimal, (an average of 3.6 percent of the total critical habitat) the overall effect of the proposed project based on this PCE will not result in adverse modification of critical habitat.

3.3.3 Contiguous open habitat

Sparrow subpopulations require large, expansive, contiguous habitat patches with few or sparse woody shrubs and trees. The constituents of this PCE are largely predicated on a combination of hydroperiod and periodic fire events. Fires prevent hardwood vegetation from invading these communities and prevent the accretion of dead plant material, both of which decrease the suitability of this habitat type for Cape Sable seaside sparrows. Implementation of the proposed action could extend or reduce hydroperiods but are expected to cause a minimal effect on the occurrence of natural fires in the area. Establishment of woody vegetation in marl prairie habitat is often complicated by a variety of factors. Insufficient hydroperiod can favor woody vegetation which prefers shorter periods of inundation. Land elevation changes, such as levees, as well as nutrient loading can also influence the presence of woody vegetation. The proposed operational changes under the COP are intended to control excessive hydroperiod changes and thereby minimize changes in woody vegetative composition. Appreciable changes in this PCE within each critical habitat area are not anticipated.

3.3.4 Hydrologic regime

In order to maintain suitable vegetative composition conducive for successful nesting, it is important that water depth, as measured from the water surface down to the soil surface, does not exceed 7.9 inches (20 cm) for more than 30 days during the period from March 15 to June 30 at a frequency of more than 2 out of every 10 years. Water depths greater than 7.9 inches (20 centimeters) during the breeding period can result in elevated nest failure rates (Lockwood et al. 2001; Pimm et al. 2002). If these water depths occur for short periods during nesting season, sparrows may be able to re-nest within the same season. These depths, if they occur for sustained periods (>30 days) within sparrow nesting season, may reduce successful nesting to a level that could be insufficient to support a population if it occurs more frequently than 2 out of every 10 years. This PCE was discussed previously in the context of its importance as an indicator of hydrologic conditions that would prevent flooding sparrow nests, maintain suitable conditions for sparrows occupying these areas, and generally support the vegetation species that are essential to sparrows.

The result of the ALT Q model simulation for the 41-year period of record (1965- 2005) for critical habitat Units 1-5 indicate that this metric is exceeded (consecutive years missing target) once in Unit 1 (CSSS-B; *e.g.*, the target was exceeded in 1982 and 1983), three times in Unit 2 (CSSS-C), 10 times in Unit 3 (CSSS-D), 8 times in Unit 4 (CSSS-E) and 0 times in Unit 5 (CSSS-F). However, on average, less than 6 percent of critical habitat in individual sparrow subpopulations B, C and D will be affected by water depths greater than 7.9 inches between

March 15 and June 30. CSSS-E and F will see effects in 9.3 percent and 6.9 percent of the area on average respectively (note CSSS-F does not experience consecutive years exceeding the target but does exceed it in 6 years over the 41-year POR).

In summary the analysis based on this PCE shows that overall effects of the action as indicated by this metric, and based on model simulations, on critical habitat for all subpopulations will be insignificant and confined to areas that are not currently utilized by breeding sparrows.

3.4 Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the Action Area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Most of the lands included in designated critical habitat for the CSSS are federally owned and managed. Therefore, the majority of impacts to designated critical habitat are anticipated to be related to future Federal actions that will require a separate consultation under the Act.

3.5 Conclusion

Cape Sable Seaside Sparrow Designated Critical Habitat

Based on the Sparrow Viewer analysis of the observed record, the extent of critical habitat that experiences a 90 to 210-day discontinuous hydroperiod that maintains habitat conditions for all phases of the CSSS life cycle has been determined to be deficient within the boundaries of many subpopulations. In addition, a number of studies have determined that vegetation change due to wetter conditions can occur rapidly, but recovery to healthy marl prairie vegetation in critical habitat is much slower (Sah et al. 2013, Armentano et al. 2006). Hydrologic modeling for the COP indicates that across all CSSS critical habitat there would be an average annual decrease of 3,037 acres (3.6 percent of the total 84,982 acres) meeting the 90 to 210-day discontinuous hydroperiod. These acres are likely to experience a reduction in optimal vegetation communities due to changes in hydrology caused by the proposed project. However, the PCEs as described for the designated critical habitat remain present across the landscape within each critical habitat unit. Further, the COP is anticipated to redistribute flows from west to east across Tamiami Trail which should have the effect of improving hydrology west of Shark Slough, as well as, in the eastern subpopulations CSSS-F and C. There will likely be short to medium-term shifts in the location of optimal habitat within some subpopulations and perhaps even loss of some marginal to low quality habitat, however the long-term benefit of restoring the distribution, volume and timing of flows through the Everglades will provide benefit for all natural resources in the Greater Everglades.

Additionally, the Marl Prairie Indicator generally mirrors the hydrologic changes expected under the COP which shifts a significant amount of flow into NESRS and also increases flows to

Taylor Slough especially during the dry season. The southern half of CSSS-Ax and nearly all of CSSS-E and CSSS-D will see declines in the percent to target met of between 1 and 20 percent. Some of this habitat that is shifting to a wetter regime was already poor habitat and could become completely unsuitable for sparrows. The northern half of CSSS-Ax and areas northeast of this subpopulation and in between CSSS-C and CSSS-E could see an increase in percent of target met between 1 and 20 percent. Most of the area outside of the currently delineated sparrow subpopulations already shows marginal habitat that could be improved with the project, however, these areas are currently unoccupied and there is considerable uncertainty as whether they can be made suitable for sparrows to occupy.

No construction activities are proposed under the COP, since most of the structural features have already been constructed under MWD and C-111 SD projects or are proposed under future CERP projects, so there will be no direct impacts to sparrow critical habitat due to construction. Some improvements in habitat conditions within limited areas of critical habitat in sparrow subpopulations C and F are likely to occur under the COP. Based on this information, the Service has determined that the COP is not likely to destroy or adversely modify designated critical habitat for the Cape Sable seaside sparrow.

4.0 EVERGLADE SNAIL KITE

4.1 Status of the Species

This section summarizes the effects of all past human and natural activities or events that have led to the current status of the Everglade snail kite and are relevant to formulating the biological opinion about the proposed action.

4.1.1 Legal Status

The Everglade snail kite is one of three subspecies of snail kite, a wide-ranging New World raptor found primarily in lowland freshwater marshes in tropical and subtropical America from Florida, Cuba, and Mexico south to Argentina and Peru. The Everglade subspecies occurs in Florida and Cuba, including Isla de la Juventud, and northwestern Honduras, though only the Florida population is listed. The Florida population was first listed under the Endangered Species Preservation Act in 1967, and protection was continued under the Endangered Species Conservation Act of 1969. The Everglade snail kite (hereafter, snail kite), and all the other species listed under the Endangered Species Conservation Act of 1969 were the first species protected under the Act of 1973, as amended, and all of these species were given the ‘endangered’ status (32 FR 4001). Critical habitat for the snail kite was later designated in 1977 (50 CFR 17.95).

4.2 Species Description

The snail kite is a medium-sized raptor, with a total body length for adult birds of 14 to 15.5 inches and a wingspan of 43 to 46 inches (Sykes et al. 1995). In both sexes, the tail is

square tipped with a distinctive white base that appears as a white patch on the rump when in flight. The wings are broad, long, and paddle-shaped and are held bowed downward or cupped when in flight (Sykes et al. 1995). Adults of both sexes have red eyes and juveniles have brown eyes (Brown and Amadon 1976; Clark and Wheeler 1987). The plumage is markedly different among adult male, adult female, and juvenile birds. Adult males have a uniformly slate gray plumage, and adult female plumage is brown dorsally and pale white to cream ventrally, with dark streaking on the breast and belly (Sykes et al. 1995). Immature kites are similar in appearance to adult females, but are more cinnamon-colored, with tawny or buff-colored streaking rather than brown streaking. Females are slightly larger than males. A slender, decurved bill is an adaptation for extracting the kite's primary prey (*Pomacea* spp.) and is a distinguishing character for field identification in both adults and juveniles.

4.3 Life History

4.3.1 Breeding and Nesting Behaviors

Initiation, peak, and duration of the snail kite breeding season in Florida varies from year-to-year and are affected by water levels and climatic conditions (temperatures, precipitation). Ninety-eight percent of the nesting attempts are initiated from December through July, while 89 percent are initiated from January through June (Sykes 1987c; Beissinger 1988; Snyder et al. 1989), with the peak in nest initiation occurring from February to April (Sykes 1987c). Snail kites often re-nest following failed attempts early in the season as well as after successful attempts (Beissinger 1986; Snyder et al. 1989), with an observed maximum number of two successful broods within a breeding season (Bennetts et al. 1998). Analysis by Fletcher et al. (2015) indicates that average annual snail kite breeding season lengths have increased concomitantly with the exotic island apple snail (*Pomacea maculata*) invasion.

Pair bonds are established prior to egg-laying and are relatively short, typically lasting from nest initiation through most of the nestling stage (Beissinger 1986; Sykes et al. 1995). Male kites select nest sites, usually over water, and conduct most nest-building, which is probably part of courtship (Sykes 1987c; Sykes et al. 1995). Unlike most raptors, snail kites do not defend large territories and frequently nest in loose colonies or in association with wading bird nesting colonies (Sykes 1987b; Sykes et al. 1995). Kites actively defend small territories extending about 4 miles around the nest (Sykes 1987b). Copulation can occur from early stages of nest construction, through egg-laying, and during early incubation, if the clutch is not complete.

Egg-laying begins soon after completion of the nest but may be delayed a week or more (Sykes 1987c). An average 2-day interval between laying each egg results in the laying of a 3-egg clutch in about 6 days (Sykes et al. 1995). The clutch size ranges from one to five eggs, with a mode of three (Sykes 1987c; Beissinger 1988; Snyder et al. 1989). Incubation may begin after the first egg is laid, but generally after the second egg (Sykes 1987c). In Florida, the incubation period lasts 24 to 30 days (Sykes 1987c). Incubation is shared by both sexes, but the contribution of incubation time between the male and female is variable (Beissinger 1987).

Hatching success is variable from year-to-year and between areas. In nests where at least one egg hatched, hatching success averaged 2.3 chicks per nest (Sykes 1987c).

After hatching, both parents initially participate in feeding young, but there is variability in the contribution of each member of the pair (Beissinger 1987). The nestling period lasts about 23 to 34 days and fledging dates may vary by 5 days among chicks (Sykes et al. 1995). Following fledging, young are fed by one or both adults until they are 9 to 11 weeks old (Beissinger 1987). In total, snail kites have a nesting cycle that lasts about 4 months from initiation of nest-building through independence of young (Beissinger 1986; Sykes et al. 1995).

Snail kites also have a relatively unique mating system in Florida that is described as ambisexual mate desertion, in which either the male or female may abandon nests part way through the nestling stage (Beissinger 1986, 1987). This behavior appears to occur primarily under conditions when prey is abundant, and it may be an adaptation to maximize productivity during favorable conditions. Following abandonment, the remaining parent continues to feed and attend chicks through independence (Beissinger 1986). Abandoning parents presumably form new pair bonds and initiate a new nesting attempt.

Snail kites mature early compared with many other raptors and can breed successfully the first spring after they hatch, when they are about 8 to 10 months old. However, not all kites breed at this age. Bennetts et al. (1998) reported that only 3 out of 9 first-year snail kites attempted to breed, while all 23 adults that were tracked attempted to breed. Reichert et al. (2012) evaluated breeding probabilities using marked birds and found that annual breeding probabilities for after-hatch-year snail kites were generally low (around 0.17 during non-drought years). Annual breeding probabilities for this group increased during drought years to 0.48, which, given that adult breeding probabilities declined during drought years, probably reflects inexperience in young kites or density dependence in breeding opportunities (Reichert et al. 2012). In contrast, reproductively active adult snail kites breeding probabilities averaged 0.87 during non-drought years and 0.62 during drought. Annual breeding probabilities vary among snail kites based on environmental conditions and individual characteristics (*e.g.*, fitness, previous breeding experience), but are significantly <1 (Reichert et al. 2012). During severe drought years, a large portion of the population (~30-70 percent [Reichert et al. 2012], up to 80-90 percent [Beissinger 1986]) may not attempt to breed. In addition, non-breeding (potentially less fit) adults were unlikely to breed in the following year (probability ≤ 0.10; Reichert et al. 2012). The oldest confirmed breeding snail kite in Florida is 24 years (Reichert et al. 2015), and the maximum lifespan of a snail kite in the wild is at least 25 years (Reichert et al. 2010).

4.3.2 Diet and Feeding Behavior

Snail kites are dietary specialists, a relatively rare foraging strategy among raptors. Throughout the range of all subspecies of snail kites, apple snails (*Pomacea* spp.) consistently compose the primary prey of snail kites, who possess several unique adaptations that allow them to efficiently capture, extract, and consume the snails (*e.g.*, the slender, deeply hooked, sharp-tipped bill that allows kites to efficiently extract snails from their shells; long slender toes that allow kites to

grasp large snails) (Sykes 1987a; Sykes et al. 1995; Beissinger 1990). Historically, snail kites in Florida foraged primarily on the Florida apple snail (*P. paludosa*), which is the only species of *Pomacea* native to North America (Sykes 1987b; Rawlings et al. 2007). Several species of non-native apple snails have recently become established within the snail kite's range in Florida. Of these, *P. maculata* is commonly eaten by snail kites, and in some wetlands composes the vast majority of the snail kite's forage base. These highly invasive exotic snails are larger, more fecund, and more drought tolerant, and have faster growth rates and longer life spans than Florida apple snails (Ramakrishnan 2007; Kyle et al. 2013; Horgan et al. 2014). Because of these factors, *P. maculata* has the potential to influence a wide variety of snail kite behaviors and demographic rates, both positively and negatively, through direct and indirect pathways (Fletcher et al. 2015; see Invasive Nonnative Species under Threats to the Species).

Under normal conditions, snail kites are nearly completely dependent on apple snails as prey. However, other prey items have been documented, especially during periods of limited prey availability, such as drought conditions or cold spells. Beissinger (1990) reported that kites captured and consumed small turtles, such as the musk turtle (*Sternotherus odoratus*) and mud turtles (*Kinosternon* spp), and they captured and consumed another type of small freshwater snail (*Viviparus georgianus*). Other prey that have been occasionally documented include crayfish (*Procambarus* spp.), speckled perch (*Pomoxis nigromaculatus*), and small snakes (Sykes et al. 1995).

Snail kites use two visual foraging methods: course-hunting, while flying 5 to 33 ft above the water surface, or still-hunting from a perch (Sykes 1987a; Sykes et al. 1995). In Florida, course-hunting is more frequent than still-hunting; still-hunting may be limited by perch availability or prey abundance (Cary 1985; Valentine-Darby et al. 1998). While course-hunting, the flight is characterized by slow wing beats alternating with gliding; the flight path is usually into the wind, with the head oriented downward to search for prey. Snails are captured with the feet at or below the surface, to a maximum reach of about 6 inches below the surface. Snail kites do not plunge into the water to capture snails and never use the bill to capture prey. Individuals may concentrate hunting in a particular foraging site, returning to the same area as long as foraging conditions are favorable (Cary 1985). Capture rates are higher in summer than in winter (Cary 1985), with no captures observed at a temperature less than 10°C (50°F). Snail kites frequently transfer snails from the feet to the bill while in flight to a perch. Feeding perches include living and dead woody-stemmed plants, blades of sawgrass (*Cladium jamaicense*) and cattails (*Typha* spp.), and fence posts. Snail kites are gregarious and may forage in common areas in proximity to other foraging kites.

Non-breeding snail kites may fly long distances over the course of days or months while tracking prey resources across the landscape (Bennetts and Kitchens 2000). Nesting snail kites often forage within 1-2 km of their nests under favorable conditions but have been observed traveling more than 6 km to find snails to feed young (Beissinger and Snyder 1987).

Pias (2012) found a negative relationship between foraging rates and home range size on Lake Tohopekaliga (Toho), suggesting that smaller home ranges may have higher densities of

available snails. However, foraging rates were not significantly different between parents of successful nests and those of failed nests (Pias 2012). Similarly, analyses investigating the effect of foraging rates on snail kite reproductive parameters did not show a strong association (Fletcher et al. 2015). Reasons for this may include over-riding factors (*e.g.*, predation, environmental factors) that have a greater effect on reproductive success, or a potential foraging/snail density threshold above which there is low variation in foraging rates and below which kites will not stay to forage (Reichert et al. 2010; Darby et al. 2012, Olbert 2013, Fletcher et al. 2015).

4.4 Habitat and Hydrologic Requirements

Snail kites and apple snails are wetland-dependent species and rely on wetland habitats for all aspects of their life histories. The primary wetland habitat types upon which kites rely consist of freshwater marshes and the shallow-vegetated littoral zones along the edges of lakes (natural and man-made) where apple snails occur in relatively high abundance and can be found and captured by kites. Within these habitats, water levels and recession/ascension rates can affect snail kite and apple snail reproductive efforts and success.

4.4.1 Nesting Habitat

Nesting almost always occurs over water, which deters predation (Sykes 1987b). An important feature for snail kite nesting habitat is the proximity of suitable nesting sites to favorable foraging areas. Thus, extensive stands of contiguous woody vegetation are generally unsuitable for nesting, whereas suitable nest sites consist of single trees or shrubs or small clumps of trees and shrubs within or adjacent to an extensive area of suitable foraging habitat. Trees usually less than 32 ft tall are used for nesting and include willow (*Salix* spp.), bald cypress (*Taxodium distichum*), pond cypress (*Taxodium ascendens*), melaleuca (*Melaleuca quinquenervia*), sweetbay (*Magnolia virginiana*), swamp bay (*Persea borbonia*), pond apple (*Annona glabra*), and dahoon holly (*Ilex cassine*). In some cases, snail kites also nest in crowns of living cabbage palms (*Sabal palmetto*) which may be present in recently or infrequently flooded areas. Shrubs used for nesting include wax myrtle (*Myrica cerifera*), cocoplum (*Chrysobalanus icaco*), buttonbush (*Cephalanthus occidentalis*), *Sesbania* spp., elderberry (*Sambucus simpsonii*), and Brazilian pepper (*Schinus terebinthifolius*). Nesting also can occur in herbaceous vegetation, such as sawgrass, cattail, bulrush, and reed (*Phragmites australis*) (Sykes et al. 1995). Nesting in lake littoral zones, especially those of the Kissimmee Chain of Lakes, is often observed in herbaceous vegetation. Nests constructed in herbaceous vegetation on the waterward side of the lakes' littoral zone are more vulnerable to collapse due to the weight of the nests, wind, waves, and boat wakes and are more exposed to disturbance by humans (Chandler and Anderson 1974; Sykes and Chandler 1974; Sykes 1987b; Beissinger 1986, 1988; Snyder et al. 1989).

Impacts of seasonal water levels and transitions on nesting snail kites and their habitat are discussed more below (see Incompatible Water Management and Nest Predation under Threats to the Species), and WCA-3A-specific impacts and targets are discussed in detail in the Environmental Baseline section of this Biological Opinion.

4.4.2 Foraging Habitat

While kites are capable of foraging successfully under a variety of habitat conditions, the preferred foraging habitat is typically a combination of relatively short-stature, sparse graminoid marsh vegetation less than 6.5 ft in height. The apple snail requires emergent aquatic plants to provide substrate that allows them to reach the water surface to breathe. However, for kites to feed, the emergent vegetation must be sparse enough that they are capable of locating and capturing snails (Kitchens et al. 2002). Snail availability is influenced by both vegetation structure and water depth. Marshes, wet prairies, and lake littoral zones composed of interconnected areas of open water 0.6 to 4.3 ft deep which are relatively clear and calm and patches of herbaceous emergent wetland plants or sparse continuous growth of herbaceous wetland plants generally provide the appropriate balance of emergent vegetation and open water (Sykes et al. 1995; Kitchens et al. 2002). Marsh species that commonly occur within favorable kite foraging habitat include spike rush (*Eleocharis cellulosa*), maidencane (*Panicum hemitomon*), sawgrass, bulrush (*Scirpus* spp.), and/or cattails. Shallow open-water areas may also contain sparse cover of species such as white water lily (*Nymphaea odorata*), arrowhead (*Sagittaria lancifolia*), pickerel weed (*Pontederia lanceolata*), and floating heart (*Nymphoides aquatica*). Snail kites also forage in deeper water in lacustrine habitats dominated by submergent or floating-leaved vegetation (Pias 2012). Periphyton growth on the submerged substrate provides a food source for apple snails, and submergent aquatic plants, such as bladderworts (*Utricularia* spp.) and eelgrass (*Vallisneria* spp.), may contribute to favorable conditions for apple snails while not preventing kites from detecting snails (Sykes et al. 1995).

Using field data from 1995 to 2004, Darby et al. (2006) estimated that snail densities less than 0.14 individuals per square-meter are unable to support kite foraging. To manage for sufficient densities, Darby et al. (2009) recommended a range of water depths between 4 and 20 inches during the peak apple snail breeding period between April and June. Deeper water can delay or reduce apple snail egg cluster production, while shallower water can prevent snail movement and breeding, also resulting in decreased egg cluster production and subsequently lower snail densities.

Foraging habitat conditions that differ substantially from those described above will result in either reduced apple snail density or reduced ability of snail kites to locate and capture snails. Vegetation cover that is either too dense or too sparse can result in reduction in the quality of the area as foraging habitat. Impacts of seasonal water levels and transitions on apple snails, foraging snail kites, and their habitat are discussed more below (see Incompatible Water Management under Threats to the Species), and WCA-3A-specific impacts and targets are discussed in detail in the Environmental Baseline section of this Biological Opinion.

4.4.3 Roosting Habitat

Outside of the breeding season, snail kites may roost communally, usually over water, typically in groups of 2 to 200 (Bennetts et al. 1994). Roost sites are typically in taller vegetation among

low profile marshes. On average, in Florida, 91.6 percent of roost sites are located in willows, 5.6 percent in melaleuca, and 2.8 percent in pond cypress. Snail kites tend to roost around small openings in willow stands at a height of 5.9 to 20.0 ft, in stand sizes of 0.05 to 12.35 acres. Roosting also has been observed in melaleuca or pond cypress stands with tree heights of 13 to 40 ft (Sykes 1985).

4.5 Distribution and Movement

4.5.1 Historic and Current Distribution

The subspecies *R. s. plumbeus* occurs in Florida, Cuba (including Isla de la Juventud), and northwestern Honduras. There is no evidence of movement of birds between Cuba and Florida, but this possibility has not been ruled out (Sykes 1979; Beissinger et al. 1983). A recent genetic survey of *R. s. plumbeus* and the two other subspecies of snail kites, *R. s. major* and *R. s. sociabilis*, that range in Mexico, Guatemala and Belize, and Nicaragua, Costa Rica, Panama and South America respectively, conducted by Haas et al. (2009) indicated that there are no genetic differences between the Florida and Cuba populations of *R. s. plumbeus*. However, due to their small sample size, additional studies would be needed to confirm these results in order to make proper inference regarding the possibility of employing translocation as a viable recovery action for the species.

In Florida, the historic range of the snail kite was larger than at present. The current distribution of the snail kite in Florida is limited to central and southern portions of the State. Six large freshwater systems are located within the current range of the snail kite: Upper St. Johns marshes, the Kissimmee Chain of Lakes (KCOL), Lake Okeechobee, Loxahatchee Slough, the Everglades, and the Big Cypress basin (Beissinger and Takekawa 1983; Sykes 1984; Rodgers et al. 1988; Bennetts and Kitchens 1997; Rumbold and Mihalik 1994; Sykes et al. 1995; Martin et al. 2006a). Other areas that have supported snail kites include the East Orlando Wilderness Park, the Blue Cypress Water Management Area, the St. Johns Reservoir, and the Cloud Lake, Strazzulla, and Indrio impoundments. In the KCOL, snail kites may occur within most of the lakes and adjacent wetlands, with the majority of snail kite nesting occurring within Lake Kissimmee, Lake Toho, and East Lake Toho. In the KCOL, snail kites have also nested in lower numbers on Lakes Hatchineha and Jackson. Snail kite nesting, sometimes in relatively large numbers, has occurred periodically since about 2002 in Lake Istokpoga. Lake Okeechobee and surrounding wetlands represent significant snail kite nesting and foraging habitats that have historically supported snail kites. In the Loxahatchee Slough region of Palm Beach County, snail kites may occur in the Arthur R. Marshall Loxahatchee National Wildlife Refuge (WCA-1) and throughout the remaining marshes in the vivinity, most frequently nesting within Grassy Waters, also known as the West Palm Beach Water Catchment Area. Snail kites may occur within nearly all remaining wetlands of the Everglades region, with nesting occurring within WCA-2B, WCA-3A, WCA-3B, and ENP (Martin et al. 2006a). Within the Big Cypress basin, snail kites may occur within most of the non-forested and sparsely forested wetlands.

Historically, the extensive littoral marshes of Lake Okeechobee, located within Fisheating Bay and near the inflow of the Kissimmee River, were used by snail kites for foraging and nesting (Martin et al. 2006). However, a significant decline in foraging and nesting occurred from 1996 through 2006, and Lake Okeechobee made only minor contributions to the snail kite population during this time (Cattau et al. 2008a). The reduction in foraging and nesting was attributed to habitat degradation resulting from the hurricanes that occurred during 2004 (Cattau et al. 2008a) and the water management practices that occurred during this time period (Bennetts and Kitchens 1997). Water management actions have resulted in more water being retained in the lake with a concomitant increase in water levels. High water levels in the 1990s resulted in a significant loss of emergent herbaceous and woody vegetation in Lake Okeechobee's emergent wetlands. The loss of emergent vegetation reduced the abundance of apple snails (the snail kite's primary prey item), because snails require emergent vegetation for feeding and egg-laying. The reduction of trees and shrubs in the littoral zone has reduced nesting and perching sites available to the snail kite.

There was no nesting within Lake Okeechobee from 2007 to 2009 and only limited nesting in 2010 within portions of the lake that are outside of the historic nesting areas. The 2010 nesting occurred in two general areas: (1) the littoral zone from just west of where the Kissimmee River enters the lake northward to the city of Okeechobee, including Eagle Bay Marsh and (2) near Observation Island, located along the open water edge of the littoral zone in the southwest portion of the lake.

Since 2010, water levels in the lake have generally been lower and aquatic vegetation has improved in the lake, resulting in increased snail kite nesting efforts (Fletcher et al. 2015). Moderate water levels observed on Lake Okeechobee in 2011 and 2012 were correlated with an increase in snail kite nesting. A total of 39 nesting attempts resulted in 16 successful nests that produced 26 nestlings in 2011, and 76 nesting attempts resulted in 23 successful nests that produced 43 nestlings in 2012. Lake Okeechobee accounted for 25 percent of the range-wide nesting effort and produced 21 percent of the fledglings in 2012 (Cattau et al. 2012). For all sites monitored in 2013, Lake Okeechobee was the most productive in terms of overall snail kite production, with 24 percent of observed fledglings (Fletcher et al. 2014). Between 2013 and 2015, there was an average of 73 active nests (range 55-107) that produced an average of 36 fledglings (range 24-44) on Lake Okeechobee. In 2016, there were 231 active nests and at least 123 were successful producing 255 fledglings (Fletcher et al. 2017); however, most of this production came from a summer nesting event where water levels were relatively stable. In 2018, there were an estimated 161 active nests on Lake Okeechobee, and 87 of these nests were determined to be successful producing a total of 167 fledglings (Fletcher et al. 2018).

Lake Okeechobee is of particular importance since it serves as a critical stopover point as snail kites traverse the network of wetlands within their range. A loss of suitable habitat and refugia, especially during droughts in the lake, may have significant demographic consequences (Takekawa and Beissinger 1989; Kitchens et al. 2002; Martin et al. 2006b). Lake Okeechobee will be critical to the snail kite's long-term population persistence, especially given the susceptibility of juvenile snail kites in the Kissimmee River Valley to an increased frequency of

local disturbance events and the treatment of hydrilla (*Hydrilla verticillata*) (Reichert et al. 2011).

WCA-3A was once an important snail kite foraging and nesting area. Historically, the WCAs, and WCA-3A in particular, have fledged proportionally the large majority of young in the region. However, no young were fledged in WCA-3A in 2001, 2005, 2007, 2008, 2010, or 2012. The decline in breeding activity and success observed in WCA-3A over recent years may reflect deteriorating habitat quality as well as significantly decreased prey abundance. Although the overall trend in WCA-3A has been down, a slight increase in nesting attempts in 2013 and 2014 may indicate a positive change in prey densities or suitable habitat, although nesting effort was down again 2015. In 2013, there were 60 nesting attempts in WCA-3A of which 12 were successful and produced 13 fledglings (Fletcher 2015). In 2014, there were 57 nesting attempts in WCA-3A of which 20 were successful and produced 34 fledglings (Fletcher 2015). In 2016, there were 16 active nests in WCA-3A and 3B, but they all failed (Fletcher et al. 2017). In 2018 WCA- 3A produced 17 successful nests out of 40 nesting attempts. WCA-3A yielded 15 successful nests in 2019 out of 28 nesting attempts (Fletcher et al 2018).

The shift in dependence from Lake Okeehobee and the WCAs to the KCOL was apparent as reproduction within this watershed has accounted for 52, 12, 89, 72, and 61 percent of the successful nesting attempts range-wide in 2005, 2006, 2007, 2008, and 2009, respectively (Cattau et al. 2009). Lake Tohopekaliga accounted for 41 percent of all successful nests and 57 percent of all fledged young that were documented on a range-wide basis from 2005-2010. In 2012, Lake Tohopekaliga accounted for 25 percent and 24 percent of all successful nests and fledged young, respectively. Additionally, in 2011 and 2012, East Lake Tohopekaliga, accounted for 27 percent and 30 percent of all successful nests and fledged young, respectively. A small number of nests have also been documented on Lake Hatchineha, Lake Istokpoga, and Lake Jackson within recent years. In 2013, the KCOL produced 37 percent of all nests and 38 percent of all fledglings. Fletcher et al. (2016) indicated that out of 72 total known-fate snail kite nests in Lakes Tohopekaliga, East Toho, and Kissimmee, only 16 were successful producing 30 fledglings. It is not clear why the success in 2014 was so low. Fletcher et al. (2016) hypothesized it could be due to changes in KCOL habitat conditions rather than from improving conditions elsewhere attracting breeding snail kites. In 2016, KCOL produced 65 fledglings from 187 known-fate nests.

Since 2010, snail kites have also nested in the Everglades Stormwater Treatment Areas 1, 3, and 5, with the majority of nesting occurring in STA 5. According to Fletcher et al (2016), “Nesting effort in STAs 1, 3, and 5 increased annually from 0 percent in 2012, to 13 percent in 2013, and 32 percent in 2014, but decreased in 2015 to 19 percent.” During the 2019 nesting season, only one pair of snail kites nested within the Everglades STAs. This nest was determined to have failed (Fletcher, et al 2019).

In addition to the primary wetlands discussed above, there are numerous records of snail kite occurrence and nesting within isolated wetlands throughout the region. In the 1990’s, Sykes et al. (1995) observed snail kites using smaller, more isolated wetlands including the Savannas

State Preserve in St. Lucie County, Hancock Impoundment in Hendry County, and Lehigh Acres in Lee County. Takekawa and Beissinger (1989) identified numerous wetlands that they considered drought refugia, which may provide snail kite foraging habitat when conditions in the larger more traditionally occupied wetlands are unsuitable. Radio tracking and satellite telemetry of snail kites has also revealed that the network of habitats used by the species includes many smaller, widely dispersed wetlands within this overall range (Bennetts and Kitchens 1997; Meyer 2015). Snail kites may use nearly any wetland within southern Florida under some conditions and during some portions of their life history. For example, 2010 snail kite nesting surveys documented nesting in surprisingly high numbers in peripheral areas such as Harns Marsh, in Lehigh Acres. That year, a snail kite nest and juveniles were also observed for the first time in the S-332D detention area in eastern ENP, also known as the Frog Pond. WCA-3B also contributed fledglings in both 2013 and 2014. In 2015, a large number of nests (most of them successful) were found in a new area, Mary A Mitigation Bank in Brevard County, and one successful snail kite nest was found on Lake Smart in Polk County. In addition, reports of foraging snail kites have been increasing in Polk County as well as Sarasota County.

4.5.2 Movements

Snail kites have generally been considered nomadic, probably responding to changing hydrologic conditions (Sykes 1979). During the breeding season, kites remain close to their nest sites until they fledge young or fail. Following fledging, adults may remain around the nest for several weeks, but once young are fully independent adults may depart the area. Outside of breeding season, snail kites regularly travel long distances within and among wetland systems in southern Florida (Bennetts and Kitchens 1997). While most movements may be in response to droughts or other unfavorable conditions, kites may also move away from wetlands when conditions appear favorable. Movements within large wetlands and movements among adjacent wetland units occurred frequently, while movements among spatially isolated wetlands occurred less frequently (Martin et al. 2006a). Fledgling kites also move frequently but are more likely to move to immediately adjacent wetland units than adults, which may indicate a degree of familiarity with the availability of wetlands across the landscape that adult kites acquire through experience.

Between breeding seasons, Fletcher et al. (2015) found a high degree of site and regional philopatry for breeding snail kites. This pattern was observed as both natal and breeding philopatry. Natal philopatry reflects the proportion of 1-year old (or 2-year old, given many 1-year old birds do not attempt to breed) birds that have their first nesting attempt in the wetland that they were born in, whereas breeding philopatry reflects the likelihood that adult birds will breed in the same site (or region) that they previously were observed to breed in. These results indicate the importance of distinguishing and interpreting movement associated with reproduction (dispersal) versus more nomadic non-breeding movements (*e.g.*, foraging that tracks variation in food availability). Analysis results of Fletcher et al. (2015) show that regional philopatry has been very high for the Kissimmee River Valley (northern region) and the Everglades (southern region); immigration between these and other portions of the population between breeding seasons still occurs, but at lower rates (Figure 20). In contrast, Lake

Okeechobee and the STAs, being centralized, appear to serve as “mixing grounds” and “stepping stones” for nesting birds. This information suggests that the snail kite population in Florida is currently experiencing significant spatial structuring; however, based on the amount of immigration occurring between regions, it is premature to consider these as separate subpopulations.

4.6 Population Dynamics

4.6.1 Population Size

Several authors (Nicholson 1926; Howell 1932; Bent 1937) indicated that the snail kite was numerous in central and southern Florida marshes during the early 1900s, with groups of up to 100 birds. Reports of snail kite population declines in the 1940s and 1950s suggested that as few as 6 to 100 individuals remained (Sykes 1979). When the snail kite was listed as endangered in 1967, the species was considered to be at an extremely low population level. In 1965, only 10 birds were found with 8 in WCA-2A and 2 at Lake Okeechobee. A survey in 1967 found 21 birds in WCA-2A (Stieglitz and Thompson 1967). Relatively large fluctuations in the snail kite population size have been widely reported and generally attributed to environmental conditions (Beissinger 1986; Beissinger 1995; Martin et al. 2006b; Cattau et al. 2008b). It is unclear whether the reports of declines were completely from a loss in the number of individuals or a result of the snail kite’s nomadic behavior, limited survey efforts, and the lack of biological knowledge of the species. As it was not known at the time that snail kites are nomadic in response to unfavorable hydrologic conditions (Sykes 1979), it is possible the surveys were documenting more the absence of snail kites from their usual locations, including Lake Okeechobee and the headwaters of the St. John’s marsh (Sykes 1979), and not entirely from the actual loss of individual snail kites. In addition, limited resources were available at that time for researchers to reach potential snail kite habitats. As such, the resulting low level of survey effort may have biased these low snail kite population estimates. Rodgers et al. (1988) have stated that it is unknown whether decreases in reported snail kite numbers in the annual count were due to mortality, dispersal (into areas not counted), decreased productivity, or a combination of these factors. However, there is little doubt that the snail kite was endangered at the time of its listing and that its range had been dramatically reduced.

Prior to 1969, the snail kite population was monitored only through sporadic and inconsistent surveys (Sykes 1979, 1984). From 1969 to 1994, an annual quasi-systematic, mid-winter snail kite count was conducted by a succession of principal investigators, with counts ranging from a low of 65 snail kites in 1972 to a high of 996 snail kites in 1994 (Sykes 1979; Sykes 1983a; Beissinger 1986; Bennetts et al. 1999a). Bennetts et al. (1993, 1994) cautioned that the 1993 and 1994 counts were performed with the advantage of having numerous birds radio-tagged. This likely increased the total count because radio-tagged birds could easily be located and often led researchers to roosts that had not been previously surveyed. Bennetts and Kitchens (1997) identified issues with the count surveys and recommended that they should not be the basis of population estimates or used to infer demographic parameters such as survival or recruitment.

Bennetts et al. (1999b) analyzed these counts and the sources of variation in these counts and determined that count totals were influenced by differences in observers, survey effort, hydrologic conditions, and site effects. While significant sources of error were identified, these data could provide a crude indication of trends if one assumes all influences of detection rates had been adequately taken into account. Because this is highly unlikely, the sources of variation in the counts should be recognized prior to using these data in subsequent interpretations, especially in attempting to determine population viability and the risk of extinction.

Beginning in 1997, refined population estimates were generated for the snail kite using a mark-recapture method (Dreitz et al. 2002). These new population estimates, which incorporate detection probability (less than 1.0), were higher than those resulting from the previous counts. Population size estimates generated from mark-recapture techniques for 1997 to 2000 are approximately 2 to 3 times higher than previous count-based estimates (*e.g.*, 800 to 1,000 estimated snail kites based on count-based surveys in 1993 and 1995, compared to an estimated 2,700 to 3,500 snail kites based on mark-recapture analyses from 1997 to 2000) (Bennetts and Kitchens 1997; Dreitz et al. 2002). Confidence intervals could also be generated for population estimates using the new method, which increased the validity of comparing population estimates among years.

Since 1997, population estimates and estimates of demographic parameters have been generated exclusively employing mark-recapture methods that incorporate detection probabilities (Figure 21). From 1997 through 1999, the snail kite population was estimated to be approximately 3,000 birds (Dreitz et al. 2002). From 1999 through 2002, the population estimates declined each year until they reached a low level of approximately 1,400 birds in 2002 and 2003, then increased slightly to about 1,700 birds in 2004 and 2005 (Martin et al. 2006b). The snail kite population exhibited steep declines in both 2007 and 2008, with estimates of 1,204 birds and 685 birds, respectively, but rebounded slightly starting in 2010. The 2012 population estimate was 1,218 birds (Cattau et al. 2012). The 2013 population estimate was similar – 1,198 birds (Fletcher et al. 2014). In 2014, the population estimate was significantly higher (1,754 birds [95 percent CI = 1605-1897]) primarily due to stable fledging rates in Lake Okeechobee and an increase in fledging in the Everglades and STAs (Fletcher et al. 2015). As shown in Figure 15, in 2015, the population estimate increased to approximately 2,100 birds, and in 2017 the estimate rose to approximately 2,600 birds. The 2018 population estimate slightly decreased to 2,347 birds. The 2019 population is currently being calculated (Fletcher et al. 2019).

4.6.2 Demographic Rates

Snail kites appear to exhibit high levels of variability in many demographic parameters, while others remain relatively constant. Adult snail kite survival appears to be relatively constant over time at a relatively high level (>80 percent) (Bennetts et al. 1999a; Martin et al. 2006a; Cattau et al. 2009). Adult survival is probably reduced in drought years (Takekawa and Beissinger 1989; Martin et al. 2006a), as was observed by the appreciable drops from 2000 through 2002, and again from 2006 through 2008 (Figure 22). These temporary low adult survival rates coincided with significant declines in the overall population associated with region-wide droughts during

2001 and 2007. Researchers have also observed geographic variation of adult snail kite survival rates, with higher rates in southern regions relative to northern regions of their range (Martin et al. 2006a, Martin et al. 2007, Fletcher et al. 2015).

In contrast to relatively constant adult survival estimates, juvenile survival appears to be highly variable among years, reaching a record low in 2002 (Figure 22) (Beissinger 1995; Bennetts and Kitchens 1999; Martin et al. 2003; Martin et al. 2006b; Cattau et al. 2009). The observed variability in juvenile survival is likely related to variation in environmental conditions, including those hydrologic conditions that directly affect the survival and productivity of the apple snail.

Other variable demographic parameters such as distribution of nesting and productivity are also likely driven by annual variability of environmental factors, most notably apple snail density and availability (which in turn, are affected by prevailing and previous year water levels). Duration of the breeding season and amount of double-brooding are also variable (Beissinger 1986). Under favorable environmental conditions, snail kites have the ability to achieve high reproductive rates (Beissinger 1986), and similarly, juvenile survival rates appear to be higher under more favorable conditions.

The observed declines in the snail kite population from 1999 to 2002 (Figure 21) coincided with a regional drought that affected central and south Florida during 2000 to 2001. During this period, nest success was generally low, and demographic parameters estimated using mark-recapture methods indicated low juvenile survival rates (Martin et al. 2006b). Despite the return to normal or wetter-than-normal hydrologic conditions from 2002 to 2006, which generally provide favorable snail kite nesting conditions, population estimates remained low, and nest success and juvenile survival rates also remained low (Martin et al. 2006b). Additionally, snail kite nesting ceased in WCA-3A due to the 2004 crash of the native apple snail population there caused by extended high water conditions during the snail breeding season. Nest success and number of young fledged increased slightly in 2007 and 2008 (Cattau et al. 2009), despite severe drought conditions in 2007. Juvenile survival significantly increased from 0.226 in 2006 to 0.558 in 2007, then decreased again to 0.381 in 2008 (Cattau et al. 2009). Conversely, adult survival decreased significantly in 2007 from 0.834 to 0.538, then rebounded to 0.826 in 2008 (Cattau et al. 2009). These irregularities are likely a result of the increased utilization of the KCOL, where a majority of young fledged in 2007. Historically, water levels in KCOL have been less affected by adverse drought conditions (Bennetts and Kitchens 1997).

Figure 15 shows that during the six years from 2009 to 2014 the number of successful snail kite nests and number of fledglings had generally increased range wide (where sampling occured). Since 2011, nesting efforts and success on Lake Okeechobee have improved greatly. Lake Okeechobee was the most productive water body in terms of overall snail kite production during 2013. Between 2013 and 2015, there were an average of 73 active nests (range 55-107) that produced an average of 36 fledglings (range 24-44) per year on Lake Okeechobee. In 2016, there were 231 active nests and at least 123 were successful, producing 255 fledglings (Fletcher

et al. 2017); however, most of this production came from a summer nesting event where water levels were relatively stable.

There was also a marked increase in nesting attempts in WCA-3A in 2013 and 2014 (36 active nests each year), with 14 and 30 fledged young observed, respectively (Fletcher 2015a). In 2015, 2016, 2017, 2018, and 2019, WCA-3A produced 10, 0, 2, 17, and 15 successful nests respectively (Fletcher et al 2019).

Snail kites appear to exhibit high levels of variability in some demographic parameters, while others remain relatively constant. For example, distribution of nesting appears to fluctuate dramatically based on annual variability of specific environmental factors, such as habitat and apple snail availability (which in turn, are affected by prevailing and previous year water levels). Similarly, productivity appears to be highly variable and heavily influenced by environmental conditions (Sykes 1979; Beissinger 1989, 1995; Sykes et al. 1995). Duration of breeding season and amount of double or triple-brooding are also variable (Beissinger 1986). Juvenile survival also appears to be highly variable among years, reaching a record low in 2002 (Fletcher et al. 2017; Beissinger 1995; Bennetts and Kitchens 1999; Martin and Kitchens 2003; Martin et al. 2006a). From 2010 to present, juvenile survival has been trending down (Fletcher et al 2019). The observed variability in juvenile survival is related to variation in environmental conditions, including those hydrologic conditions that directly affect the survival and productivity of apple snails. Because apple snails are the primary source of food for the snail kite, hydrologic conditions that affect the survival and productivity of apple snails may have significant effects on snail kite nest success and the survival of juvenile snail kites.

4.6.3 Trends

Recent population estimates are 2 to 3 times more accurate than those produced prior to 1997 owing to the improved mark-resighting method first applied in 1997-2000 and refined in 2002 (Dreitz 2000; Dreitz et al. 2002). While it is not possible to compare the current population size to those recorded from the 1970s through 1997 due to differences in sampling methods, several lines of evidence suggest that the current snail kite population declined drastically from 2000 to 2008. Two major reductions in numbers occurred following region-wide droughts in 2001 and 2007 (Dreitz et al. 2002; Martin et al. 2007; Cattau et al. 2008b). The snail kite population estimate dropped by more than 75 percent during this time, from an estimate of approximately 3,400 birds in 1999 to fewer than 700 in 2008 and 2009 (Figure 21; Cattau et al. 2009).

Concurrent with the apparent population declines, number of nesting attempts, nest success, and the number of young fledged, particularly in wetlands such as Lake Okeechobee and the WCAs historically used by breeding kites, also generally declined (Fletcher et al. 2015). Recent retrospective analyses by Fletcher et al. (2015) indicate the population decline was largely driven by reduced contributions of these southern regions to total population growth.

As shown in Figure 15, since 2009, snail kite population growth has been generally positive, which marks a period of population recovery (Fletcher et al. 2015). This overall trend has been

driven by increased contributions from the Kissimmee Chain of Lakes since 2005 and is due primarily to increases in reproduction and juvenile recruitment (Fletcher et al. 2015). Both demographic parameters have been positively linked to the invasion of the exotic apple snail, *Pomacea maculate*, as discussed below (see Invasive Nonnative Species under Threats to the Species). However, during this recovery period, dispersal has become increasingly limited between the northern and southern regions (Fletcher et al. 2015). Such limited dispersal highlights the importance of suitable local demographic rates and, for the southern region, quality breeding and foraging habitat in "stepping stone" wetlands to maintain the population into the future.

4.6.4 Population Viability Analysis

Based on demographic parameters generated using mark-recapture methodology, a population viability analysis (PVA) for the snail kite was conducted in 2006. This PVA indicated there was a high probability of quasi-extinction (identified as ≤50 female snail kites) within the next 50 years if current reproduction, survival, and drought frequency rates remained the same as those observed from 1996 to 2006 (Martin et al. 2007; Cattau et al. 2008b, 2009). Quasi-extinction risk is the probability of a population falling below a critical density – an extremely undesirable population level that may be unlikely to be recoverable even with drastic management steps, such as captive breeding. In 2010, snail kite researchers conducted a new PVA which updated the demographic parameters and incorporated effects of variable environmental (hydrologic) states. According to Cattau et al. (2012), preliminary results from this PVA "predict a 95 percent probability of population extinction within 40 years." They further stated, "These results are especially concerning, as they indicate an increased risk of extinction when compared to results from a previous PVA conducted in 2006." Their analyses also provided indications of an aging population with problems inherent to older individuals, including increased adult mortality rates and decreased probabilities of attempting to breed, both of which have been shown to be exacerbated during times of harsh environmental conditions (Cattau et al. 2012).

More recent analyses conducted by Fletcher et al (2015) indicated population growth rates near or above 1.0 when exotic snail effects were included in demographic rates, compared to 0.974 and 0.925 under scenarios without *Pomacea maculata* effects. This retrospective analysis showed an increasing trend in the contribution of juvenile recruitment to population growth rate in the northern region. Based on per capita contributions, the northern region was a population source five out of seven years from 2007 to 2013, primarily due to this increase in local recruitment. Conversely, per capita contribution for the southern region had been <1.0 for all but 4 years during the 18-year study duration, and the highest contribution to population growth rate in the southern region was from surviving adults (not immigrants). Declines in per capita contribution of local adult survival in the southern region were not offset by increases to emigration from the northern region (Fletcher et al. 2015).

4.7 Threats to the Species

There are a variety of threats that have been identified which can affect snail kite nesting, foraging, and survival. These threats include loss and degradation of wetland habitat, incompatible water management, nest predation, invasive nonnative species, potential disease and contaminants concerns, human disturbance, and environmental stochasticity (*e.g.*, extreme weather events).

4.7.1 Habitat Loss and Degradation

The principal threat to the snail kite is the loss, fragmentation, and degradation of wetlands in central and southern Florida resulting from urbanized and agricultural development and alterations to wetland hydrology through ditching, impoundment, and water level management. Nearly half of the Everglades have been drained for agriculture and urban development (Davis and Ogden 1994; Corps 1999). The Everglades Agricultural Area (EAA) eliminated 3,100 square-miles of the original Everglades and the urban areas in Miami-Dade, Broward, and Palm Beach Counties have contributed to the reduction of habitat. North of ENP, which has preserved only about one-fifth of the original extent of the Everglades, the remaining marsh has been fragmented into shallow impoundments (*i.e.*, WCAs). The Corps' C&SF Project encompasses 18,000 square-miles from Orlando to Florida Bay and includes about 994 miles each of canals and levees, 150 water control structures, and 16 major pump stations. This system, which was originally designed and constructed to serve flood control and water supply purposes, has disrupted the volume, timing, direction, and velocity of freshwater flow and has resulted in habitat loss and degradation in the WCAs and other portions of the historic Everglades. Drainage of Florida's interior wetlands has reduced the extent and quality of habitat for both the apple snail and the snail kite (Sykes 1983b). Widespread drainage has permanently lowered the water table in some areas. This drainage permitted development in areas that were once kite habitat.

Habitat loss and fragmentation are also factors influencing survival during droughts, despite the species' dispersal ability (Martin et al. 2006a). As discussed above, the snail kite may use nearly any wetland within southern Florida under some conditions and during some portions of their life history. In dry years, snail kites depend more on water bodies that normally are suboptimal for feeding, such as canals, impoundments, or small marsh areas, remote from regularly used sites (Beissinger and Takekawa 1983; Bennetts et al. 1988; Takekawa and Beissinger 1989). The fragmentation or loss of wetland habitat significantly limits the snail kites' ability to be resilient to disturbance events such as various climatic events. As wetland habitats become more fragmented, the dispersal distances become greater, putting increased stress on dispersing kites that may not be able to replenish energy supplies.

Degradation of wetland habitat, particularly due to water quality impacts associated with runoff of phosphorus from agricultural and urban sources, is another concern for the snail kite. The Everglades was historically an oligotrophic system (*i.e.*, having a deficiency of plant nutrients that is usually accompanied by an abundance of dissolved oxygen), but major portions have

become eutrophic (*i.e.*, rich in nutrients and supporting a dense plant population, the decomposition of which may kill aquatic animal life by depriving it of oxygen), primarily due to anthropogenic sources of phosphorus and nitrogen (cultural eutrophication). Most of this increase has been attributed to non-point source runoff from agricultural lands north of Lake Okeechobee, in the Kissimmee River, Taylor Slough, and Nubbin Slough drainages (Federico et al. 1981). Elevated phosphorus concentrations and loads in the Everglades have long been associated with increases in cattail expansion, which may influence the critical habitat for the snail kite. In lacustrine environments, cultural eutrophication also is a concern, especially in the KCOL. Nutrient enrichment leads to growth of dense stands of herbaceous emergent vegetation and floating vegetation (primarily water hyacinth [*Eichhornia crassipes*] and water lettuce [*Pistia stratiotes*]), which inhibit the ability of snail kites to forage along the shorelines of lake areas. Large areas of marsh are also heavily infested with water hyacinth, which inhibits the kite's ability to see its prey (Service 2007b). The Service is not aware of any scientific investigations that directly relate effects of differing nutrient concentrations to the reproductive success of snail kites; however, there is a weight of evidence that indicates that most of the lakes and large areas of Everglades wetlands within the snail kite's range have received nutrient inputs higher than normal and at levels which require various governmental agencies to perform aquatic plant management. These attempts to control, reduce, and eliminate the spread of invasive and exotic plant species have had positive as well as negative effects on snail kites, as discussed below in section 4.7.7.

4.7.2 Incompatible Water Management

The snail kite has experienced population fluctuations associated with hydrologic influences, both man-induced and natural (Sykes 1983a; Beissinger and Takekawa 1983; Beissinger 1986; Dreitz et al. 2002; Martin et al. 2007; Cattau et al. 2008a). Of particular concern are the water management strategies that have negatively affected snail kite nesting and foraging habitat in Lake Okeechobee, the WCAs, and the Kissimmee Basin. Within Lake Okeechobee and WCA-3A, water management activities, in part, have rendered unsuitable large areas that were once productive breeding grounds. For example, the Clewiston Flats was the primary area within Lake Okeechobee which provided suitable nesting and foraging habitat for snail kites prior to 2006. However, the water stages in 2006 to 2009 were too low to allow successful nesting and foraging in the Clewiston Flats. Despite higher stages in 2010, the habitat within the Clewiston Flats did not support snail kite nesting or foraging as it became too thick to support sufficient numbers of apple snails; and as of 2014, Clewiston Flats still did not support snail kite nesting (Fletcher et al. 2014). In other portions of Lake Okeechobee's littoral zone, prolonged deep water caused vegetation changes resulting in loss of snail kite foraging habitat as well as decreasing growth and survival of woody plants that snail kites use for nesting and perching. Fortunately, relatively lower lake levels in later years, coupled with improvements to the aquatic vegetation and an increase in the exotic apple snail population, have allowed snail kites to nest in some areas of the lake (Moonshine Bay, Observation Island, Okeetantie, and Eagle Bay Marsh) since 2010.

Similar to effects seen on Lake Okeechobee, water management activities have increased water depths and hydroperiods in WCA-3A as well as some of the other WCAs, converting significant areas within these impoundments from wet prairie habitats to slough-type habitats. Vegetation changes have also occurred on lakes within the Kissimmee Basin, although deep water is not the culprit. Water regulation schedules designed to maximize flood control, and in some cases water supply, have greatly decreased the amount of intra-annual and inter-annual variation in lake stages. As a result, lake littoral zones have shrunk, as have the amounts of suitable snail kite habitat within them. Lack of extreme (high and low) water levels also contributes to the need for more frequent aquatic plant management activities, of both native and nonnative species, which can negatively affect kites as discussed below (see Human Disturbance). All of these vegetative changes represent a reduction in the quality of foraging habitat for snail kites, and a reduction in the suitability of habitat to support abundant apple snails. Managing for appropriate seasonal water levels in lakes and the WCAs is particularly important to maintain the balance of vegetative communities required to sustain snail kites. Restoration of habitat, including the management of appropriate water levels within the WCAs and Lake Okeechobee, as suggested by several researchers, is the key to successful recovery of the snail kite as it is predicated on their ability to successfully nest in these areas.

In addition to habitat effects, hydrologic conditions, and thus water management actions, may also adversely affect snail kite nest success, productivity, and juvenile survival both directly (*e.g.*, increased predation) and indirectly (*e.g.*, decreased foraging opportunities). Rapid recession rates during the dry (breeding) season and associated low water levels can allow nests to become accessible to land-based predators (discussed below), resulting in decreased nest success (Beissinger 1986; Sykes 1987b). The potential for this effect is higher for kites nesting near land (*i.e.*, in lakes or reservoirs) compared to those nesting in expansive marsh systems such as WCA-3A. Extremely low water levels and rapid recession rates can also limit foraging opportunities for nesting adults and juvenile snail kites, both of which require a sufficient forage base in the vicinity of the nest (Mooij et al. 2002). A decrease in the amount of suitable foraging habitat (snail availability) within the vicinity of a nest can lead to increased nest failures (due to nest abandonment by adults), decreased productivity (*i.e.*, less young fledged), and decreased juvenile survival and recruitment. Apple snail abundance has also been definitively linked to water regimes (Kushlan 1975; Sykes 1979, 1983a; Darby et al. 2005). Water levels which are too high or too low during the snail breeding season can delay, curtail, or entirely preclude egg cluster production in a given year, thereby resulting in decreased snail abundance and density in the following year(s). In addition, dry season reversals or very rapid wet season ascension rates can curtail egg cluster production and potentially kill native apple snail eggs if they become submerged. If reversals or ascension rates are large, they can also flood snail kite nests, causing nests to fail or nestlings to die. Impacts of water management operations and related water levels specifically within WCA-3A are discussed in more detail in the Environmental Baseline section of this Biological Opinion.

4.7.3 Nest Predation

Nest predation is another threat to snail kites. In 2010 and 2011, Olbert (2013) used cameras to monitor nests on Lake Toho. She found predation to be the primary cause of nesting failure, with almost no instances of nest collapse. Over the course of the study, she recorded a total of 32 predation events (57 eggs or young) where there was either a partial or complete loss of nest contents. The observed predator community included yellow rat snakes (*Elaphe obsoleta quadrivittata*), marsh rice rats (*Oryzomys palustris*), raccoons (*Procyon lotor*), American alligators (*Alligator mississippiensis*), a great horned owl (*Bubo virginianus*), fish crow (*Corvus ossifragus*), and a purple gallinule (*Porphyrio martinica*). Yellow rat snakes were the most common predator to consume both eggs and young (Olbert 2013). Fletcher et al. (2015) reported a snail kite nestling predation by a bald eagle (*Haliaeetus leucocephalus*) in WCA-3A.

According to Olbert (2013), raccoons were observed accessing nests in shallower water (approximately 18.79 ± 14.7 cm deep). The likelihood of predation by yellow rat snakes was not affected by water depth beneath the nest but did increase for nests closer to shore (average distance of 4.15 m) compared to nests sites farther away (average 32.78 m). Alternatively, marsh rice rats were found to be present in nests farther from shore (average distance of 115.08m) but were absent from nest sites closer (approximately 16.01 m) to shore. Out of the 30 predation events where the predator was successfully recorded, seven events (23 percent) occurred diurnally and 23 events (77 percent) were nocturnal (Olbert 2013). Other sources of nest failure resulted from abandonment of eggs (n=10), unhatched eggs (n=3), accidental egg or young loss (n=2), and nest collapse (n=1) (Olbert 2013).

4.7.4 Invasive Non-native Species

Exotic snails can directly impact kite demography by facilitating or hindering energy acquisition, while indirect impacts derive from effects on kite behavioral decisions including movement, habitat use, and the timing of reproduction. Fletcher et al. (2015) found that snail kite breeding distribution closely tracked the spread of *Pomacea maculata* over the last decade. They did not find evidence that the exotic snail has direct negative effects on snail kite vital rates, but instead found a positive association with kite breeding rates, breeding season length, number of young fledged per successful nest, and juvenile apparent survival. They found no direct effects of *P. maculata* on adult apparent survival, but suggest that indirect negative effects may exist associated with altered spatial dynamics as it relates to geographically varied adult survival (*i.e.*, more kites breeding in the northern half of their range where adult survival is lower). This could partially offset the direct positive effects on snail kite recruitment, which likely result from increased prey density and availability in wetlands with *P. maculata* (Fletcher et al. 2015).

Nonetheless, their modeling indicates that the cumulative impacts of the exotic snail have resulted in a small positive population growth, and "…that the exotic snail invasion has (overall) likely helped to lower short-term extinction risk for the snail kite, particularly in light of recent habitat degradations elsewhere in their range" (Fletcher et al. 2015). However, long-term effects of exotic snails on kite habitat and kite health are unknown. *P. maculata* has been known to

profoundly alter the structure, function and composition of wetland ecosystems (Horgan et al. 2012; Monette 2014). In addition, exotic snails may serve as intermediate hosts of parasites and as vectors for diseases such as Avian Vacuolar Myelinopathy (AVM) as discussed below (see Disease) (Wilde and Netherland 2015). Although more investigation is needed, the presence of large numbers of exotic snails could also produce an evolutionary trap, if snail kites are attracted to areas subject to elevated rates of disturbance, predation, or other risks (Fletcher et al. 2015). Due to the amount of uncertainty related to potential future impacts of exotic snail populations on snail kite survival and recovery, growing and sustaining populations of the Florida apple snail remain important considerations when developing management strategies for, and addressing potential impacts to, the snail kite.

4.7.5 Disease

AVM is a neurological disease that comes from direct or indirect consumption of neurotoxins produced by blue-green algae (cyanobacteria) that can grow on the leaves of submersed plants, especially hydrilla. When herbivores consume hydrilla while the cyanobacteria and the neurotoxin are present, they can display loss of muscle control resulting in difficulty flying or swimming, and eventual death. AVM has been found to affect many species that consume infested hydrilla or that prey on species which do. Apple snails can accumulate the toxin, though not all show clinical signs of the disease (Wilde and Netherland 2015). Feeding trials have verified that the exotic apple snails can accumulate the toxin from hydrilla and pass AVM to their predators (chickens in the feeding trial).

Several studies on the KCOL have confirmed that at least some portions of hydrilla populations in lakes East Toho, Toho, Cypress, Hatchineha, and Kissimmee have the cyanobacteria present. These studies have also verified through a feeding trial (using chickens) that hydrilla collected from Lake Toho can pass AVM to consumers (Wilde and Netherland 2015). A smaller, follow-up study found that feeding exotic apple snails collected directly from Lake Toho to chickens did produce some signs of AVM (2 of 3 birds had mild brain lesions upon necropsy), but none of the birds showed any clinical signs of the disease (Wilde and Netherland 2015). Further, biologists collected coots from Lake Toho that they suspected may be showing clinical signs of AVM (slower flying, erratic flight, inability or reluctance to fly, etc) and necropsies confirmed several had mild AVM lesions (5 of 22 birds). To date, no sightings of eagles or snail kites displaying signs of AVM have been reported.

4.7.6 Contaminants

Additional potential threats to snail kites include exposure to bioaccumulated contaminants in their prey. Copper, used in fungicide applications and commonly found in disturbed areas of Everglades wetlands such as former agricultural lands, has been shown to bioaccumulate in apple snails and may lead to birth defects in snail kite nestlings (Frakes et al. 2008). Uptake of copper through sediments and diet has been demonstrated, with uptake from the latter being the primary exposure route for the Florida apple snail (Frakes et al. 2008; Hoang et al. 2008a). The ability of Florida apple snails to bioaccumulate copper has implications for the successful survival and

recruitment of the Florida apple snail and its predator, the snail kite, at STAs and water reservoirs created for Everglades restoration projects; however, there is still uncertainty regarding the amount of copper that is actually bioavailable to snail kites. Additional information on Florida apple snail bioaccumulation of copper, copper bioavailability, and average exposure patterns of snail kites under various environmental conditions may be necessary to identify appropriate risk management scenarios for Everglades restoration projects.

Preliminary research has also been conducted to investigate potential effects of mercury on snail kites. Fletcher et al. (2015) evaluated mercury levels of snail kite nestlings (obtained from feathers collected in 2013 across the breeding range) to examine potential effects at the individual level (nestling size, juvenile survival), nest level (number of eggs, nestlings, and fledglings per successful nest), and site level (daily nest survival, number of fledglings per successful nest). Their analyses did not find significant correlations between nestling mercury levels and snail kite vital rates, although mercury concentration had a negative (but non-significant) effect on monthly juvenile apparent survival (Fletcher et al. 2015). However, they recognize that some potential effects of mercury could limit reproductive success prior to fledging (*e.g.*, egg viability), and that additional research is needed in this area including investigation into the relationship between adult/parent mercury levels and reproductive metrics (Fletcher et al. 2015).

4.7.7 Human Disturbance

Snail kites can be negatively impacted by a variety of human activities including habitat management activities (*e.g.*, aquatic plant maintenance, prescribed burning) and recreational activities (*e.g.*, boating, fishing, hunting, wildlife viewing). The Service works cooperatively with many agencies, organizations, and entities to avoid negative impacts to snail kites associated with these types of activities. Rodgers et al. (2001) described a program to reduce impacts of aquatic plant management on snail kites. They found that the actions of several agencies in controlling aquatic plants have caused nest collapse, particularly in herbaceous vegetation such as cattail and bulrush. They state that these impacts in Lake Okeechobee and the KCOL were reduced through cooperation and improved communication between agencies. In addition to the potential collapse of nests, the Service is concerned about any excessive application of herbicides, because this would reduce available habitat for apple snails. In some cases, the removal of vegetation has improved habitat for snail kites and the apple snails by opening up areas for snail kite foraging. The Service has expanded on these coordination efforts by notifying aquatic plant management groups during the snail kite nesting season of the location of active snail kite nests (Service 2006c) to assist them in avoiding effects, and by proactively coordinating throughout the year to optimize aquatic plant management to benefit, or at least avoid negative impacts to, kite nesting and foraging areas.

4.7.8 Environmental Stochasticity

Natural variation in weather patterns and inclement weather may also affect snail kite nesting success and survival. Windstorms can cause toppling of nests, particularly on Lake Okeechobee

and Lake Kissimmee due to the long wind fetch across these large lakes. Heavy rain can cause mortality of young through exposure, decreased foraging ability of tending adults, or nest collapse. Cold weather can halt or delay nest-building and courtship as well as cause nest failure, either through decreased availability of apple snails or mortality of young snail kites due to exposure. Abandonment of nests before egg-laying is also common, particularly during drought or following passage of a cold front.

4.8 Summary of Species Status

As previously explained, the overall snail kite population exhibited steep declines from 1999 to 2002 and from 2006 to 2008 but began to rebound starting in 2010. In 2014, the population estimate was significantly higher (1,754 birds). As shown in Figure 15, in 2015, the population estimate increased to approximately 2,100 birds, and in 2017 the estimate rose to approximately 2,600 birds. However, the 2018 population estimate slightly decreased to an estimate of 2,347 birds. The 2019 population is currently being calculated (Fletcher et al. 2019).

On average, adult snail kites have relatively high annual survival rates although it is probably reduced in drought years. Snail kites are considered nomadic; following fledging, adults may remain around the nest for several weeks, but once young are fully independent adults may depart the area. Outside of the breeding season, snail kites regularly travel long distances within and among wetland systems in southern Florida. The observed variability in juvenile survival is related to variation in environmental conditions, including those hydrologic conditions that directly affect the survival and productivity of the apple snail.

Additionally, hydrologic conditions have significant effects on snail kite nest success. Marshes and lake littoral zones with patches of herbaceous emergent wetland plants and open water generally provide the best snail kite foraging habitat. Native and exotic apple snails are critical because they comprise the great majority of the snail kites' diet. Apple snail survival and recruitment can be impacted by dry conditions. Optimal water depths should range between 4 and 20 inches during the peak native apple snail breeding period (April and June). Snail kite nesting primarily occurs between January and June with peak nest initiation from February to April. The clutch size ranges from one to five eggs, with a mode of three. Nesting almost always occurs over water, which may deter predation. Nests constructed in herbaceous vegetation are more vulnerable to collapse due to the weight of the nests, wind, waves, and boat wakes and are more exposed to disturbance by humans.

The principal threat to the snail kite is the loss, fragmentation, and degradation of wetlands. Hydrologic conditions, both natural and unnatural (*i.e.,* water management), may also adversely affect snail kite nest success and juvenile survival both directly (*e.g.,* increased predation) and indirectly (*e.g.,* decreased foraging opportunities). Rapid recession rates during the dry (breeding) season and associated low water levels can allow nests to become accessible to land-based predators, resulting in decreased nest success. The abundance of apple snails is also linked to water regimes. Extremely low water levels and rapid recession rates can limit foraging

opportunities for juvenile and nesting adult snail kites, both of which require a sufficient forage base in the vicinity of the nest.

4.9 Environmental Baseline

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the Everglade snail kite within the Action Area.

4.9.1 Status of the Species within the Action Area

The information in the Status of the Species section also addresses the status of the species within the action area and is incorporated here by reference. The following discussion provides supplemental information specific to WCA-3A.

In the unaltered Everglades ecosystem, Everglade snail kites were able to cope with extreme and varying hydrologic conditions during a given year or at a given location due to their nomadic behavior and the network of suitable habitat that existed within the Everglades and throughout the rest of the kite's range in Florida. These extremes, when experienced at a natural frequency, are essential to maintaining suitable nesting and foraging habitat for the Everglade snail kite and its prey, and the natural variability within the system resulted in a habitat mosaic which ensured long-term persistence of suitable habitat for Everglades wildlife, including Everglade snail kites and apple snails. The impoundment and management of the Everglades has changed the timing, duration, and frequency of high and low water conditions, and has resulted in the observed long-term adverse effects of extreme low and high water levels in WCA-3A.

After serving as a stronghold for snail kite breeding for several decades, reproductive effort and productivity in WCA-3A dropped sharply after 1998. The number of young known to have fledged from the area between 1999 and 2013 (162 fledglings) is less than the number of young fledged in WCA-3A during 1998 alone (176 fledglings) and about half of the number fledged in 1997 alone (303 fledglings). No young were reported as fledged from WCA-3A during 2001, 2005, 2007, 2008, 2010, or 2012, and only two young (from one nest) successfully fledged in 2009. More recently, nesting effort and productivity have slightly increased in WCA-3A, with 36 active nests in both 2013 and 2014, with 14 and 30 fledglings in those years, respectively. In 2015 there were 10 successful snail kite nests in WCA-3A, but in 2016 there were no successful nests out of 11 nesting attempts. In 2017 there were two successful nests out of five nesting attempts.

Snail kite nesting productivity increased in WCA-3A during 2018 with 17 successful nests out of 40 nesting attempts. In 2019 nesting productivity slightly decreased as there were 15 successful nests out of 28 nesting attempts. (Fletcher et al. 2019).

While short-term drops in kite nesting can be attributed to drought conditions in a given year, it is believed that the longer-term decrease in kite nesting in WCA-3A is due to previous and concurrent decreases in apple snail populations and habitat quality and quantity in this area.

Although high apple snail densities (*e.g.*, >1.0 snail per m^2) were found in WCA-3A in 2002 and 2003, this was followed by lower egg cluster production in the spring of 2003 and a subsequent 80 percent reduction in snail densities in southern WCA-3A sites in 2004 (Darby et al. 2005). Relatively low densities (0.02 to 0.40 snails per m^2) continued at sampled sites into 2005 to 2007 and again at a subset of these sites in 2010 (0.06 to 0.08 snails per m^2). Sampling in WCA-3A in 2010-2012 by Wight et al. (2013) also found slightly higher but still relatively low densities of native apple snails, suggesting that these populations had not recovered since their decline in 2004 (Figure 23). Snail densities in southern WCA-3A in 2010-2012 were 5 to 10 times lower than densities observed in 2002-2003 (Wight et al. 2013). Observed egg cluster densities and per capita egg cluster (PCE) estimates were also relatively low in 2010-2012, indicating that the reproductive rate and recruitment into the apple snail population was relatively low (Wight et al. 2013). Subsequent annual sampling has found higher apple snail densities at some sites within kite foraging polygons in southwestern WCA-3A. In 2014, native apple snail densities ranged from 0.16 to 0.94 snails per m^2 in eight sites supporting foraging kites (Therrien and Darby 2014). However, in this same year, zero native apple snails were found at seven of eight random sites. In 2015, native apple snail densities ranged from 0.30 to 0.70 snails per m^2 in four sites supporting foraging kites (Therrien and Darby 2015). In two "poor kite foraging sites" (kites observed foraging but not capturing snails) and 14 of 16 random sites, zero native apple snails were found (Therrien and Darby 2015). Observed native apple snail egg cluster densities continue to be relatively low in nearly all sites.

The somewhat higher densities of native apple snails found in areas supporting foraging kites in southwestern WCA-3A during 2014 and 2015 is promising, but continued low (to zero) densities throughout the rest of the water conservation area indicate that native apple snail populations have not begun to recover from the 2004 population crash. Continued low densities have caused researchers to question whether an Allee effect is, at least in part, to blame (Wight et al. 2013; Pomacea Project 2013). This can occur when population densities decline to such low levels that scattered individuals have trouble finding mates. Thus, low snail populations resulting in low egg cluster production in addition to high predation rates may explain the continued low snail densities in WCA-3A (Wight et al. 2013).

Foraging kites in southwestern WCA-3A are also utilizing exotic snails, and the increase in exotic snail populations in this area have likely been a contributing factor to the increase in kite nesting in this area in recent years. *Pomacea maculata* was first found in samples at several sites in southwestern WCA-3A during 2011, and subsequent monitoring has indicated the exotic snail is still concentrated in this area (near SR 41), radiating from the 40-mile bend boat ramp and, beginning in 2015, starting to spread further east (Wight et al. 2013; Therrien and Darby 2015). The percentage of exotic snails found in throw traps has continued to increase since 2011, and exotic snails have been found in all kite-foraging sites in recent years. Observations by Darby (2015) indicate that kites are foraging in proportion to what is available (native versus exotic snails).

Apple snails are found in varied wetland habitats in WCA-3A, although densities tend to be higher in sparse prairies and emergent sloughs, compared with much lower densities (often by a

factor of two to three) in *Nymphaea odorata*-dominated sloughs (Karunaratne et al. 2006). Within wet prairie habitats, Karunaratne et al. (2006) found greater snail densities in P*anicum hemitomon* as compared to *Eleocharis cellulosa*. Significantly fewer snails were found in dense *E. cellulosa* as compared to habitats with lower stem density. Wight et al. (2013) found that apple snail egg cluster density was significantly greater along the *Cladium jamaicense* (sawgrass) ecotone than in wet prairie habitat, which was consistent with previous studies (Turner 1996; Darby et al. 1999), and that egg cluster densities were greatest along the western sawgrass ecotone. However, their results also indicated that egg cluster production in wet prairie habitat contributed to over 50 percent of total egg cluster production in most sites (although, in 4 of 11 sites, there was zero egg cluster production in wet prairie) (Wight et al. 2013). This information suggests that wet prairie habitat contributes more significantly to egg production than had been described in the past (Wight et al. 2013). Wight et al. (2013) concluded that habitat containing a sawgrass ecotone and transitional wet prairie habitat (for egg cluster production), as well as deeper water slough habitats (which may provide refugia for some snails during a drying event) would provide the greatest variety of habitats to support local apple snail populations.

Previous studies in this region (Wood and Tanner 1990; David 1996) indirectly documented the conversion of wet prairies to aquatic sloughs, which constitutes a loss of quality snail kite foraging habitat (Kitchens et al. 2002). These studies, occurring largely outside kite foraging and nesting areas, were not designed to provide inferences beyond the isolated sites in which they were conducted. Because of the concern that conversion of wet prairie/emergent slough habitats to deeper, less desirable sloughs will lower kite reproduction, primarily through lower prey base availability in those communities, Dr. Christa Zweig and other researchers initiated a study in 2002 to monitor critical kite breeding and foraging habitat in WCA-3A. Three communities (as described by cluster/indicator species analysis; Fletcher et al. 2014) important to kite foraging in southern WCA-3A are eleocharis, eleocharis/sawgrass prairie, and *Bacopa caroliniana* transitional. During the period of study by Zweig, the eleocharis community only occurred in the western side of the study area (WCA-3A south of Interstate 75 and west of the Miami Canal) and had disappeared from four out of five plots under continuous sampling from 2009 to 2011 (Fletcher et al. 2015). Further analyses suggested a continuing decreasing trend for eleocharis communities in WCA-3A from 2010-2013, indicating further declines of foraging habitat for snail kites in this area (Fletcher et al. 2014).

The eleocharis/sawgrass community has appeared intermittently across the landscape, but predominantly in southwestern WCA-3A. It is currently only present in one plot in the southwest quadrant (Fletcher et al. 2015). The bacopa transitional community also only occurs in the western portion of the study area and has been stable in two of the continuous sampling plots (Fletcher et al. 2015). Between 2012 and 2013, it appeared in four other plots, one in the southwest and three in the northwest of the study area. Continued significant increases in the *N. odorata* community and decreases in *E. elongata* community were also observed, although there was a small decrease in *N. odorata* in 2011 due to dry conditions (Fletcher et al. 2014). Stem density of *N. odorata* increased significantly over time, while stem density of all emergents decreased significantly over time (Fletcher et al. 2015). These data suggest further degradation

of snail kite foraging habitat has occurred over the last decade, although the extent has not yet been quantified across WCA-3A.

4.9.2 Factors Affecting the Species Environment within the Action Area

The persistence of the snail kite in Florida depends upon maintaining hydrologic conditions that support the specific vegetative communities that compose their habitat along with sufficient apple snail availability across their range each year (Martin et al. 2008). Operation of the C&SF Project and other hydrologic management actions has a significant effect on hydrologic conditions within most of the areas occupied by snail kites. Within the Action Area, the Corps and District manage water levels in snail kite habitat in accord with many different local and regional water management plans and schedules. The Service has conducted formal consultation on the MWD and C-111 Projects, IOP, ERTP, the Lake Okeechobee Regulation Schedule, and many other projects that have affected snail kites and their habitat. Water operations affect water levels in marshes and lakes upon which snail kites rely, the rates of water level recessions in lakes and marshes, and the timing of high and low water events. These factors, in turn, directly affect snail kite habitat suitability.

In the unaltered Everglades ecosystem, snail kites were able to cope with extreme and varying hydrologic conditions during a given year or at a given location due to their nomadic behavior and the network of suitable habitats that existed within the Everglades and throughout the rest of the kite's range in Florida. These extremes, when experienced at a natural frequency, are essential to maintaining suitable nesting and foraging habitat for the snail kite and its prey, and the natural variability within the system resulted in a habitat mosaic which ensured long-term persistence of suitable habitat for Everglades wildlife, including kites and apple snails.

The compartmentalization of Everglades' wetlands under the C&SF Project, and subsequent hydrologic management of each of the compartments, has reduced the connectivity of wetland systems upon which kites rely and has changed the timing, duration, and frequency of high and low water conditions within wetlands. Separate and independent management regimes for the different compartments have also impacted snail kites, in some cases by allowing unfavorable conditions in adjacent wetland units at the same time. Both short-term natural disturbances (*e.g.*, drought) and long-term habitat degradation, including impacts to their prey base, limit the snail kite's reproductive ability. WCA-3A has been identified as the most critical component of snail kite habitat in Florida, in terms of its influence on demography (Mooij et al. 2002; Martin 2007; Martin et al. 2007). A concern is the lack of or decreased reproduction within this area since the late 1990s.

Current water regulation schedules shorten the window of time during which kites can breed, and rapid recession rates often result in nest abandonment (Cattau et al. 2008a). Hydrologic conditions within WCA-3A have also resulted in reduced apple snail productivity, abundance, and density. Researchers have identified that high water during the breeding season can have significant negative impacts to apple snail egg cluster production (Darby et al. 2005; Darby et al. 2009). In addition, higher-water levels and longer hydroperiods have been implicated in the

conversion of wet prairies (prime kite foraging habitat) to sloughs within WCA-3A beginning around 2001 (Zweig 2008; Zweig and Kitchens 2014). The current WCA-3A Regulation schedule does not mimic the seasonal patterns driven by the natural hydrological cycle, resulting in water depths in southern WCA-3A that are too deep from September through January and sometimes into the spring (Cattau et al. 2008a). The subsequent rapid drop in water level recession rates from the elevated stage schedule to the dry season low decreases foraging opportunities around individual nests and locally within wetland units, negatively affecting nesting adult kites and their young and resulting in decreased nest success, juvenile survival, and recruitment (Cattau et al. 2008a).

Under the current WCA-3A Water Regulation Schedule, there are three primary factors which have the potential to adversely affect snail kites: (1) prolonged high water levels during September through January (or beyond in some years); (2) prolonged low water levels during the early spring and summer; and (3) rapid recession rates during the breeding season. Each is discussed in detail below.

4.9.2.1 Prolonged High Water Levels

During most years, water levels naturally peak late in the wet season (*i.e.*, September-October) and begin receding shortly thereafter. Water management in WCA-3A has resulted in high water levels that extend into the beginning of the dry season – often early January and sometimes beyond. This can result in decreased snail kite nest success and juvenile survival, decreased apple snail productivity and availability, and, if frequent, degradation of nesting and foraging habitat.

Prolonged high water extending into January is associated with decreased snail kite nest success and juvenile kite survival (Cattau et al. 2008a). From as early as late November into the spring, snail kite courtship and pair formation activities, including nest site selection and construction, are occurring. High water conditions during this time can act as an ecological trap in which kites build nests at higher ground surface elevations (GSEs) and are then left “high and dry” when water levels recede (Sykes et al. 1995; Cattau et al. 2008a). It is believed that snail kites choose nest sites based on water depths directly underneath the nest and in the immediate vicinity. Appropriate water depths in these areas are important to deter predation and provide sustained foraging opportunities for nesting adults and their young. If water levels change rapidly during the nesting season – for instance, due to water management operations conducted in order to meet the target water regulation schedule by alleviating high water conditions that extended into the dry season – nesting adult kites and juveniles fledged from these nests may suffer from reduced foraging opportunities, especially when low water levels cause snails to stop moving and become unavailable to foraging kites, resulting in both decreased nest success and lower juvenile survival rates.

High water during the breeding season also adversely affects apple snail productivity, and by extension snail density. Apple snail studies have documented a dramatic increase in spring egg cluster production as water depths fall below approximately 1.3 to 2.0 ft (40 to 60 cm) in

WCA-3A and other wetlands (Darby et al. 2005). Darby et al. (2005) found high snail densities (*e.g.*, >1.0 snail per m^2) in WCA-3A in 2002 and 2003, where densities reflected 2 years (2001 and 2002) of relatively low water levels. In contrast, water depths in 2003 remained above 1.3 to 2.0 ft during the peak reproductive season, and they observed a delay in the peak of egg laying and a decline in annual per capita egg production and egg cluster counts (*e.g.*, approximately 130 egg clusters per 50-meter transect in an area with >1.0 snail per m^2; Darby et al. 2008).

This decrease in 2003 spring egg cluster production resulted in a subsequent 80 percent reduction in snail densities in southern WCA-3A sites in 2004. Native apple snail densities in WCA-3A had still not recovered in 2013 compared to densities found in 2002-2003 (Wight et al. 2013). High water during the breeding season also significantly affected the proportion of juvenile snails – specifically, the deeper the water in the previous year, the greater the proportion of small (<20 mm) snails found in March and April (Darby et al. 2009). This may result from (1) a shift in egg production from summer to fall months, with snails still not of adult size as winter approaches, and/or (2) suppressed snail growth in deeper water, although the mechanism behind this has not been studied (Darby et al. 2005, Darby et al. 2009). Since kites typically select snails >20 mm for foraging (Sykes et al. 1995), a high percentage of apple snails with shells <20 mm in March and April may not support the energetic needs of nesting kites, resulting in fewer nest initiations and more nest failures (Darby et al. 2009).

To isolate the effect of water depth on apple snail egg production, Therrien and Darby (2015) conducted a mesocosm study in March-June 2015, utilizing 26 mesocosms in southeastern and southwestern WCA-3A, and compared the number of egg clusters between mesocosms located in shallow (30-49 cm), middle (50-80 cm), and deep (90-100 cm) water depths. Their results indicate that egg production was approximately four times greater in shallow versus deep water depths across all months (Darby 2015). Preliminary analyses suggest that depth alone explains approximately 50 percent of variation in mesocosm egg production, with the remaining variation probably explained by nutrients, behavior (*e.g.*, movement), and the presence of parasites (Darby 2015). Observations by Darby (2015), both during field surveys and the mesocosm study, indicate that the highest egg production consistently occurs at water depths between 20 to 50 cm.

High water levels and extended hydroperiods have resulted in vegetation shifts within WCA-3A, degrading snail kite habitat. The extended deep water conditions from September into January or beyond, whether resulting from weather conditions, water management operations, or a combination of both, appear to have reduced the amount of woody vegetation in the area and contributed to the transition of wet prairies to open water sloughs (Zweig 2008; Zweig and Kitchens 2008). These habitat conversions directly affect snail kites in several ways, most importantly by reducing the amount of suitable nesting and foraging habitat and reducing prey abundance and availability. Woody vegetation, such as pond apple, willow, and cypress which are used by kites for nesting and perch hunting, can be killed or severely stressed by extreme high water conditions and extended hydroperiods. Such vegetation is slightly elevated above the surrounding marsh and therefore is affected by prolonged higher-than-normal water levels.

Within WCA-3A and the Greater Everglades, wet prairie exists as a component of the ridge and slough landscape, occurring in the transition zone between higher sawgrass ridges and deeper lily-dominated sloughs. Wet prairies serve as the prime habitat for apple snail egg production and snail kite foraging, which species experts believe is the limiting factor to snail kite productivity in WCA-3A (Darby 2008; Kitchens 2008). In addition to deeper water conditions, hydroperiods in WCA-3A have increased, lengthening the time between drying events and further contributing to the conversion of wet prairie. Prolonged hydroperiods reduce habitat structure in the form of emergent vegetation, which is critical for apple snail aerial respiration and egg deposition (Turner 1996; Darby et al. 1999). Occasional drying events are essential to maintain healthy wet prairie and the mosaic of vegetation types that exist in the Everglades system (Sklar et al. 2002; Karunaratne et al. 2006; Darby et al. 2008). However, little annual variation in low water depths has occurred within WCA-3A since 1993, virtually eliminating these essential drying events. The effects of this are particularly apparent in southwestern WCA-3A, which has experienced excessive ponding in recent years, as the observed habitat community changes discussed above illustrate.

The transition of wet prairies to open water sloughs also affects prey availability for snail kites. Snails tend to avoid areas where water depths are greater than 50 cm (Darby et al. 2002). Avoidance of deeper depths may be related to the type and density of vegetation in deeper water areas, food availability, or energy requirements for aerial respiration (van der Walk et al. 1994; Turner 1996; Darby 1998; Darby et al. 2002). Water-lily sloughs support lower snail densities as compared with wet prairies (Karunaratne et al. 2006). Limited food quality and lack of emergent vegetation in the sloughs may account for the lower snail densities. Research indicates that snails depend upon periphyton for food (Rich 1990; Browder et al. 1994; Sharfstein and Steinman 2001), which may be limited within deeper water environments. Karunaratne et al. (2006) observed little or no submerged macrophytes and epiphytic periphyton in the sloughs they studied in WCA-3A. In contrast, species commonly encountered within wet prairie habitat (*e.g.*, *Eleocharis* spp., *Rhynchospora tracyi*, *Sagittaria* spp.) support abundant populations of epiphytic periphyton (Wetzel 1983; Browder et al. 1994; Karunaratne et al. 2006). Apple snails also depend upon emergent vegetation for aerial respiration and oviposition. A reduction in the number of available emergent stems for egg deposition would also contribute to the observed lower snail densities within sloughs.

4.9.2.2 Prolonged Low Water Levels

Low water levels have a significant effect on snail kite nest success in WCA-3A. If water levels become too low and food resources become too scarce, adults will abandon their nest sites and young (Sykes et al. 1995). Nest success analyses performed by Cattau et al. (2008) suggest that decreasing values of the annual minimum stage (*MIN*) has a significant negative effect on nest success. During the years used in their analysis, *MIN* in WCA-3A ranged from 8.51 to 9.43 ft NGVD. Within this range, observed nest success was highest (approximately 60 percent) at a stage of 9.3 ft NGVD. The highest minimum level (9.43 ft NGVD) occurred in a year with observed nest success equal to approximately 40 percent. In the regression analysis, this data point fell outside (below) the 95 percent confidence interval. This illustrates the observation of

Cattau et al. (2008) that, while values of *MIN* on the lower end of the scale have a predictable negative effect on nest success, high values of *MIN* do not guarantee high nest success. Based on the regression analysis, an annual minimum stage of 8.8 ft NGVD is associated with nest success of approximately 35 percent. Nest success observed in the 2 years (1999, 2000) with this approximate MIN value was calculated to be approximately 18 percent and 30 percent, respectively – below the regression line. However, during years with approximate *MIN* values near 8.5 ft NGVD (2002, 2004, 2006), observed nest success ranged from approximately 20 to 45 percent. The highest of these was observed in the year with the lowest stage (2004, 8.51 ft NGVD), and this data point fell outside (above) the regression line.

A strong relationship also exists between juvenile kite survival rate and annual minimum stage (Martin et al. 2007; Cattau et al. 2008a). Due to their inability to move large distances, juvenile snail kites rely upon the marshes surrounding their nests for foraging. If water levels within these marshes become too low to support foraging (due to decreased apple snail availability), juvenile survival will be diminished. Survival analyses performed by Cattau et al. (2008a) indicate that decreasing values of *MIN* also had a significant negative effect on juvenile kite survival. During the years used in the analyses, *MIN* in WCA-3A ranged from 8.51 to 9.70 ft NGVD. Within this range, model-averaged estimated juvenile survival was highest (approximately 54 percent) at a minimum stage of 9.07 ft NGVD (Cattau et al. 2008a). With the exception of the 2003 estimate, the data suggest that juvenile survival levels off near 50 percent at minimum water levels ≥9.0 ft NGVD. With the exception of the 2000 estimate (associated with a severe region-wide drought which also greatly affected adult kite survival), juvenile survival remained ≥40 percent at minimum water levels ≥8.8 ft NGVD. In terms of water depths (as opposed to stage), estimated juvenile kite survival rates for years when water levels fell below 10 cm was substantially lower compared to years where estimated water depths stayed above 10 cm (Cattau et al. 2008a).

While high water during the breeding season can result in delayed and decreased snail productivity, low water levels can also negatively affect snail egg cluster production, recruitment, and survival. Apple snail egg production is maximized when dry season low water levels are less than 40 cm but greater than 10 cm (Darby et al. 2002). Once water levels drop below approximately 0.33 ft (10 cm), snails stop moving (and reproducing), remaining stranded near the ground surface until water levels rise again (Darby et al. 2002; Darby et al. 2008). Thus, water levels below 0.33 ft will negatively affect snail egg cluster production. Depending upon the timing and duration of such low water conditions, apple snail recruitment can be significantly affected by the truncation of annual egg production and stranding of juveniles (Darby et al. 2008). Since apple snails have a 1.0 to 1.5-year life span (Hanning 1979; Ferrer et al. 1990; Darby et al. 2008), they only have one opportunity (*i.e.*, one dry season) for successful reproduction. Egg cluster production may occur from February to November (Odum 1957; Hanning 1979; Darby et al. 1999); however, approximately 77 percent of all apple snail egg cluster production occurs during April through June (Darby et al. 2008). Water levels <10 cm during peak apple snail egg cluster production substantially reduce annual per capita egg production, and thus recruitment and apple snail densities (Darby et al. 2008). If possible, dry downs during this critical time frame should be avoided. The length of the dry down, and age

and size of the snail, are all important factors in determining apple snail survival. Larger apple snails can survive dry downs better than smaller apple snails (Kushlan 1975; Darby et al. 2006, 2008). Darby et al. (2008) found that 94 percent of pre-reproductive adult-sized snails survived dry down conditions lasting 6 weeks, 71 percent survived after 12 weeks, and 27 percent survived after 18 weeks. Smaller snails exhibited significantly lower survival rates – approximately 50 percent after only 8 weeks dry (Darby et al. 2008). Snails in dry wetlands may experience significantly lower survival in the presence of substrate-probing predators.

However, short-term (same year) impacts can be balanced by longer-term improvements to apple snail habitat. Periodic dry downs promote maintenance of wet prairie habitat, as discussed below, and regeneration of emergent vegetation critical for snail oviposition and aerial respiration (Karunaratne et al. 2006). Periodic drying events may also result in a decrease in predation pressure on juvenile snails, thereby increasing recruitment and allowing a greater proportion of the annual snail cohort to reach adult size (Darby et al. 2009). When attempting to minimize dry down-associated impacts to apple snails, timing is as important as duration, and the two are often intertwined (*i.e.*, dry downs occurring earlier in the spring will typically be longer in duration). The longer the drying event overlaps with peak egg cluster production, the greater the impact on the population (Darby et al. 2008).

Wet prairie vegetation needs occasional dry downs (water depths <0.13 ft [4 cm], depending on vegetation species) for regeneration, and it has long been recognized that water levels should recede below ground periodically to maintain healthy wet prairie habitat, although moist soil conditions are needed for seed germination and establishment of new seedlings (Dineen 1974; Goodrick 1974; Zaffke 1983). Analyses conducted by Richards et al. (2009) defined a spikerush community occurring across the Everglades landscape which was dominated by *E. cellulosa* and contained *P. hemitomon*. This community contained an average dry season depth of 0.13±0.10 ft (4±3 cm) with a hydroperiod of 327±7 days. Ross et al. (2006) described a similar spikerush community in northern and central Shark Slough, ENP which exhibited a hydroperiod of 344 days. These results suggest a dry down duration of approximately 3 to 6 weeks. Frequency can be inferred from research on community composition and transition between communities in WCA-3A conducted by Zweig and Kitchens (2008). Based on their analyses of hydrological and vegetation data (sampling initiated in 2002), Zweig and Kitchens (2008) found evidence of wet prairie converting to deeper, less desirable habitats for snail kites (*e.g.*, sloughs) in as little as 4 years. Their results also suggested that such effects on community composition were highly correlated with recent (within 2 years) and historic (within 4 years) minimum and mean water levels during the dry season. These results suggest a minimum frequency for dry down conditions of approximately once every 4 years. Dry downs that occur more frequently, or for longer periods of time, can result in proliferation of sawgrass.

4.9.2.3 Rapid Recession Rates

Under high water conditions early in the nesting season, kites tend to initiate nests in upslope, shallower sites. Also, in these years, water regulation schedules can require water managers to initiate rapid recession rates in the spring to meet the target dry season low water level. Rapid

recession rates can also be caused or exacerbated by high rates of evapotranspiration and low precipitation. Whatever the reason, rapid recession rates during the breeding season, and the resulting large amplitude (overall difference between high and low water levels), can result in decreased snail kite nest success and decreased juvenile kite survival. Breeding adults may not be able to raise their young before the water levels reach a critical low water depth, below which snail availability to kites is drastically reduced. In addition, when water levels recede below an active snail kite nest, predation risk increases due to nest exposure to terrestrial predators (Sykes et al. 1995). As a result, nesting success can be further reduced in these areas. Nest success analyses performed by Cattau et al. (2008a) suggest that increasing recession rate (difference between stage on January 1 and the dry season minimum stage, divided by the number of days between these) had a significant negative effect on snail kite nest success. Of the eight single-variable models, recession rate had the strongest negative effect on nest success, with a beta parameter estimate almost 8 times greater than that of the annual minimum water level and more than 15 times greater than any other hydrological variable (Cattau et al. 2008a).

However, recession rate appears in only one of the top five multivariate models, suggesting that its effect on nest success may be buffered by other hydrological variables (*e.g.*, a high minimum water level) (Cattau et al. 2008). During the years used in their analyses, recession rates in WCA-3A ranged from approximately 0.04 to 0.14 ft per week in WCA-3A (Cattau et al. 2008a). Based on the regression analysis, a recession rate of 0.05 ft per week was associated with a nest success slightly above 50 percent, and recession rates of 0.06-0.10 ft per week were associated with a nest success of approximately 38 to 48 percent. Based on methodology used by Cattau et al. (2008), these recession rates can also be applied throughout the dry season to calculate related values of amplitude, where 0.05 ft per week translates to an amplitude of approximately 1.0 ft between January 1 and the dry season low (occurring, on average, around May 15). Their analysis also indicated a negative relationship between amplitude (between pre-breeding maximum and breeding season minimum water levels) and juvenile survival (Cattau et al. 2008a).

Studies of apple snails suggest that receding water promotes egg cluster production (Hanning 1979; Turner 1996); yet rapidly decreasing water levels associated with fast recessions may cause egg clusters laid on emergent stems during higher water levels to fall into the water and die, while rapid increases in water level (*e.g.*, dry season reversals, typically associated with storm events) may drown egg clusters. Thus, a slow, gradual recession, similar to that specified for snail kites, is preferred (as opposed to having no recession, rapid recession, or reversal of water levels).

4.9.2.4 Multi-Species Transition Strategy for WCA-3A

In order to address the adverse effects to snail kites in WCA-3A discussed above, the Service along with Drs. Kitchens, Darby, and Zweig, and others, developed a series of water level recommendations for WCA-3A that addressed the needs of snail kites, apple snails, and vegetation characteristic of their habitat. These recommendations were then incorporated with those for additional at-risk species and habitats to develop a comprehensive strategy for water

management in WCA-3A during the transition from current to "restored" conditions, using increased snail kite productivity as a success criterion. This water management strategy, the Multi-Species Transition Strategy for WCA-3A (MSTS), identified water stage and depth recommendations (based on the 3-gauge average of 3A-3, 3A-4 and 3A-28 (3AVG)) divided into 3 time periods representing: (1) the high peak-stage of the wet season (September 15 to October 15); (2) the pre-breeding season (January); and (3) the latter portion of the peak breeding season during which dry season water levels are typically lowest (May 1-31; hereafter referred to as the dry season low). Additionally, it identified recommended rates of change between high and low water levels between each of these time periods (*i.e.*, recession and ascension rates). Complete documentation of the MSTS, including its specific recommendations, discussions of the best available science used in its development, its intended implementation, and its limitations and recommendations for further refinement are provided in the ERTP 2010 BO.

By design, the MSTS does not attempt to incorporate extremely wet and extremely dry years which will naturally occur at some infrequent basis (*e.g.*, once every 10-20 years), during which attempts to meet minimum or maximum water levels or target recession rates may be impractical due to system constraints. In accordance with the intent of the MSTS, such events can be viewed as opportunities to incorporate natural stochasticity and inter-annual variability into the system. Such years will likely require additional coordination and may necessitate water management outside the MSTS but can still work to the benefit of species.

The intent of the MSTS is to facilitate decision-making amongst multiple interests and to serve as a tool when evaluating potential water management actions within WCA-3A. It is important to note that the water stages and depths identified in the MSTS are not targets which should be managed for in isolation or without consideration of appropriate biological, hydrological, and meteorological information. To properly implement and apply the MSTS to achieve the desired benefits for species and habitats, regular and close coordination is necessary between water managers and biologists.

The recommendations in the MSTS have provided the Service and other agencies with the best available scientific information to inform best professional judgment for multi-species management within WCA-3A. As such, the MSTS formed the basis for many ERTP Performance Measures (PMs) and Ecological Targets (ETs) in the Corps' BAs (2010 and 2015) and were incorporated into the Service's ITS. The MSTS is still used today. Another interagency group created as a result of the ERTP 2010 planning process, which included the Multi-Species Transition Strategy, is the Ecosystem Based Management Group. This group consists of staff from the Corps, ENP, FDACS, FWC, Service, SFWMD and others. The Ecosystem Based Management Group meets weekly during the dry season transition and seasonally three times annually to help guide the formation of recommendations of water managers.

The MSTS contains the best available science linking hydrologic ranges in WCA-3A to suitable conditions for several species such as snail kites, apple snails, wading birds and tree islands. As

water management scenarios change in the Everglades, the MSTS will need to be reassessed to ensure that the targets are still pertinent.

While we anticipate that this decision support tool will allow for comprehensive evaluations of water management and, ultimately, better-informed decisions to benefit the Everglades ecosystem, critical gaps (including further development and implementation of a snail kite HSI) must be filled before the tool can be used. Therefore, our analysis of effects under the COP will utilize the recommendations under the current MSTS, updated with any new or revised information as applicable.

4.9.2.5 Water Quality

The Everglades was historically an oligotrophic system, lacking plant nutrients such as phosphorus, but having high levels of dissolved oxygen. Major portions have become rich in nutrients that promote excessive plant growth and deplete dissolved oxygen primarily due to anthropogenic sources of phosphorus and nitrogen (cultural eutrophication). Degradation of water quality, particularly runoff of phosphorus from agricultural and urban sources, is a concern because it can cause rapid encroachment of cattail (*Typha* sp.) and other undesirable invasive and exotic species into snail kite habitat, reducing the habitat suitability for nesting and foraging. Dense growth of these plants also has the potential to reduce the ability of snail kites to forage for apple snails. In addition, the effects of higher nutrient inputs on plant growth can necessitate habitat management activities in areas used by snail kites. These activities can have negative effects on nesting kites if not conducted appropriately.

4.9.2.6 Climate Change

Climate change represents significant short- and long-term threats to the environmental baseline of the kite and their habitat (Miller and Traxler 2018). Surface temperatures and evapotranspiration are expected to increase which will likely increase recession rates during the snail kite breeding season and when native apple snail production is at its peak. Changes in rainfall patterns can create changes in vegetation and habitat resulting in changes in habitat suitability for both kites and snails.

Rainfall patterns are expected to change with more El Nino events resulting from climate change. For example, in 2016, wetter than average conditions due to the very strong El Nino effects prevailed in South Florida through the first half of 2016, encompassing the 2016 kite breeding season. These El Nino events have a significant effect on water levels and depths in the habitat. The occurrence of El Nino conditions resulted in a major short term negative effect on the environmental baseline for kite habitat in 2016 because of the wetter conditions. After the peak of El Nino, the first observation of kites in the WCA-3A during 2016 was in January (13 total kites). Kites began active nesting at the beginning of March (observed during the completion of the 3rd survey), and by April there were a total of 9 active nest in the WCA-3A with the highest number of kites observed at 34. After the completion of survey 5 (May 6 – 8, 2016) there was only one kite observed within the 3A area, and all active nesting during that time

had failed, indicating that there was no suitable habitat (foraging and nesting) for kites in the WCA-3A.

The Service will continue to monitor this situation closely and will implement Strategic Habitat Conservation Planning, an adaptive science-driven process that begins with explicit trust resource population objectives, as the framework for adjusting our management strategies in response to climate change (Service 2006b).

4.10 Summary of Baseline Conditions

From a high of 247 nests and 303 fledglings in 1997, snail kite nesting in WCA-3A has dropped drastically since. This long-term decrease is believed to be due to a similar crash in apple snail populations in WCA-3A and continued habitat degradation (primarily of foraging habitat). Over this same time span, the snail kite population in Florida decreased from approximately 3,000 birds in 1999 to a low of approximately 685 birds in 2008. While some of this steep decline was known to be caused by regional droughts, the population was also greatly impacted by the removal of WCA-3A (and Lake Okeechobee) as productive breeding grounds. As previously explained, since 2010, the snail kite population has begun rebounding. By 2014, the snail kite population estimate was significantly higher (1,754 birds) primarily due to stable fledging rates in Lake Okeechobee and an increase in fledging in the Everglades and STAs (Fletcher et al. 2015). As shown in Figure 15, in 2015, the population estimate increased to approximately 2,100 birds, and in 2017 the estimate rose to approximately 2,600 birds. The 2018 population estimate slightly decreased to an estimate of 2,347 birds (Fletcher et al. 2018). The increase is believed to be in part, due to the high nesting effort and productivity in the Kissimmee Chain of Lakes (KCOL) since 2005 and, in more recent years, in Lake Okeechobee. It is also believed to be, in part, due to the ability of shail kites to rapidly find and exploit novel habitat conditions, such as recently flooded areas where exotic snail populations boom, but often later bust._ WCA-3A has experienced modest, but not sustained, increases in nesting effort in recent years, although nesting success has been high in 2014, 2015, 2018, and 2019 at 53 percent, 53 percent, 43 percent, and 54 percent nesting success respectively for these years (Fletcher et al. 2019). While this is encouraging, there is no evidence that native apple snail populations in WCA-3A have recovered or that habitat degradation there has stopped.

4.11 Effects of the Action

Effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (50 CFR 402.02).

4.11.1 Effects of the Action to the Everglade Snail Kite

The effects of the COP to snail kites are expected to be completely hydrologic since the COP consists of water management operations and does not involve construction of structural features. Potential adverse effects from the COP to the Everglade snail kite that are included in this evaluation include effects to apple snail populations, vegetation types, prolonged high water levels during September through January (or beyond in some years), prolonged low water levels during the early spring and summer, and recession rates during the breeding season (December through July).

The COP is anticipated to be in place for 7 years until construction of new CERP infrastructure, including features which would enable increased flow deliveries into the WCAs, ENP, and into Florida Bay. Thus, these effects are anticipated to occur throughout the projected 7-year operational period of the COP.

Based on the best available information regarding the Everglade snail kite, the foraging and habitat needs of the species, the project description, and the documented occurrences within and near the action area (see Figure 23), there is reasonable certainty that the COP will likely result in take of the Everglade snail kite.

Modeling and analyses related to how the COP operations may affect the Everglade snail kite, the apple snail, and habitat suitability for these species have been updated from previous evaluations that were done for IOP, ERTP, and ERTP 2016. The updates are primarily due to the synthesis of more recent and longer-term data sets which have encouraged the development of performance measures (PMs) and ecological targets (ETs). We recognize that past water management operations in WCA-3A have likely reduced the suitability of the area for apple snails and nesting kites. Decreases in suitable habitat, as well as the apparent significant decreases in population and estimated demographic parameters, also likely function to limit the Everglades snail kite's former resiliency to weather extreme conditions and the normally short-lived, adverse effects such conditions would have on productivity and survival.

4.11.2 Effects to Apple Snail Populations

As previously stated, Everglade snail kites are dietary specialists and feed almost exclusively on apple snails (*Pomacea* spp.). Nesting snail kites often forage within 1-2 km of their nests under favorable conditions but have been observed traveling more than 6 km to find snails to feed young (Beissinger and Snyder 1987). An ecological planning tool to describe the dynamics of the apple snail population as a function of hydrology and temperature was developed using the USGS Everglades Depth Estimation Network (EDEN). This tool was available to evaluate potential effects from the COP on apple snails within the Action area. For more information on the apple snail population model, refer to Darby et al. 2015. The numbers and size distribution of snails are simulated and can be calculated for any day of a year with input data. Adult apple snails during a given year are a product of egg production, and thus environmental conditions, from the previous year.

Figure 16 and Figure 17 depict apple snail adult population numbers for a dry year (2004) and a wet year (1995) respectively. Results are shown for adult snails (>20 mm) during the spring of a dry year (April 20), before that year's reproductive period. End of spring results are shown as this is the population of snails of the size class consumed by the Everglade snail kite. The top left panel of each graphic depicts the modelled existing condition (ECB19RR). The bottom left panel depicts ALT Q, and the bottom right panel depicts the difference between each alternative relative to ECB19RR. Changes in apple snail population numbers were observed within the boundaries of designated critical habitat for the Everglade snail kite. Snail kite nesting is currently concentrated in southern portions of WCA-3A. During a wet year, ALT Q would increase apple snail population numbers in portions of southern WCA-3A and ENP on the flanks of NESRS; however, decreases were observed within portions of eastern WCA-3B. During a dry year, similar patterns were observed; however potential decreases in apple snail population numbers appeared to be more severe where they occurred within the study area.

Figure 18 illustrates means of daily percent change in total apple snail population relative to ECB19RR by year for the COP area of interest (*i.e.*, light brown line in Figure 16 and Figure 17). Values begin in 1995, giving the model three years to calibrate. ALT Q improved apple snail production in six out of the 11 years, respectively. Observed differences between ALT Q and ECB19RR were most often not more than a ±10 percent change. Implementation of the COP may produce a variety of wetland habitats that would support conditions conducive to apple snail production. During a wet year, each COP alternative increased apple snail population numbers in the study area thereby increasing the spatial extent of suitable foraging opportunities for snail kites providing a minor long-term beneficial effect. However, decreases in apple snail population numbers were observed during a dry year. As shown in Figure 18, under ALT Q, the COP operations are expected to result in an overall approximate 2 percent decrease of snail production per year, on average.

4.11.3 Effects to Vegetation Types

While it is commonly observed that wet prairie habitat requires periodic dry downs during the spring for plant regeneration, it has also been documented that Everglades wet prairies occur in areas with typically lower wet season water depths (relative to sloughs). Based on management observations, Dineen (1974) recommended a "wet prairie" regulation schedule for WCA-2A that included a wet season high water level of 12.5 ft; using the average GSE in WCA-2A (10.5 ft NGVD), this equates to a wet season water depth of approximately 2.0 ft. No duration was recommended, but the regulation schedule reflects a high water peak occurring at the end of October and receding immediately thereafter. Goodrick (1974) reported on wet season water depths during 1963-1972 at both a wet prairie site (near gauge 3-2, north of Alligator Alley) and a slough site (near gauge 3A-28) in WCA-3A. He found that October water depths in the wet prairie site never exceeded 2.3 ft, compared to slough water depths which exceeded 2.5 ft approximately 40 percent of the time. These observations suggest that water depths >2.5 ft are more conducive to slough vegetation (*Nymphaea* and submerged species), and that such wet season water levels have the potential to contribute to the conversion of wet prairies to slough.

Maintaining water levels at such depths for prolonged periods of time would serve to increase the potential for this to occur. In addition, increasing the frequency of this occurrence in consecutive years could also increase the likelihood of wet prairie degradation and conversion. Recent research indicates that shifts from one vegetation type to another may occur in a relatively short time frame (1 to 4 years) following hydrological alteration (Armentano et al. 2006; Zweig 2008; Zweig and Kitchens 2008; Sah et al. 2008).

The Everglades Landscape Vegetation Succession Model (ELVeS) was used to predict vegetation community change over time in response to environmental conditions. The model uses empirically based probabilistic functions of vegetation community niche space and temporal lags to evaluate expected community response within the model's domain. For the evaluation, ELVeS was run with ten vegetation communities (1) sawgrass; (2) sawgrass short; (3) open marsh; (4) cattail; (5) floating emergent marsh; (6) marl prairie (drier); (7) marl prairie (wetter); (8) swamp shrub land; (9) willow shrub cattail; (10) cypress shrub sawgrass; (11) bay head shrub; and (12) rockland pine. Table 19 provides a description of the vegetation classes used in ELVeS as shown in Figures 19, 20, and 21. For more details, reference Pearlstine et al. 2011.

Figures 19, 20, and 21 illustrate changes in vegetation communities relative to ECB19RR for a representative wet year (1995), dry year (1989) and an average year (1978). Results of the modeling indicated that at the broad landscape scale there were vegetation community changes predicted to occur within most of the action area. The largest changes were predicted to occur during a representative dry year (1989) and average year (1978). Suitable foraging habitat for the Everglade snail kite is typically a combination of low-profile marsh and a mix of shallow open water. The lower right quadrant in these figures shows areas that were changed in each alternative (green = change). The light brown line noted as the COP area of interest in these figures was identified at the start of the planning efforts for the COP and was used to define the maximum acreage that could be potentially affected by the COP. Changes in vegetation primarily were observed to occur in northern WCA-3A east of the Miami Canal, in portions of WCA-3B, in southern WCA-3A and in portions of ENP including NESRS and Taylor Slough. Decreases in floating emergent marsh were observed in portions of WCA-3A adjacent to the L-67A/C levees. ELVeS was not available for ALT Q+ but it is believed that ALT Q+ would result in similar effects as discussed under ALT Q.

4.11.4 Effects to Water Levels

4.11.4.1 Prolonged high water levels during September through January (or beyond in some years)

During most years, water levels naturally peak late in the wet season (*i.e.*, September-October) and begin receding shortly thereafter. Water management in WCA-3A has resulted in high water levels that extend into the beginning of the dry season – often early January and sometimes beyond. This can result in decreased snail kite nest success and juvenile survival, decreased apple snail productivity and availability, and, if frequent, degradation of nesting and foraging habitat.

Prolonged high water extending into January is associated with decreased snail kite nest success and juvenile kite survival (Cattau et al. 2008a). From as early as late November into the spring, snail kite courtship and pair formation activities, including nest site selection and construction, are occurring. High water conditions during this time can act as an ecological trap in which kites build nests at higher GSEs and are then left "high and dry" when water levels recede (Sykes et al. 1995; Cattau et al. 2008a). It is believed that snail kites choose nest sites based on water depths directly underneath the nest and in the immediate vicinity. Appropriate water depths in these areas are important to deter predation and provide sustained foraging opportunities for nesting adults and their young. If water levels change rapidly during the nesting season – for instance, due to water management operations conducted in order to meet the target water regulation schedule by alleviating high water conditions that extended into the dry season – nesting adult kites and juveniles fledged from these nests may suffer from reduced foraging opportunities, especially when low water levels cause snails to stop moving and become unavailable to foraging kites, resulting in both decreased nest success and lower juvenile survival rates.

High water during the breeding season also adversely affects apple snail productivity. Apple snail studies have documented a dramatic increase in spring egg cluster production as water depths fall below approximately 1.3 to 2.0 ft (40 to 60 cm) in WCA-3A and other wetlands (Darby et al. 2005). Darby et al. (2005) found high snail densities (*e.g.*, >1.0 snail per m^2) in WCA-3A in 2002 and 2003, where densities reflected 2 years (2001 and 2002) of relatively low water levels. In contrast, water depths in 2003 remained above 1.3 to 2.0 ft during the peak reproductive season, and they observed a delay in the peak of egg laying and a decline in annual per capita egg production and egg cluster counts (*e.g.*, approximately 130 egg clusters per 50-meter transect in an area with >1.0 snail per m^2; Darby et al. 2008). This decrease in 2003 spring egg cluster production resulted in a subsequent 80 percent reduction in snail densities in southern WCA-3A sites in 2004. Relatively low densities (0.02 to 0.40 snails per m^2) continued at sampled sites into 2005-2007, and at those sites that were re-sampled in 2010 (0.06 to 0.08 snails per m^2) (Darby et al. 2008; Darby 2010).

High water during the breeding season also significantly affected the proportion of juvenile snails – specifically, the deeper the water in the previous year, the greater the proportion of small (<20 mm) snails found in March and April (Darby et al. 2009). This may result from: (1) a shift in egg production from summer to fall months, with snails still not of adult size as winter approaches and (2) suppressed snail growth in deeper water, although the mechanism behind this has not been studied (Darby et al. 2005, Darby et al. 2009). Since kites typically select snails >20 mm for foraging (Sykes et al. 1995), a high percentage of apple snails with shells <20 mm in March and April may not support the energetic needs of nesting kites, resulting in fewer nest initiations and more nest failures (Darby et al. 2009).

4.11.4.2 Prolonged low water levels during the early spring and summer

While high water during the breeding season can result in delayed and decreased snail productivity, low water levels can also negatively affect snail egg cluster production, recruitment, and survival. Once water levels drop below approximately 0.33 ft (10 cm), snails stop moving (and reproducing), remaining stranded near the ground surface until water levels rise again (Darby et al. 2002; Darby et al. 2008). Thus, water levels below 0.33 ft will negatively affect snail egg cluster production. However, such short-term (same year) impacts are balanced by longer-term improvements to apple snail habitat. Periodic dry downs promote maintenance of wet prairie habitat and regeneration of emergent vegetation critical for snail oviposition and aerial respiration (Karunaratne et al. 2006). Periodic drying events may also result in a decrease in predation pressure on juvenile snails, thereby increasing recruitment and allowing a greater proportion of the annual snail cohort to reach adult size (Darby et al. 2009). Depending on size, apple snails can survive weeks to months during periodic drying events. In lab studies by Darby et al. (2008), 94 percent of pre-reproductive adult-sized snails survived dry down conditions lasting 6 weeks, 71 percent survived after 12 weeks, and 27 percent survived after 18 weeks. Smaller snails exhibited significantly lower survival rates – approximately 50 percent after only 8 weeks dry (Darby et al. 2008). Snails in dry wetlands may experience significantly lower survival in the presence of substrate-probing predators. When attempting to minimize dry down-associated impacts to apple snails, timing is as important as duration, and the two are often intertwined (*i.e.*, dry downs occurring earlier in the spring will typically be longer in duration). The longer the drying event overlaps with peak egg cluster production, the greater the impact on the population (Darby et al. 2008).

The intent of low water evaluation criteria is twofold: (1) to assess the potential for frequent and extended extreme low water levels which result in reduced snail kite reproduction and recruitment, and reduced apple snail productivity and juvenile survival, and (2) to assess the opportunities for lower (but not extreme, frequent, or extended) water levels which are essential to restoration and maintenance of wet prairie habitat, and which species experts believe are necessary, at least in the transition period, to return WCA-3A to a productive kite area.

Nest success analyses performed by Cattau et al. (2008) suggest that decreasing values of the annual minimum stage (*MIN*) had a significant negative effect on nest success. During the years used in their analysis, *MIN* in WCA-3A ranged from 8.51 to 9.43 ft NGVD. Within this range, observed nest success was highest (approximately 60 percent) at a stage of 9.3 ft NGVD. The highest minimum level (9.43 ft NGVD) occurred in a year with observed nest success equal to approximately 40 percent. In the regression analysis, this data point fell outside (below) the 95 percent confidence interval. This illustrates the observation of Cattau et al. (2008) that, while values of *MIN* on the lower end of the scale have a predictable negative effect on nest success, high values of *MIN* do not guarantee high nest success. Based on the regression analysis, an annual minimum stage of 8.8 ft NGVD is associated with nest success of approximately 35 percent. Nest success observed in the 2 years (1999, 2000) with this approximate *MIN* value was calculated to be approximately 18 percent and 30 percent, respectively – below the regression line. However, during years with approximate *MIN* values near 8.5 ft NGVD (2002,

2004, 2006), observed nest success ranged from approximately 20 to 45 percent. The highest of these was observed in the year with the lowest stage (2004, 8.51 ft NGVD), and this data point fell outside (above) the regression line. Survival analyses performed by Cattau et al. (2008) indicate that decreasing values of *MIN* also had a significant negative effect on juvenile kite survival. During the years used in the analyses, *MIN* in WCA-3A ranged from 8.51 to 9.70 ft NGVD. Within this range, model-averaged estimated juvenile survival was highest (approximately 54 percent) at a minimum stage of 9.07 ft NGVD (Cattau et al. 2008a). The data suggest that juvenile survival rates typically level off near 50 percent at minimum water levels ≥9.0 ft NGVD. The lowest juvenile survival rate occurred in 2000 but it remained above 40 percent at minimum water levels ≥8.8 ft NGVD. It should also be noted that the estimate in 2000 was associated with a severe region-wide drought which greatly affected adult and juvenile survival.

4.11.5 Effects to Recession Rates

Rapid recession rates during the breeding season, and the resulting large amplitude, can result in decreased snail kite nest success (through increased predation or decreased forage availability) and decreased juvenile kite survival (due to decreased forage availability). The primary ecological driver for this is related to higher water conditions during the pre-breeding season (*e.g.,* early January) which encourage kites to build nests at higher ground surface elevations (GSEs). Under rapid recession rates, these locations are then left "high and dry" when water level recedes, reducing the availability of apple snails for nesting adult kites and juveniles fledged from these nests.

Nest success analyses performed by Cattau et al. (2008) suggest that increasing recession rate (difference between stage on January 1 and the dry season minimum stage, divided by the number of days between these) had a significant negative effect on snail kite nest success. Of the eight single-variable models, recession rate had the strongest negative effect on nest success, with a beta parameter estimate almost 8 times greater than that of the annual minimum water level and more than 15 times greater than any other hydrological variable (Cattau et al. 2008a). However, recession rate appears in only one of the top five multivariate models, suggesting that its effect on nest success may be buffered by other hydrological variables (*e.g.,* a high minimum water level) (Cattau et al. 2008a). During the years used in their analyses, recession rate in WCA-3A ranged from approximately 0.04 to 0.14 ft per week in WCA-3A (Cattau et al. 2008a). Based on the regression analysis, a recession rate of 0.05 ft per week was associated with a nest success slightly above 50 percent, and recession rates of 0.06 to 0.10 ft per week were associated with an approximate nest success of approximately 38 to 48 percent. Based on methodology used by Cattau et al. (2008), these recession rates can also be applied throughout the dry season to calculate related values of amplitude, where 0.05 ft per week translates to an amplitude of approximately 1.0 ft between January 1 and the dry season low (occurring, on average, around May 15).

Studies of apple snails suggest that receding water promotes egg cluster production (Hanning 1979; Turner 1996); yet rapidly decreasing water levels associated with fast recessions may

cause egg clusters laid on emergent stems during higher water levels to fall into the water and die, while rapid increases in water level (*e.g.*, dry season reversals, typically associated with storm events) may drown egg clusters. Thus, a slow, gradual recession, similar to that specified for snail kites, is preferred (as opposed to having no recession, rapid recession, or reversal of water levels).

In addition to the apple snail population model, an incidental take trigger developed during consultation between the Corps and the Service for the ERTP 2016 BO was also used to evaluate potential effects on the Everglade snail kite for the COP. In accordance with 50 CFR 402.14(I)(1)(I), the ERTP 2016 BO included exceedance criteria that are linked to habitat quality as a surrogate for incidental take of snail kites. Per the ERTP 2016 BO, those exceedance criteria are as follows: (1) Dry Season High Water: Number of days when maximum water levels exceed 9.2 feet, NGVD at gauge 3AS3W1 on or after April 15 in two consecutive years; (2) Wet Season High Water: Number of days maximum water levels exceed 10.5 feet, NGVD at gauge 3AS3W1 for 60 days in two consecutive years (June 1 – December 31); and (3) Recession Dry Season Amplitude: WCA-3A stage difference as measured at specific gauges should not recede by more than 1.7 feet, NGVD from January 1 through May 31 or the onset of the wet season, whichever is sooner as measured in two consecutive years. Rapid recession rates during the breeding season can also result in decreased nest success (through increased predation or decreased forage availability) and decreased juvenile survival (due to decreased forage availability) (Service 2016).

According to the BA, ALT Q reduced the number of years in the period of record (1965-2005) when maximum water levels exceed 9.2 feet, NGVD at gauge 3AS3W1 on or after April 15 in two consecutive years (exceedance criteria number 1 of the 2016 ERTP BO). The number of times in the period of record (1965-2005) when maximum water levels exceed 10.5 feet, NGVD at gauge 3AS3W1 for 60 days during the wet season (June 1-December 31) in two consecutive years (exceedance criteria #2 of the 2016 ERTP BO) for ALT Q did not deviate from ECB19RR.

ALT Q reduced the number of years over the period of record (1965-2005) the WCA-3A stage difference receded by more than 1.7 feet, NGVD during the dry season (January 1 through May 31) in a given year (exceedance criteria #3 of the 2016 ERTP BO) at gauges 3A-4 and 3AS3W1, which are two of the four gauges closest to where most snail kite nesting has occurred in WCA-3A. At gauges 3A28 the exceedance of this criteria is expected to increase from 6 times to 8 times for the POR under ALT Q. At gauge WCA3-W2 the exceedance of this criteria is expected to increase from 4 times to 8 times during the POR under ALT Q. Although, ALT Q is expected to increase the number of times this recession rate criteria is exceeded at gauge WCA3-W2, the depth duration curve at this gauge will be essentially the same with ALT Q as it is for ECB19RR for the entire period of record (1965-2005) (Figure 22).

The Service requested that these exceedance criteria be utilized during the COP to understand potential effects on the Everglade snail kite within WCA-3A. High water stages may reduce the abundance, growth, and reproduction of apple snails and reduce woody vegetation that kites use for nesting and perch-hunting. Depending on the amount of lost snail productivity and the initial

snail population size, a single year of high water during the dry season can result in long-term impacts to apple snail populations and decrease numbers of snail kite nest initiations, nest success, and juvenile survival in an area, as has been observed in WCA-3A.

4.12 Summary and Analysis of Effects of the Action

In summary, there is reasonable certainty that the proposed Action is likely to result in take of snail kites in the form of disturbance of adults and juveniles that leads to injury or mortality of juvenile snail kites, loss of nests, and reduced nest success. The mechanisms for these effects are reductions to apple snail populations, woody vegetation that snail kites use for nesting and perch-hunting, prolonged high water levels during September through January (or beyond in some years), prolonged low water levels during the early spring and summer, and recession rates during the breeding season (December through July).

These effects would occur throughout the projected operational period of the COP. According to the Corps' Integrated Delivery Schedule (IDS), the COP water management activities will be continuous over either: (1) the 7-year period identified in the IDS; (2) until construction of new CERP infrastructure, including features which would enable increased flow deliveries into the WCAs, ENP, and Florida Bay; or (3) if new information becomes available through implementation of the COP Water Control Plan and/or the COP Adaptive Management and Monitoring Program (AMMP) that would necessitate a need to modify water management operations. Therefore, the expected reasonable duration of the COP operations is 7 years.

As shown in Figure 23, Everglade snail kites have been documented nesting and foraging within the Action area of the COP. Historic nesting patterns of Everglade snail kites indicate that the species has a propensity to nest in the same vicinity year after year. Therefore, it is reasonable to assume that Everglade snail kites will continue to use the Action area for nesting and foraging. Based on the best available data concerning the Everglade snail kite's use of the action area (Fletcher and University of Florida 2020), the foraging and habitat needs of the species, its life history, the project description, and the documented occurrences within and near the action area over the past 23 years, it is reasonably certain that the proposed action will adversely affect the reproductive and foraging capabilities of Everglades snail kites that utilize the proposed action area for nesting and foraging.

Based on best available data (Fletcher and University of Florida 2020), there have been a total of 807 successful Everglade snail kite nests produced within the action area from 1996 to 2019. This equates to an annual average of 35 (807/23) successful Everglade snail kite nests within the action area. A successful nest is defined as any nest that produces at least one fledgling. The average successful Everglade snail kite nest included in the 23-year dataset produced 1.8 fledglings. Therefore, we estimate that a total of 1,463 Everglade snail kites have successfully fledged from the Action area from 1996 to 2019, and that the action area produces an average of 63 (35 x 1.8) Everglade snail kite fledglings per year.

Depending on the amount of lost apple snail productivity and the initial apple snail population size, a single year of high water during the dry season can result in long-term impacts to apple snail populations and decrease numbers of snail kite nest initiations, nest success, and juvenile survival in an area, as has been observed in WCA-3A in recent years. Rapid recession rates during the breeding season can also result in decreased nest success (through increased predation or decreased forage availability) and decreased juvenile survival (due to decreased forage availability). For these reasons, we believe that of the previously mentioned affects, the reductions to apple snail populations provides the most direct and measurable criteria to measure and estimate the proposed Action's effects to Everglade snail kites.

As shown in Figure 18, the COP operations are expected to result in an overall approximate 2 percent decrease of snail production per year, on average. The projected annual 2 percent reduction in apple snails would occur throughout the projected 7-year operational period of the COP. Thus, we estimate that, on average, 1.26 (2 percent of 63) Everglade snail kites will be harmed as a result of the COP annually. Therefore, we estimate that a total of 9 (1.26 x 7) (rounded up from 8.8) Everglade snail kites will be harmed as a result of the COP during its 7-year operational period.

Even though this is a reasonable conclusion, based on the best available data, we realize that there is significant annual variability and uncertainty surrounding this estimate due to the following reasons:

- A reduction in the number of snail kites in WCA-3A or ENP in one year would not necessarily indicate a loss of snail kites due to the action if the unaccounted snail kites were elsewhere in the larger system. For example, if adult snail kites that encounter high water levels in WCA-3A subsequently nest in the STAs, KCOL or Lake Okeechobee, that disturbance does not necessarily indicate harm has occurred;
- It is impractical to monitor each individual snail kite and snail kite nest;
- It is impractical to discern the number of individual snail kites that are incidentally taken as a result of habitat impacts from other demographic and environmental parameters that will be occurring at the same time as the action, even if it was practical to monitor each individual snail kite; and
- Current methodologies for tracking population trends are insufficient to document the incidental taking of individual snail kites or their reproductive success from a specific action in a subset of the range of the species (Service 2010a).

Due to these factors of uncertainty and because it is impractical to monitor the number of individual snail kites that are incidentally taken, in accordance with 50 CFR 402.14(i)(1)(i), the estimated number of individuals will not be used to measure when the level of anticipated take has been exceeded. Only the surrogate measures based on species habitat will be used to measure when the level of anticipated take has been exceeded. Therefore, we re-affirm the evaluation and exceedance criteria that were developed for the ERTP 2016 BO that are linked to habitat quality as a surrogate for incidental take of snail kites. These criteria are described below and are summarized in Table 24.

4.13 Evaluation Criteria and Performance Measures

4.13.1 Prolonged High Water Criteria

Based on the potential for adverse effects to snail kites, apples snails, and their habitats as described in the Environmental Baseline section, the Service developed recommendations in the MSTS to guard against extended high water levels during the pre-breeding season (approximately January) and to provide favorable water levels associated with improved snail kite and apple snail productivity in the breeding (dry) season. These recommendations established the following criteria, as expressed as part of the following ERTP performance measures (PMs):

Performance Measure B (Snail Kites) – Pre-breeding Water Levels: Strive to reach water levels measured by 3AVG between 9.8 and 10.3 ft NGVD by December 31. These water levels, measured by 3AVG, when coupled with the recommended recession rate (0.05 ft per week, as described below), are recommended to provide favorable conditions in southwest WCA-3A for optimal snail kite nest success during the peak breeding season (March-June). The Service determined it was most important to apply snail kite and apple snail PMs to conditions in southwestern WCA-3A, the area most frequently used by kites in recent years (Figure 24) and where adverse impacts to snail populations should be avoided or minimized.

Performance Measure C-1 (Apple Snails) – Pre-breeding Water Levels: Strive to reach water levels between 9.7 and 10.3 ft NGVD by December 31. These water levels are based on reaching maximum water depths of 40 cm to 60 cm at the 3AVG average GSE of 8.34 ft NGVD. When coupled with a slow, gradual recession rate (approximately 0.05 ft per week), these water depths were recommended to provide favorable conditions (*i.e.,* water depths ≤40 cm, as discussed below) for apple snail egg production beginning in March, and to prevent delayed or reduced apple snail egg production.

Performance Measure C-2 (Apple Snails) – Dry Season Water Levels: Strive to reach water levels between 8.7 and 9.7 ft NGVD between May 1 and June 1. The top end of the specified range (*i.e.,* 9.7 ft, measured using the 3AVG) is related to a depth of 40 cm at the 3AVG average GSE of 8.34 ft NGVD. As discussed above, snail research suggests that this approximate water depth acts as a threshold in its effects (positive or negative) on apple snail productivity in a given year. It is important to note that, in the MSTS, the Service recognized that the stages will result in deeper water (*i.e.,* >40 cm) in southern WCA-3A, which would negatively impact snail egg production in that area, and consequently reduced the top end of the multi-species recommended dry season range to 9.3 ft NGVD (measured using the 3AVG). Our evaluation took this discrepancy into account.

4.13.2 Low Water Criteria

The intent of low water evaluation criteria was twofold; 1) to assess the potential for frequent and extended extreme low water levels which would result in reduced snail kite reproduction and recruitment, and reduced apple snail productivity and juvenile survival, and 2) to assess the opportunities for lower (but not extreme, frequent, or extended) water levels which are essential to restoration and maintenance of wet prairie habitat, and which species experts believe are necessary, at least in the transition period, to return WCA-3A to a productive kite area. Based on the information described in the snail kite Environmental Baseline section, the Service developed recommendations in the MSTS to provide favorable water levels associated with improved snail kite and apple snail productivity in the breeding (dry) season. Recommended water levels were intended to represent the annual minimum stage which typically occurs sometime in May before the onset of wet season rains. These recommendations established the following criteria, as expressed as part of the following ERTP PMs and ET:

Performance Measure B (Snail Kites) – Dry Season Water Levels: Strive to reach water levels between 8.8 and 9.3 ft between May 1 and June 1. These water levels (measured using the 3AVG) are recommended to provide favorable conditions in southwest WCA-3A for optimal snail kite nest success and juvenile survival, balanced with the need for lower water levels during the dry season to avoid negative effects to wet prairie vegetation.

Performance Measure C-2 (Apple Snails) – Dry Season Water Levels: Strive to reach water levels between 8.7 and 9.7 ft between May 1 and June 1. The bottom end of the specified range (*i.e.*, 8.7 ft, measured using the 3AVG) is related to a depth of 15 cm at the 3AVG average GSE of 8.34 ft NGVD. This water level translates to dry season minimum water depths ≥10 cm at GSE <8.36 ft NGVD, and thus, should avoid negative effects to snail movement and reproduction in these areas.

Ecological Target 3 (Wet Prairie): Hydroperiod: In dry years, strive to maintain optimal snail kite foraging habitat by allowing water levels to fall below ground surface level between 1 in 4 and 1 in 5 years (208-260 weeks average flood duration) between May 1 and June 1 to promote regenerations of marsh vegetation. Do not allow water levels below ground surface for more than 4 to 6 weeks to minimize adverse effects on apple snail survival.

4.13.3 Recession Criteria

Based on the information described in the Environmental Baseline section, the Service developed a recession recommendation for snail kites in the MSTS, and this recommendation established the following criteria, as expressed as part of the following ERTP PM:

Performance Measure D (Snail Kites) – Dry Season Recession: Strive to maintain a recession rate of 0.05 ft per week from January 1 to June 1 (or the onset of the wet season). This equates to a stage difference of approximately 1.0 ft between January and the dry season low. The Service defined the onset of the wet season as a sustained increase in water levels associated with

increased rainfall frequency, which has occurred prior to June 1 over 50 percent of the time since 1965. The recession rate guideline is most important to follow during the peak snail kite breeding season (March-June). Recession rates >0.05 ft but <0.10 ft per week, while generally more rapid than desired, may be considered acceptable under certain environmental conditions (*e.g.*, unseasonably heavy rainfall). Rates >0.0 and <0.05 ft per week are not associated with direct negative impacts to nesting snail kites, although rates approaching 0.0 ft may result in delayed or reduced snail egg cluster production, depending on water depths at that time (*i.e.*, greater impacts when water is >40 cm deep).

4.13.4 Exceedance Criteria for Incidental Take

Incidental take of snail kites will be considered exceeded if any of the following three criteria are not met during the COP operations:

<u>Dry Season High Water Timing: by April 15</u>
Trigger: stage >9.2 ft NGVD at gauge 3AS3W1
Frequency: 2 consecutive years

<u>Wet Season High Water Timing: June 1 – December 31</u>
Trigger: stage >10.5 ft at gauge 3AS3W1 for 60 days
Frequency: 2 consecutive years

<u>Recession: Dry Season Amplitude</u>
Timing: January 1 – May 31 (or onset of wet season, whichever is sooner)
Trigger: stage difference >1.7 ft as measured at gauge(s) closest to kite nesting, as determined by the Service
Frequency: 2 consecutive years

4.14 Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the Action Area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section, because they require separate consultation pursuant to section 7 of the Act.

Most of the wetlands within the Action Area for the Everglade snail kite are subject to Corps' jurisdiction and permitting under Section 404 of the CWA. In some instances, wetlands may be determined to be outside the Corps' jurisdiction. For an unknown percentage of these Federal exemptions, it is expected that the State, or county if delegated wetland permitting by the State, will claim jurisdiction and require the process of minimization of, and compensation for, wetland impacts, which should assist in minimizing impacts.

Lands surrounding or adjacent to wetlands used by the snail kite that do not require Federal involvement are where the majority of the cumulative effects are likely to occur. These lands

may be developed resulting in disturbance, habitat degradation, reduction in prey availability, isolated hydrologic changes, or permanent habitat loss. Land management activities conducted by State agencies may also have detrimental impacts to the species.

Some wetlands and the areas adjacent to those and other wetlands may be adversely affected by actions without Federal involvement, resulting in a decrease in habitat quality and quantity, prey availability, and productivity for snail kites. However, based on the status of the species discussed previously and the status of the species in the Action Area, we believe that this loss and reduction is not expected to affect the recovery or survival of the snail kite.

4.15 Conclusion

Pursuant to 50 CFR § 402.02, *"jeopardize the continued existence of"* means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species. *Recovery* is defined as the improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in section 4(a)(1) of the ESA (50 CFR § 402.02).

After reviewing the current status of the Everglade snail kite, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that the proposed action is not likely to jeopardize the continued existence of the Everglade snail kite. Consequently, we do not expect the effects of the proposed action to impede the survival or recovery of the Everglade snail kite. We make these findings for the following reasons:

- The potential effects from the COP on the Everglade snail kite and its habitat are confined to the action area which is approximately 2,374,782 acres (See Figure 20). This area produces an average of 63 Everglades snail kites per year which is approximately 3 percent of the current estimated range wide snail kite population of 2,347 birds (See Figure 15). As explained in the *Summary and Analysis of the Effects of the Action* section, the COP is estimated to reduce snail kite production within the action area by 2 percent a year for 7 years, which is estimated to result in take to a total of 9 Everglade snail kites. Therefore, the COP is estimated to result in a 0.4 percent loss to the current range wide Everglade snail kite population estimate of 2,347 birds.
- The COP operations are expected to result in continued habitat degradation within WCA-3A, which has been one of the most significant areas of kite habitat within the past 30 years. The COP operations may result in reduced nest success of kites within WCA-3A, reduced foraging habitat suitability, and reduced abundance of the kite's primary prey. These impacts may limit population growth in WCA-3A and possibly cause further reductions in the overall kite population. However, a potential increase in hydroperiods resulting from the COP within ENP may provide an overall net benefit for Everglade snail kites and apple snail habitat. Increases in flow volume into NESRS provide an opportunity for improved vegetation, including expansion of sloughs and wet

prairies, and contraction of sawgrass ridges which would provide increased foraging and nesting habitat for the Everglade snail kite and apple snails.

- Snail kites are long-lived, have high rates of adult survival, and continue to successfully nest in other portions of their range in southern Florida, the impacts of the COP are not anticipated to appreciably reduce the likelihood of survival and recovery of the species in the wild during the expected 7-year duration of the COP operations.
- The Corps shall implement specific minimization measures as part of the COP, including species and habitat monitoring to identify population trends for the Everglade snail kite. The Corps will continue conducting and coordinating Periodic Science Calls (PSC) similar to those conducted in compliance with the ERTP 2016 BO (Service 2016). Periodic Science Calls (PSC) will allow the Corps and its Tribal and governmental partners to discuss ecological, hydrological, and meteorological conditions to achieve the objective of managing water levels and releases for the protection of multiple species and their habitats, including the Everglade snail kite. Regularly scheduled interagency PSC allow the Corps to gather input on desired long term (annual and/or seasonal) conditions within the system. In addition, the PSC occur on an as needed basis with the frequency of the calls determined based upon ongoing or anticipated conditions within the WCAs, SDCS, and ENP. The PSC focus on the status of a suite of species to allow for adaptive management of the system based upon the needs of multiple species and their habitats. Under the COP, the Corps will continue to implement PSC to provide real-time assessment of conditions within the action area to ensure wildlife recommendations are considered during the water management decision process.

5.0 EVERGLADE SNAIL KITE CRITICAL HABITAT

5.1 Status of the Critical Habitat

This section summarizes the effects of all past human and natural activities or events that have led to the current status of designated critical habitat for the Everglade snail kite and are relevant to formulating the biological opinion about the proposed action.

5.1.1 Critical Habitat Description and Status

Approximately 841,635 acres (See Figure 24) were designated as critical habitat for the snail kite in 1977 (50 CFR 17.95). Because this designation was one of the earliest under the Act, specific physical or biological features that are needed by the species were not defined. Considering that snail kites feed almost exclusively on apple snails, we believe the presence of apple snail populations would be defined as a physical or biological feature of snail kite critical habitat. The designation identified nine critical habitat units that included two small reservoirs, a portion of the littoral zone of Lake Okeechobee, and areas of the Everglades' marshes within the WCAs and ENP. Since this designation, the utilization of these critical habitat units by snail kites as productive nesting areas has varied significantly. Since 2007, the Kissimmee Chain of Lakes (KCOL) has supported a large number, and in some years the majority, of nesting snail kites in Florida. This shift in productive nesting areas was in response to regional droughts as well as

habitat degradation in historic breeding locations. While the KCOL is now considered an important habitat for the snail kite, this was not the case when critical habitat was designated in 1977, and the KCOL was not included in the original designation. Since 2010, 347 snail kite nesting attempts have been documented within the Everglades STAs. STA-5 accounted for approximately 32 percent of successful snail kite nests and 35 percent of fledglings produced in 2014. However, in 2019 only one pair of Everglade snail kites nested within the Everglades STAs, and this nest failed. The STAs are designed and operated as water treatment wetlands and are not designated as critical habitat for the snail kite.

5.1.2 Factors Affecting Critical Habitat

The factors affecting designated snail kite critical habitat are generally the same as those described in the Environmental Baseline of this BO. Therefore, that information is incorporated here by reference. In general, habitat degradation occurs due to prolonged high water conditions and increased hydroperiods, and is manifested as a loss of woody vegetation and conversion of wet prairies (in WCAs) or marshes (in Lake Okeechobee, St Johns Marsh) to open, deeper water wetlands. High water levels and extended hydroperiods have resulted in vegetation shifts, degrading snail kite habitat. In addition to deeper water conditions, hydroperiods have increased, lengthening the time between drying events and further contributing to the conversion of wet prairie or marsh to less suitable habitat.

Since designation of critical habitat, the Service has consulted on the loss of 18.66 acres of critical habitat for the construction of C&SF Project infrastructure. A Biological Opinion, dated September 12, 2006, addressed the effects of construction of the Miccosukee Tribe's Government Complex Center, which resulted in the loss of 16.88 acres of critical habitat. In addition, the Service has consulted on impacts to 88,000 acres of critical habitat resulting from prolonged flooding and temporary degradation of critical habitat because of prescribed fire. Additional degradation of snail kite critical habitat has occurred because of the effects of long-term hydrologic management, natural climatic events, and eutrophication.

5.2 Environmental Baseline

5.2.1 Status of the Critical Habitat within the Action Area

The status of snail kite critical habitat is generally based on the same information in the *Status of the Species* section. Therefore, that information is incorporated here by reference. The Service does not anticipate that critical habitat outside of WCA-3A or ENP would be affected by this project. The previous loss of suitable snail kite foraging and nesting areas within WCA-3A (in both designated critical habitat and other habitat used by snail kites) have been attributed to shifts in water management regimes, and precipitation (including potential habitat degradation due to hurricanes).

WCA-3A, is an important snail kite foraging and nesting area, but the number of successful nests has fluctuated since 2001. There were no successful nests within WCA-3A in 2001, 2005, 2007,

2008, or 2010. An increased nesting effort was observed in both 2013 (12 successful nests) and 2014 (19 successful nests). The increase may be an indication that habitat quality was improving (Fletcher et al. 2015). However, in WCA-3A nesting decreased in 2015 (10 successful nests), and no successful nests were observed in WCA-3A in 2016. Only 2 successful nests were recorded in 2017. Nest success has increased recently with 17 successful nests observed in 2018 and 15 successful nests produced in 2019.

Similar to WCA-3A, snail kite nesting effort in ENP increased in 2014 as compared to 2013 (Fletcher et al. 2015). But, decreased in 2015 to 2018. In 2018, only one snail kite nest was recorded in Everglades National Park (Fletcher et al 2018).

5.2.2 Factors Affecting Critical Habitat within the Action Area

Habitat degradation within the WCA-3A Unit of critical habitat is discussed in detail in the *Threats to the Species* section of this Biological Opinion and incorporated here by reference. More specifically, prolonged high water conditions and increased hydroperiods (from September into January or beyond, whether resulting from meteorological conditions, water management operations, or a combination of both) have resulted in the loss of woody vegetation, conversion of wet prairies to open water sloughs, and vegetation shifts that degrade critical habitat within WCA-3A (Zweig 2008; Zweig and Kitchens 2008). The increased hydroperiods in WCA-3A have lengthened the time between drying events and further contribute to the conversion of wet prairie.

Similar habitat changes in ENP are likely less evident due to the lack of containment (*i.e.,* levees or embankments) that occurs around WCA-3A. The result is that water cannot "stack" over the ENP Unit of critical habitat to the same extent as is does in WCA-3A. This limits the extent of habitat degradation due to high water but could result in habitat changes due to low water, especially during droughts. For the effects of low water on kite habitat see *Prolonged Low Water Levels*.

5.3 Effects of the Action

The proposed Action Area overlaps approximately 531,910 acres of designated snail kite critical habitat (Figure 24), which is approximately 63 percent of the total range wide critical habitat for the species. As previously stated, no biological and physical features essential to the conservation of the species have been defined for snail kite critical habitat. Considering that snail kites feed almost exclusively on apple snails, we believe the presence of apple snail populations would be defined as a physical or biological feature of snail kite critical habitat. The effects analysis should use the best available scientific and commercial data available to determine and document those characteristics of the designated critical habitat that support the species' conservation.

The factors affecting the Everglade snail kite, as described previously in this BO, are similar to the factors affecting Everglade snail kite critical habitat. Like the species itself, the effects of the

COP to snail kite critical habitat is expected to be completely hydrologic since the COP consists of water management operations and does not involve construction of structural features. Potential adverse effects from the COP to Everglade snail kite critical habitat that are included in this evaluation include effects to apple snail populations, vegetation types, prolonged high water levels during September through January (or beyond in some years), prolonged low water levels during the early spring and summer, and recession rates during the breeding season (December through July).

We have considered these effects on the physical and biological features essential to the conservation of snail kites within their critical habitat, with emphasis on that portion of the critical habitat within the WCAs and ENP. Suitable water depths and hydroperiods are needed to support a moderately dense wet prairie or marsh community, with a predominance of spikerush, beakrush, and other herbaceous plants. Wet prairies (with interspersed aquatic sloughs) dominated by *Eleocharis* spp. and *Panicum* sp. are necessary for snail kite foraging, while areas with woody shrubs, such as tree islands, are optimal nesting locations (Kitchens et al. 2002). Water depths and the timing and rate of water recessions in the normally dry spring season must support survival and reproduction of apple snails during most years. Overly dense stands of vegetation, including rooted stands of cattails and floating tussocks of either cattails or other vegetation, are not suitable for the visual foraging technique of the snail kite even if apple snails are abundant in such areas.

5.4 Cumulative Effects

A variety of State and local government actions can directly or indirectly affect water volumes and water quality that could, in turn affect the quantity and quality of critical habitat for the snail kite (see section 4.14 *Cumulative Effects*). To the extent practicable, the Service attempts to track such State and local actions that may affect snail kite critical habitat and provide technical assistance, as appropriate. While these actions are not necessarily subject to the consultation requirements of the Act, the Service often becomes aware of such proposals through a variety of public forums, news reports, or through early inquiries by environmental consultants who request a list of threatened or endangered species that may be present in the project area. In the case of a wetland-dependent species such as the snail kite, any early comments by the Service will normally lead to the opportunity for consultations through the Corps' Section 404 permit process.

Exotic vegetation removal, habitat management, or fire management programs are on-going in designated snail kite critical habitat by FWC, District, FDEP, and some counties. These efforts are targeted at either removing exotic plants or opening up dense areas of cattails with herbicides or mechanical removal. No Corps permit would be required for such beneficial actions; however, the Service is engaged with these agencies to ensure adverse effects to snail kite critical habitat are avoided during vegetation removal.

General water quality conditions in snail kite critical habitat are likely stable or improving. The adoption of Total Maximum Daily Loads (TMDL) for phosphorus combined with Best

Management Practices upstream of Lake Okeechobee should benefit water quality conditions in critical habitat downstream of the lake. Similarly, the establishment of the phosphorus water quality standard in the Everglades Protection Area should serve to further improve water quality conditions in critical habitat in the WCAs and ENP.

In summary, although cumulative effects to snail kite critical habitat may occur, they would likely be limited in scope, because the larger water development projects which may affect wetlands or water quality and quantity are anticipated to require a Corps permit. Consequently, these actions are subject to section 7 consultation under the Act.

5.5 Summary and Analysis of Effects of the Action

The mechanisms for effects from the COP to Everglade snail kite critical habitat are the same as those for the species. They are reductions to apple snail populations, presence of woody vegetation that snail kites use for nesting and perch-hunting, prolonged high water levels during September through January (or beyond in some years), prolonged low water levels during the early spring and summer, and recession rates during the breeding season (December through July).

Although, there are no physical and biological features defined for Everglade snail kite critical habitat, we believe that apple snail populations are essential for the intent of snail kite critical habitat, which is to function for the conservation of the species. As previously explained, and as shown in Figure 18, the COP operations are expected to result in an overall approximate 2 percent decrease of snail production per year, on average.

These effects would occur throughout the projected operational period of the COP. According to the Corps' Integrated Delivery Schedule (IDS), the COP water management activities will be continuous over either: (1) the 7-year period identified in the IDS; (2) until construction of new CERP infrastructure, including features which would enable increased flow deliveries into the WCAs, ENP, and Florida Bay; or (3) if new information becomes available through implementation of the COP Water Control Plan and/or the COP Adaptive Management and Monitoring Program (AMMP) that would necessitate a need to modify water management operations. Therefore, the expected reasonable duration of the COP operations is 7 years.

In summary of these findings, there is reasonable certainty that the proposed Action is likely to adversely affect Everglade snail kite critical habitat by decreasing apple snail production by 2 percent throughout the 531,910 acres of snail kite critical habitat that overlaps the action area of the COP (Figure 24). This area constitutes approximately 63 percent of the total rangwide snail kite critical habitat. The estimated 2 percent reduction in apple snail production is expected to be temporary and reversible with improved hydrologic conditions which are anticipated after full implementation of the CERP.

5.6 Conclusion

"Destruction or adverse modification" means the direct or indirect alteration that appreciably diminishes the value of critical habitat, as a whole, for the conservation of a listed species." (50 CFR 402.02). After reviewing the status of the snail kite critical habitat, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that the COP is not likely to result in the *"Destruction or adverse modification"* of Everglade snail kite critical habitat.

We find that the portion of snail kite critical habitat within the action area will remain functional to serve the intended conservation role for the Everglade snail kite. And, as a net result, this portion of the snail kite's critical habitat would remain functional to support conservation of snail kites. Consequently, we do not expect the effects of the proposed action to appreciably diminish the value of critical habitat, as a whole, for the conservation of the Everglade snail kite. We make these findings for the following reasons:

- No permanent loss of Everglade snail kite critical habitat is expected.
- Degradation of designated critical habitat within WCA-3A may continue under the COP during the expected 7-year duration of the COP, but this is reversible with improved hydrologic conditions which are anticipated after full implementation of the CERP.
- The Corps shall implement specific minimization actions as part of the COP, including species and habitat monitoring to identify population trends for the Everglade snail kite. The Corps will continue conducting and coordinating Periodic Science Calls (PSC) similar to those conducted in compliance with the ERTP 2016 BO (Service 2016). Periodic Science Calls (PSC) will allow the Corps and its Tribal and governmental partners to discuss ecological, hydrological, and meteorological conditions to achieve the objective of managing water levels and releases for the protection of multiple species and their habitats, including the Everglade snail kite. Regularly scheduled interagency PSC allow the Corps to gather input on desired long term (annual and/or seasonal) conditions within the system. In addition, the PSC occur on an as needed basis with the frequency of the calls determined based upon ongoing or anticipated conditions within the WCAs, SDCS, and ENP. The PSC focus on the status of a suite of species to allow for adaptive management of the system based upon the needs of multiple species and their habitats. Under the COP, the Corps will continue to implement PSC to provide real-time assessment of conditions within the action area to ensure wildlife recommendations are considered during the water management decision process.

6.0 WOOD STORK

6.1 Status of the Species

6.1.1 Legal Status

The United States breeding population of the wood stork (*Mycteria americana*) was first listed under the Act as endangered on February 28, 1984. Recent population estimates indicate the wood stork population has reached its highest level since it was listed as endangered in 1984. Approximately 12,105 wood stork pairs nested within their breeding range in the southeastern United States in 2018, primarily in Georgia, Florida and South Carolina and the number of colonies increased to 100 (Service 2018). The U.S. Fish and Wildlife Service upgraded the status for wood storks from endangered to threatened under the Endangered Species Act on July 30, 2014 (79 FR 37077). No critical habitat has been designated for the wood stork.

6.2 Species Description

The wood stork is a large, long-legged wading bird, with a head to tail length of 33 to 45 inches and a wingspan of 59 to 65 inches (Coulter et al. 1999). Wood storks are distinguishable in flight as they fly with their neck and legs extended. Their plumage is white, except for iridescent black primary and secondary wing feathers and a short black tail. On adults, the rough scaly skin of the head and neck is un-feathered and blackish in color, the legs are dark, the feet are dull pink, and the bill is blackish in color. Immature wood storks (*i.e.*, wood storks up to the age of about three years) have yellowish or straw-colored bills and varying amounts of dusky feathering on the head and neck (Coulter et al. 1999). During courtship and the early nesting season, adults may develop buff or pinkish coloration on the wing linings; fluffy, plume-like under tail coverts; and bright pink toes.

6.3 Life History

The wood stork is found primarily in the Southeast and is the only stork that breeds in the United States. Storks typically begin breeding at three to four years of age. Egg laying in wood storks historically began in early October in south Florida and nesting continued into June (Rodgers 1990) but has shifted to between January and March in recent decades (Ogden 1996). In addition, there was a significant north-south temporal difference in clutch initiation with egg laying in central Florida occurring from February to May. The wood storks in the northern distribution of their range (Georgia, South Carolina, North Carolina) begin pair formation in early March or April. A single clutch of two to five (average three) eggs are laid per breeding season, but a second clutch may be laid if a nest failure occurs early in the breeding season (Coulter et al. 1999). There is variation between years in the clutch sizes, and clutch size does not appear to be related to longitude, nesting density, or nesting numbers. Clutch size may be more related to habitat conditions at the time of egg-laying. Egg-laying is staggered, and

incubation, which lasts about 30 days, begins after the first egg is laid. Therefore, the eggs hatch at different times and the nestlings vary in size (Coulter et al. 1999).

Wood storks produce an average of 1.29 (±1.16) fledglings per nest and 0.42 (±0.37) fledgling per egg. The probability of survival for each egg during the nesting season (egg-laying to fledging) was 46 percent (Rodgers and Schwikert 1997) (Table 18). The greatest loss (30 percent) occurs from egg-laying to hatching. From hatching to nestlings of two weeks of age, nest productivity loss is an additional eight percent. Corresponding losses for the remainder of the nesting cycle are on the average of six percent per two-week increase in age of the nestling (Rodgers and Schwikert 1997). The young fledge in about eight weeks but will stay at the nest for three to four additional weeks while they continue to be fed by the adults.

Adults feed the young by regurgitating whole fish into the bottom of the nest. This occurs at a rate of approximately three to ten times per day. Feedings are more frequent when nestlings are young (Coulter et al. 1999) and are influenced greatly by the distance adults must fly to locate food (*i.e.*, as foraging flight distance increases feeding rate decreases) (Bryan et al. 1995). The total nesting period, from courtship and nest-building through the independence of young, lasts about 100 to 120 days (Coulter et al. 1999). Within a colony, nest initiation may be asynchronous, and consequently a colony may contain breeding wood storks for a period much longer than the 120 days required for a pair to raise young to independence. Adults and independent young may continue to forage around the colony site following the completion of breeding.

Wood storks feed almost entirely on fish sized anywhere from 1 to 10 inches long (Kahl 1964; Ogden et al. 1976; Coulter 1987), but may occasionally consume crustaceans, amphibians, reptiles, mammals, birds, and arthropods. Wood storks generally use a specialized feeding behavior called tactilocation, or grope feeding, but also forage visually under some conditions (Kushlan 1979). Storks typically wade through the water with their beak immersed and open about 2.5 to 3.5 inches. When the wood stork encounters prey within its bill, the mandibles snap shut, the head is raised, and the food swallowed (Kahl 1964). Occasionally, wood storks stir the water with their feet in an attempt to startle hiding prey (Rand 1956; Kahl 1964; Kushlan 1979). This foraging method allows them to forage effectively in turbid waters, at night, and under other conditions when other wading birds that employ visual foraging may not be able to forage successfully.

During the nesting period, storks are dependent on consistent foraging opportunities in wetlands within about 18.6 miles of the nest site with the greatest energy demands occurring during the middle of the nestling period, when nestlings are 23 to 45 days old (Kahl 1964). The average wood stork family requires 201 kilograms of fish, crustaceans, and other prey during the breeding season with 50 percent of the nestlings' food requirement occurring during the middle third of the nestling period (Kahl 1964). It is estimated that about 50 kilograms of food are needed to meet the foraging requirements of the adults and nestlings in the first third of the nesting cycle. Receding water levels are necessary in south Florida to concentrate suitable densities of forage fish (Kahl 1964; Kushlan et al. 1975).

Gawlik (2002) characterized wood storks as “searchers” that employ a foraging strategy of seeking out areas of high-density prey and optimal (shallow) water depths. They seem to abandon foraging sites when prey density begins to decrease below a particular efficiency threshold but while prey is still sufficiently available for other wading bird species to forage in large numbers (Gawlik 2002). Wood stork choice of foraging sites was significantly related to both prey density and water depth (Gawlik 2002). Because of this strategy, wood stork foraging opportunities are more constrained than many of the other wading bird species (Gawlik 2002).

Following the completion of the nesting season, both adult and fledgling wood storks generally begin to disperse away from the nesting colony. Fledglings have relatively high mortality rates within the first 6 months following fledging, most likely due to their lack of experience and the selection of poor foraging locations (Hylton et al. 2006). Post-fledging survival also appears to be variable among years, probably reflecting the environmental variability that affects storks and their ability to forage effectively (Hylton et al. 2006). In southern Florida, both adult and juvenile storks consistently disperse northward following fledging in what has been described as a mass exodus (Kahl 1964). Storks in central Florida also appear to move northward following the completion of breeding, but generally do not move as far (Coulter et al. 1999). Many of the juvenile storks from southern Florida move beyond Florida into Georgia, Alabama, Mississippi, and South Carolina (Coulter et al. 1999; Borkhataria et al. 2004, Borkhataria et al. 2006). Some flocks of juvenile storks have also been reported to move well beyond the breeding range of storks in the months following fledging (Kahl 1964). This post-breeding northward movement appears consistent across years.

Adult and juvenile storks return southward in the late fall and early winter months. In a study employing satellite telemetry, Borkhataria et al. (2006) reported that nearly all storks that had been tagged in the southeastern United States moved into Florida near the beginning of the dry season, including all sub-adult storks that fledged from Florida and Georgia colonies. Adult storks that breed in Georgia remained in Florida until March, and then moved back to northern breeding colonies (Borkhataria et al. 2006). Overall, about 75 percent of all locations of radio-tagged wood storks occurred within Florida (Borkhataria et al. 2006). Preliminary analyses of the range-wide occurrence of wood storks in December, recorded during the annual Christmas bird surveys, suggest that the majority of the southeastern United States population occurs in central and southern Florida. Relative abundance of storks in this region was 10 to 100 times higher than in northern Florida and Georgia (Service 2007a). Because of these general population-level movement patterns during the earlier period of the breeding season in southern Florida, it is apparent that the wetlands upon which nesting storks depend are also heavily used by a large portion of the southeastern United States wood stork population, including storks that breed in Georgia and the Carolinas, and sub-adult storks from throughout the species’ range. In addition, these same wetlands support a variety of other wading bird species (Gawlik 2002).

The wood stork life history strategy has been characterized as a “bet-hedging” strategy (Hylton et al. 2006) in which high adult survival rates and the capability of relatively high reproductive output under favorable conditions allow the species to persist during poor conditions and

capitalize on favorable environmental conditions. This life-history strategy may be adapted to variable environments (Hylton et al. 2006) such as the wetland systems of southern Florida.

6.4 Habitat

Wood stork nesting habitat consists of mangroves as low as 3 feet, cypress as tall as 100 feet, and various other live and dead shrubs or trees located in standing water (swamps) or on islands surrounded by relatively broad expanses of open water (Palmer 1962; Rodgers et al. 1987; Ogden 1991; Coulter et al. 1999). Wood storks generally occupy the large-diameter trees at a colony site because storks often nest in conjunction with other wading bird species (Rodgers et al. 1996). The same colony site will be used for many years as long as the colony is undisturbed and sufficient feeding habitat remains in surrounding wetlands. However, not all storks nesting in a colony will return to the same site in subsequent years (Kushlan and Frohring 1986). Natural wetland nesting sites may be abandoned if surface water is removed from beneath the trees during the nesting season (Rodgers et al. 1996). In response to this type of change to nest site hydrology, wood storks may abandon a site and establish a breeding colony in managed or impounded wetlands (Ogden 1991). Wood storks that abandon a colony early in the nesting season due to unsuitable hydrological conditions may re-nest in other nearby areas (Borkhataria et al. 2004; Crozier and Cook 2004).

Between breeding seasons or while foraging, wood storks roost in trees over dry ground, on levees, or large patches of open ground. Wood storks may also roost within wetlands while foraging far from nest sites and outside of the breeding season (Gawlik 2002). While the majority of stork nesting occurs within traditional stork rookeries, a handful of new stork nesting colonies are discovered each year (Meyer and Frederick 2004; Brooks and Dean 2008). These new colony locations may represent temporary shifts of historic colonies due to changes in local conditions, or they may represent formation of new colonies in areas where conditions have improved.

Wood storks forage in a wide variety of wetland types within 31 miles of the colony site, where prey are available and the water is shallow and open enough to hunt successfully (Ogden et al. 1978; Browder 1984; Coulter 1987; Bryan and Coulter 1987). However, foraging occurs most frequently within 12.5 miles of the colony (Coulter and Bryan 1993). Fixed width areas around colonies (*i.e.*, Core Foraging Areas (CFA)) needed for nesting wood storks to successfully produce and fledge offspring have been delineated as 13, 15, and 18.6 miles for North, Central, and South Florida, respectively (Kahl 1964; Browder 1984; Frederick and Collopy 1988; Cox et al. 1994; Bryan et al. 2012). Maintaining this wide range of feeding site options ensures sufficient wetlands of all sizes and varying hydroperiods are available during shifts in seasonal and annual rainfall and surface water patterns to support nutritional changes. Calm water, about 2 to 16 inches deep and free of dense aquatic vegetation is ideal (Coulter and Bryan 1993). Typical foraging sites include freshwater marshes, ponds, hardwood and cypress swamps, narrow tidal creeks or shallow tidal pools, and artificial wetlands such as stock ponds, seasonally flooded shallow roadside or agricultural ditches, and managed impoundments (Coulter et al. 1999; Coulter and Bryan 1993). Generally, storks use wet prairie ponds early in the dry season

then shift to slough ponds later in the dry season, thus following water levels as they recede into the ground (Browder 1984).

Several factors affect the suitability of potential foraging habitat for wood storks. Suitable foraging habitats must provide both a sufficient density and biomass of forage fish and other prey, and have vegetation characteristics that allow storks to locate and capture prey. Hydrologic and environmental characteristics have a strong effect on fish density and these factors may be some of the most significant in determining foraging habitat suitability, particularly in southern Florida. Areas with longer hydroperiods generally support more and larger fish (Loftus and Eklund 1994; Turner et al. 1999; Trexler et al. 2002). In addition, nutrient enrichment (primarily phosphorus) within the oligotrophic Everglades wetlands generally results in increased density and biomass of fish in potential foraging sites (Rehage and Trexler 2006). Distances from dry-season refugia, such as canals, alligator holes, and similar long hydroperiod sites also affect fish density and biomass. Wetlands of varying hydroperiod are typically needed to provide sufficient food resources for parent storks and their young during the 85 to 105-day breeding season (Fleming et al. 1994). Within the highly modified environments of southern Florida, fish availability varies with respect to hydrologic and nutrient availability gradients, and it becomes very difficult to predict fish density. The foraging habitat for most wood stork colonies within southern Florida includes a variety of hydroperiod classes, nutrient conditions, and spatial variability.

6.5 Distribution

The wood stork occurs from northern Argentina, eastern Peru and western Ecuador, north to Central America, Mexico, Cuba, Hispaniola, and the southeastern United States (American Ornithologists Union 1983). Only the population segment that breeds in the southeastern United States is listed as threatened. In the United States, wood storks were historically known to nest in all coastal states from Texas to South Carolina (Wayne 1910; Bent 1926; Howell 1932; Oberholser 1938; Dusi and Dusi 1968; Cone and Hall 1970; Oberholser and Kincaid 1974).

Storks are found year-round throughout their breeding range, except in South Carolina, North Carolina, and Georgia. Most individuals retreat to Florida and South Georgia during midwinter after breeding season dispersal. Currently, wood stork nesting occurs in Florida, Georgia, South Carolina, and North Carolina. Breeding colonies of wood storks exist in all southern Florida counties, except for Okeechobee County. Additional expansion of the breeding range of wood storks in the southeastern United States has continued, both to the north and to the west along the Gulf Coast (Service 2007a).

6.6 Population Dynamics

The United States breeding population of wood storks declined from an estimated 20,000 pairs in the 1930s to about 10,000 pairs by 1960 (49 FR 7332). From the early 1960s, the wood stork population has declined in southern Florida and increased in northern Florida, Georgia, and South Carolina (Ogden et al. 1987). The number of nesting pairs in the Everglades and Big

Cypress ecosystems (southern Florida) declined from 8,500 pairs in 1961 to 969 pairs in 1995. During the same period, nesting pairs in Georgia and South Carolina increased from 4 to 1,501 and from 11 to 829, respectively (Service 1997).

Since being listed under the ESA in 1984, annual nest counts have increased significantly in south Florida from 1,245 pairs in 1984 to 5,777 pairs in 2018 (Service 2014; Cook and Baranski 2019). However, despite two previously successful nesting seasons in 2017 and 2018, wood storks in the Everglades region had a poor year with all nests failing in 2019 (Frederick and Garner 2020). The 5-year averages for nesting in the Everglades and Big Cypress Systems are below 2,500 nesting pairs, as nesting in south Florida remains variable (Service 2014). From 1991 to 2005 statewide surveys in Florida suggest that the nesting population increased, and, while colonies were declining in size, the overall number of colonies was also increasing (Frederick and Meyer 2008). Florida's nest counts have increased from 5,647 to up to 9,428 pairs since listing (Service 2018). Historically, colonies in the south were associated with extensive wetland systems and predictable patterns of prey availability. Ogden et al. (1987) suggested the population shift was the result of deteriorating feeding conditions in south Florida and better nesting success rates in north-central Florida that compound population growth in that area. Further evidence of a general northern breeding range expansion occurred in 2005 when storks were first documented nesting successfully in North Carolina. Wood storks have continued to nest in North Carolina and have increased their nesting pairs to 128 in 2018, from 32 in 2005 (Service 2018).

Nest initiation date, colony size, nest abandonment, and fledging success of a wood stork colony varies from year-to-year based on availability of suitable wetland foraging areas, which can be affected by local rainfall patterns, regional weather patterns, and anthropogenic hydrologic management (Service 1997). A colony site may be vacant in years of drought or unfavorable conditions due to inadequate foraging conditions in the surrounding area (Kahl 1964). Storks may abandon traditional colony nesting sites completely when hydrological changes occur such as removing surface water from beneath the colony trees (Service 1997; Coulter et al. 1999). Nesting failures and colony abandonment may also occur if unseasonable rainfall causes water levels to rise when they are normally receding, thus dispersing rather than concentrating fish prey (Kahl 1964; Service 1997; Coulter et al. 1999).

6.7 Threats

The primary cause of the wood stork population decline in the United States was the loss of wetland habitats or loss of wetland function that resulted in reduced prey availability. Dahl (1990) estimates about 38 million acres, or 45.6 percent, of historic wetlands were lost between the 1780s and the 1980s. However, it is important to note wetlands and wetland losses are not evenly distributed in the landscape. Hefner et al. (1994) estimated 55 percent of the 2.3 million acres of the wetlands lost in the southeastern United States between the mid-1970s and mid-1980s were located in the Gulf-Atlantic Coastal Plain. These wetlands were strongly preferred by wood storks as nesting habitat. Since the 1970s, wood storks have been observed shifting their nest sites to artificial impoundments or islands created by dredging activities (Ogden 1991).

The percentage of nests in artificial habitats in central and north Florida has increased from about 10 percent of all nesting pairs in 1959 to 1960 to 60 to 82 percent between 1976 and 1986 (Ogden 1991). Nest trees in these artificially impounded sites often include exotic species such as Brazilian pepper or Australian pine (*Casuarina equisetifolia*). Ogden (1996) suggested the use of these artificial wetlands indicated wood storks were not finding suitable conditions within natural nesting habitat, or they were finding better conditions at the artificial wetlands. The long-term effect of these nesting areas on wood stork populations is unclear.

Ogden and Nesbitt (1979) indicated a reduction in nesting sites was not the cause of the population decline, because the number of nesting sites used from year to year was relatively stable. They suggested loss of an adequate food base was a contributing cause of wood stork declines. Changes in remaining wetland systems in Florida, including drainage and impoundment, may have been a larger problem for wood storks than loss of foraging habitat (Ogden and Nesbitt 1979). Almost any shallow wetland depression where fish become concentrated, through either local reproduction or receding water levels, may be used as feeding habitat by the wood stork during some portion of the year, but only a small portion of the available wetlands support foraging conditions (high prey density and favorable vegetation structure) that storks need to maintain growing nestlings. Browder et al. (1976) and Browder (1978) documented the distribution and total acreage of wetland types (cypress domes and strands, wet prairies, scrub cypress, freshwater marshes and sloughs, and saw grass marshes) occurring south of Lake Okeechobee, Florida, for the period 1900 through 1973 and found these habitat types had been reduced by 35 percent.

The alteration of wetlands and the manipulation of wetland hydroperiods have also reduced the amount of foraging habitat available to wood storks. The decrease in wood storks nesting on Cape Sable was related to the construction of the drainage canals during the 1920s (Kushlan and Frohring 1986). Water level manipulation can aid raccoon predation of wood stork nests when water is kept too low (alligators deter raccoon predation when water levels are high). Artificially high water levels may retard nest tree regeneration since many wetland tree species require periodic droughts to establish seedlings. Water level manipulation may decrease food productivity if the water levels and length of inundation do not match the breeding requirements of forage fish. Dry-downs of wetlands may selectively reduce the abundance of the larger forage fish species that wood storks tend to use, while still supporting smaller prey fish.

6.7.1 Non-native Invasive Species

The Burmese python, native to South Asia, is now breeding and expanding its range in the greater Everglades ecosystem increasing concerns among land managers about the potential impacts of this invasive snake. More than 1,400 Burmese pythons have been removed from ENP since 2000. Their population numbers are now estimated to be in the thousands in ENP, potentially impacting a wide variety of listed and native species. A growing wild population of pythons has the potential to create a major ecological problem in ENP and threaten successful restoration of the greater Everglades (NRC 2005, Hart et al. 2015).

The rapid and widespread invasion of Burmese pythons is facilitated by aspects of their natural history such as diverse habitat use, broad dietary preferences, long lifespan (15 to 25 years), high reproductive output, and ability to move long distances. Burmese python hatchlings are larger than hatchlings of native species and are less susceptible to predators. These multiple advantages may allow pythons to compete with native snakes and other predators for food, habitat, and space.

Burmese pythons are generalist predators that consume a wide variety of mammal and bird species, as well as other reptiles, amphibians, and fish (Snow et al. 2007). Like other constrictors, the Burmese python seizes prey with its teeth and then wraps its body around the animal and kills it by constriction. Pythons in Florida have consumed prey as large as white-tailed deer (*Odocoileus virginianus*) and adult American alligators (Snow et al. 2007). As Burmese pythons expand their range in south Florida, it becomes increasingly important to learn what they are eating in order to assess their impact on native fauna and to predict what species are at risk. Previous studies found fourteen species of mammals, five species of birds, and one species of reptile in the stomachs of pythons collected and examined in Florida (Snow et al. 2007). More recent studies have discovered as many as 25 bird species in the digestive tracts of Burmese pythons in ENP including the wood stork (Dove et al. 2011). Juveniles of these large constrictors will climb to remove prey from bird nests and capture perching or sleeping birds. The overall risk of python predation on wood storks is currently unknown. By preying on native wildlife, and competing with other native predators, pythons have the potential to seriously impact the natural order of south Florida's ecological communities.

6.7.2 Contaminants

The role of contaminants in the decline of the wood stork is unclear. Pesticide levels high enough to cause eggshell thinning have been reported in wood storks, but decreased productivity was not linked to contaminants (Ohlendorf et al. 1978; Fleming et al. 1984). Burger et al. (1993) studied heavy metal and selenium levels in wood storks from Florida and Costa Rica. Adult birds generally exhibited higher levels of contaminants than young birds. Burger et al. (1993) attributed this to bioaccumulation in the adults who may be picking up contaminants at the colony nesting site and while foraging at other locations during the non-breeding season. There were higher levels of mercury in young birds from Florida than young birds or adult birds from Costa Rica. Young birds from Florida also exhibited higher levels of cadmium and lead than young birds from Costa Rica. Though Burger et al. (1993) recommended the lead levels in Florida be monitored; they drew no conclusions about the potential health effects of contaminants to wood storks.

6.7.3 Ongoing Conservation Efforts (Recovery)

Reasonable actions believed to be required for the recovery of the wood stork are outlined in the Service’s recovery plan (1997). The plan’s recovery criteria for reclassification from endangered to threatened is 6,000 nesting pairs and annual regional production greater than 1.5 chicks per nest/year (both calculated over a 3-year average). Delisting could be considered when there are

10,000 nesting pairs calculated over a 5-year period beginning at the time of reclassification and annual regional production is greater than 1.5 chicks per nest/year (calculated over a 5-year average). As a subset of the 10,000 nesting pairs, a minimum of 2,500 nesting pairs must occur in the Everglades and Big Cypress systems in south Florida.

In 2001, the Service reinitiated another 5-year synoptic aerial survey effort for wood stork colonies throughout the southeast range of the species (Service 2003), and surveys have been conducted annually since then. The wood stork population is increasing and expanding its overall and breeding ranges in the southeastern United States (Brooks and Dean 2008). The southeastern U.S. total wood stork population has exceeded 10,000 nesting pairs in multiple years following the 2006 breeding season but has not entirely met recovery goals for south Florida (Cook and Baranski 2019). Three-year averages calculated from nesting data from 2001 through 2013 indicated that the total nesting population had been consistently above the reclassification threshold of 6,000 nesting pairs. These averages have ranged from about 7,086 to 10,147 nesting pairs during this time period (Service 2014). Consequently, on July 30, 2014, the wood stork was downlisted to threatened (79 FR 37077).

The 5-year average since 2013 has been above 10,000 pairs. The previous period that the nesting population surpassed 10,000 pairs was in the early 1960s. Wood stork nesting continues to be recorded in North Carolina after it was first documented there in 2005. This suggests that the northward expansion of wood stork nesting may be continuing. The number of colonies also continues to increase with 100 nesting colonies reported in 2018 throughout the southeastern United States (Table 19).

6.7.4 Wood Stork Nesting in the Everglades and Big Cypress Systems

The number of nesting pairs in south Florida's Everglades and Big Cypress ecosystems declined from 8,500 pairs in 1961 to fewer than 500 pairs from 1987 through 1995 (Service 2007a). The *South Florida Multi Species Recovery Plan* (Service 1999) defines the Everglades and Big Cypress ecosystems as the area south of Lake Okeechobee from Lee County on the west coast to Palm Beach County on the east coast. Total nesting pairs for colonies in this region have varied from year to year. In a review of nesting data for the Everglades and Big Cypress basin region, wood stork nesting effort has shown an increase from 2005 to 2018 with 634 and 5,777 pairs, respectively (Table 20). The highest peak of nesting occurred in 2009 with over 6,000 nesting pairs. These observed fluctuations in nesting between years and nesting sites have been attributed primarily to variable hydrologic conditions during the nesting season. Frequent heavy rains during nesting can cause water levels to rise rapidly. The abrupt increase in water levels (*i.e.*, a "reversal") during nesting may cause nest abandonment, re-nesting, late nest initiation, and poor fledging success. Abandonment and poor fledging success have been reported to affect most wading bird colonies in southern Florida (Crozier and Cook 2004; Cook and Call 2005; Cook and Kobza 2008). (*Note: Hydrologic condition can be located in the South Florida Wading Bird reports for each breeding season from 1996-2018*).

Since 1996, the annual South Florida Wading Bird Report has included a summary of nesting patterns for wood storks in the Everglades using a set of performance measures meant to capture ecological relationships found in the historical ecosystem. These annual summaries are useful for characterizing pre-CERP nesting patterns. The key parameters are number of nesting pairs, location of nesting colonies, timing of stork nesting, and the occurrence and frequency of wood stork "super colonies". The Service's recovery goal for wood storks in south Florida include a 5-year running average of 2,500 nesting pairs per year and a nest production that averages at least 1.5 young per active nest (Service 1997). The 5-year average has been above 2,500 pairs 6 times since 1996 and was 3,079 in 2018 (Table 20).

6.8 Environmental Baseline

6.8.1 Status of the Species within the Action Area

Since 1986, the Corps has funded a program to monitor nesting effort and success of wading birds, including wood storks, in the WCAs. The objectives are to track the demographics of the various species in an attempt to understand the environmental variables that relate to successful breeding. The program includes aerial surveys that identify locations of wading bird nesting colonies each year and estimate the number of nests produced by each wading bird species. Ground surveys are also conducted in colonies that contain wood storks. The results of these surveys help researchers estimate nesting success (number of young fledged) in a sub-set of marked nests. Nesting effort (number of nests) of wood storks from 2009 to 2018 in the various colonies in the WCAs and just south of WCA-3B in ENP is summarized in Table 21. There is no clear trend in the number of storks nesting in the action area. Nesting effort from the years 2009 through 2018 is variable with an average of 80.9 nests per year and an average 3-year running average over the same period of 54.7 nests per year (Table 21).

The implementation of ERTP began in October 2012 and the anticipated date for the COP implementation is August 2020. The Restoration Coordination & Verification (RECOVER) program establishes Performance Measures (PMs) to estimate the ecological response to restoration projects and evaluate the impact and effectiveness of CERP. The RECOVER PM for wood storks uses the 3-year running average of the numbers of wood stork nesting pairs in the mainland Everglades (target of 1,500 nesting pairs), the timing of wood stork nesting, and the proportion of the population that nest in the coastal ecotone (Ogden et al. 1997). Wood storks met their 3-year running average RECOVER PM targets for the Everglades in 2012-2014, 2013-2015, and 2016-2018 (Cook and Baranski 2019).

The 5-year running average of wood stork nesting pairs occurring in the Everglades and Big Cypress Basins met the Service's wood stork recovery goal for delisting (target of 2,500 nesting pairs) in 2017 and 2018 (Table 20). During the period of 2012 to 2018, the 3-year running average number of wood stork nests initiated in South Florida had an average annual growth rate of 19 percent (Table 20). Additional data are needed to discern whether the increase was related to 1) improved water management operations under ERTP (recession rates/water depths), or 2) the increase in overall abundance of the wood stork breeding population.

The initiation of wood stork nesting in the action area has shifted from November-December (1930s through 1960s) to January-March (1980s to present). This shift increases the risk of mortality of nestlings and overall nest failures. Wood storks in South Florida have shown a consistent trend towards later nesting between the 1930s and the 1980s, with variation around a February mean initiation date since the 1980s (Cook and Baranski 2019). This is even more evident as nest initiation has occurred later than the average date of early February during the implementation of ERTP (2012-2017), except for 2018 when wood storks initiated nesting by the end of December.

In 2012, 2015, 2016, and 2019 wood storks did not initiate any nesting activity in the WCAs; however, wood storks did nest within ENP. The 2012 season had above average water levels throughout the system despite strong recession rates that were within 60 percent of years in the period of record. A strong reversal, due to rain starting in late April, pushed water levels well above average. High water levels limit nest success by decreasing prey availability. It is believed that most nests failed due to heavy rains that occurred before any young had fledged. Similar conditions were apparent in 2015 and 2016, when widespread storms and water-level reversals in late April also led to widespread nest failures. The overall low nesting effort in 2019 was clearly related to record rainfall in late January and then subsequent reversals in February and March. This provided essentially none of the water recession and drying that has in the past been important to wading bird nesting numbers and nesting success in the region.

Wood stork nesting success is highly dependent on the availability of aquatic prey (fish), which are easy to find and feed upon when concentrated at high densities in shallow water during the dry season (winter-spring) but are not available during the wet season (summer-fall) when they move into deeper waters and disperse across the landscape. To successfully fledge their young, wood storks require a continuous supply of abundant and concentrated fish throughout the reproductive period. In a hydrologically fluctuating wetland such as the Everglades, prey production is influenced largely by the duration and frequency of wetland flooding and drying, with optimal conditions for population growth varying by species. Most fish populations peak after extended periods (multiple years) of relatively deep, flooded conditions over extensive areas of wetland (Trexler et al. 2005). These conditions seem to have been most prevalent in 2013-2014 and 2017-2018 when conditions were conducive for nesting within the action area.

6.9 Factors Affecting the Species Environment within the Action Area

6.9.1 Hydrology

Within the wetland systems of southern Florida, the annual hydrologic pattern is very consistent, with water levels rising over 3 feet during the wet season (June to October), and then receding gradually during the dry season (November to May). Historically, the annual climatological pattern that appeared to stimulate the heaviest nesting efforts by wood storks was a combination of the average or above-average rainfall during the summer rainy season prior to colony formation and an absence of unusually rainy or cold weather during the following winter-spring

nesting season (Kahl 1964). This pattern produced widespread and prolonged flooding of summer marshes that maximized production of freshwater fishes, followed by steady drying that concentrated fish during the dry season when storks nest (Kahl 1964).

Wood storks nest during the dry season, and rely on the drying wetlands to concentrate prey items in the ever-narrowing wetlands (Kahl 1964). Because of the continual change in water levels during the wood stork nesting period, any one site may only be suitable for wood stork foraging for a narrow window of time when wetlands have sufficiently dried to begin concentrating prey and making water depths suitable for wood storks to access the wetlands. Once the wetland has dried to where water levels are near the ground surface, the area is no longer suitable for wood stork foraging, and will not be suitable until water levels rise and the area is again repopulated with fish. Consequently, there is a general progression in the suitability of wetlands for foraging based on their hydroperiods, with the short hydroperiod wetlands being used early in the season, the mid-range hydroperiod sites being used during the middle of the nesting season, and the longest hydroperiod areas being used later in the season (Kahl 1964; Gawlik 2002).

Short hydroperiod wetlands are an important pre-nesting food source and have a greater effect on early nestling survival for wood storks than indicated by the amount of foraging base (ounces of fish per square foot) produced in these wetlands (Fleming et al. 1994; Ceilley and Bortone 2000). For instance, Loftus and Eklund (1994) provide an estimate of 5 fish per square foot for long hydroperiod wetlands and 0.5 fish per square-foot for short hydroperiod wetlands. Because of the consistent pattern of drying that normally occurs during the wood stork nesting season, the short hydroperiod wetlands would also be the areas used for foraging early in the season when long hydroperiod wetlands remain too deep for wood storks to forage effectively, or sufficient prey concentration has not yet occurred due to drying. Although the short hydroperiod wetlands support fewer fish and lower fish biomass per unit area than long hydroperiod wetlands, these short hydroperiod wetlands were historically more extensive and provided foraging areas for wood storks during colony establishment, courtship and nest-building, egg-laying, incubation, and the early stages of nestling provisioning. This period corresponds to the greatest periods of nest failure (*i.e.*, 30 and 8 percent, respectively, from egg-laying to hatching and from hatching to nestling survival to 2 weeks) (Rodgers and Schwikert 1997).

Based on Kahl's (1964) estimate that 201 kg (443 lbs) of fish, crustaceans, and other prey are needed for the success of a nest and that 50 percent of the foraging base is needed in the middle third of the nesting cycle when chicks are about 23 to 45 days old (Kahl 1962), it is estimated about 50 kg (110 lbs) are needed to meet the foraging needs of the adults and nestling in the first third of the nesting cycle. Considering the relatively low foraging values these short hydroperiod wetlands provide in relation to corresponding long hydroperiod wetlands, a much larger proportion of long hydroperiod wetlands are needed to ensure survival and to sustain development of nestlings. The disproportionate reduction (85 percent) of long hydroperiod wetlands known to have occurred from development and over drainage has been postulated as a major cause of late colony formation and a reduction in early nestling survival rates (Fleming et al. 1994).

Consequently, the Corps began testing new operating rules for water management facilities in the Modified Water Deliveries (MWD) project in October 2015. The goal of the MWD operational tests is to increase water deliveries from WCA-3A through Northeast Shark River Slough (NESRS) to ENP. The construction phase of the MWD project was completed in 2018.

The MWD project was expected to result in continued high water levels in WCA-3A during the wet season and early dry season, followed by a rapid spring recession and rapidly increasing stages in the early wet season (Service 2002; Service 2006a; Service 2010a; Service 2012a; Service 2016). The ERTP provided avenues for near real-time water management decisions to provide benefits to multiple species within WCA-3A. It also provided a means for reducing high water periods and prolonged flooding within WCA-3A, with the intent of restoring vegetation within the area (Corps 2011). These effects would result in relatively high abundance of wood stork prey because of high stages and long hydroperiods, allowing prey to become available to wood storks at a rapid rate in the late dry season.

On September 15, 2017, the Corps initiated an emergency and a planned temporary deviation from MWD Increment 1 Plus and the 2012 Water Control Plan in order to provide high water relief for Water Conservation Area 3A and the South Dade Conveyance System in the wake of Hurricane Irma. The planned temporary deviation included delayed closure of the S-12A, S-12B, S-343A, S-343B and S-344 structures until the WCA 3 three gage average (3AVG) falls below the MWD Increment 1 Action Line or January 1, 2018. The WCA-3A emergency and planned temporary deviations resulted in an increased rate of recession beginning on October 13, 2017. Depths and recession rates during the dry season were near optimal for wading bird foraging, and wading birds responded by feeding in large numbers along the drying front in WCA-3A throughout the nesting season (Cook and Barinsky 2019). The expected effect of this hydrologic condition was early nesting initiation and increased rates of nest initiation in those colonies closely associated with WCA-3A (*i.e.*, L-28 Crossover, Jetport, Jetport South, WCA13, and Cypress City). However, water levels peaked on October 30, 2017 at nearly one foot above the historic average in WCA-3B, which meant water levels remained too deep for optimal wading bird foraging until the beginning of April. Consequently, no nesting was initiated in those colonies closely associated with WCA-3B (*i.e.*, 3B Mud East, Tamiami Trail). Within the vicinity of western ENP and lower SRS, the emergency and planned temporary deviations resulted in water levels peaking in October with early recession rates within the short-hydroperiod marshes south of Tamiami Trail. This resulted in early initiation of nesting within these areas and increased amounts of potential foraging habitat for the active colonies closely associated with this region (*i.e.*, Broad River, Grossman Ridge West).

The MWD field tests in addition to the planned and emergency deviations from 2016 to 2018 have provided opportunities to increase water deliveries to NESRS. Since the start of the MWD field tests stage levels within NESRS have routinely exceeded the upper quartile of the 2002–2015 operational, pre-project baseline conditions, including prolonged durations above the pre-project baseline maximums (RECOVER 2019). Two of the three highest annual inflow volumes to NESRS (since water year 2003) have occurred since the start of the field test in water year

2016. Modeling indicated that the MWD field tests under ERTP 2016 would occasionally result in increased water levels in NESRS during the spring dry season. These conditions occurred when stages were sufficiently low that the G-3273 constraint did not restrict inflows, and water from WCA-3A was diverted into NESRS through the S-333 structure. In these cases, water levels within NESRS, in the immediate vicinity of the Tamiami West stork colony, would rise by up to 1 ft during the period when storks were nesting and when water levels were generally receding throughout the system. This type of action produces an artificial reversal, can cause a reduction in stork foraging conditions in areas near the colony, and may be significant enough to cause colony abandonment. Because the foraging radius of the Tamiami West colony includes parts of WCA-3A, WCA-3B, ENP, the Pennsuco Wetlands, and urban areas, sufficient foraging opportunities remained in other areas to offset the poor foraging conditions in NESRS that resulted from the MWD planned and emergency deviations.

Beneficial effects to wood stork foraging habitat in ENP have occurred through implementation of the incremental field tests conducted under the authority of the MWD Project. The Corps began implementation for the MWD Increment 2 Field Test to raise the L-29 Canal maximum operating limit up to 8.5 feet NGVD, subject to downstream constraints, on February 21, 2018. Raising of the L-29 Canal constraint above 7.8 feet NGVD (the maximum operating limit under Increment 1.2) was dependent upon completion of critical features necessary to operate the C-111 SD Project North Detention Area (NDA). Following completion of the C-111 SD Project construction (both the NDA and South Detention Area (SDA) components) in August 2018, and following recovery of the 8.5 SMA flood mitigation system from an early September 2018 rainfall event, the L-29 Canal maximum operating limit was incrementally increased from 8.3 feet NGVD to 8.5 feet NGVD on September 19, 2018. In 2018, 343,400 acre feet of water (inflow volume of S-333 plus S-356 minus S-334 outflows) was delivered to NESRS (Corps 2019a). Increased flows have continued through 2019 and as of October 31, 2019, more than 442,000 acre feet has been delivered. This is an increase of more than 235,725 acre feet of water into NESRS as compared to the average of 105,125 acre feet delivered per year from 2012 through 2015 prior to implementation of the MWD incremental field tests (Corps 2019a).

6.9.2 Invasive and Exotic Species

Invasive and exotic species may also affect wood storks. Invasive plant species such as melaleuca, Australian pine, Brazilian pepper, and other woody species can become established in wood stork habitat and reduce habitat suitability, although wood storks are known to use such habitat, it is considered of lower quality than native habitats (Service 2007a). The potential expansion of dense stands of cattail due to high phosphorus may also reduce wood stork foraging habitat. Dense submergent and emergent vegetation may reduce foraging suitability by preventing wood storks from moving through the habitat and interfering with prey detection (Coulter and Bryan 1993).

Limited information is available on the effects of invasive exotic animals on wood storks. Species such as the Burmese python have become established in wood stork habitat, and telemetry data collected in the southern Everglades suggests the large constrictors are attracted to

wading bird colonies. There has been one documented case of a python consuming a juvenile wood stork. In 2013 and 2014, camera traps revealed pythons were moving towards initiating colonies and even have been found in empty nests. However, there was no recorded activity of pythons predating on wading birds throughout the study, and this may be due to the cryptic behavior of the species (Cook 2013, 2014).

6.9.3 Water Quality

The Everglades were historically an oligotrophic system, lacking plant nutrients such as phosphorus, but having high levels of dissolved oxygen. Major portions of the Everglades have become enrich in nutrients that promote excessive plant growth and deplete dissolved oxygen primarily due to anthropogenic sources of phosphorus and nitrogen (cultural eutrophication). Degradation of water quality, particularly runoff of phosphorus from agricultural and urban sources, is a concern because it can cause rapid encroachment of cattail (*Typha* sp.) and other undesirable invasive and exotic species that reduce the habitat suitability. Dense growth of these plants also has the potential to reduce the ability of wood storks to locate prey.

6.9.4 Climate Change

Climate change represents significant short- and long-term threats to the environmental baseline of the wood stork and their habitat (Miller and Traxler 2018). Surface temperatures and evapotranspiration are expected to increase which will likely adversely impact recession rates during the wood stork foraging and breeding season. Rainfall patterns are expected to change with more rain in the fall and winter months and less rain during the spring and summer months. Changes in rainfall patterns can increase the incidence of reversals during nesting causing nest abandonment, re-nesting, late nest initiation, and poor fledging success. Climate change may also lead to changes in breeding and foraging behavior.

The Service will continue to monitor this situation closely and will implement Strategic Habitat Conservation Planning, an adaptive science-driven process that begins with explicit trust resource population objectives, as the framework for adjusting our management strategies in response to climate change (Service 2006b).

6.9.5 El Niño

Wetter than average conditions due to the very strong El Niño effects prevailed in South Florida through the first half of 2016, encompassing the 2016 wood stork breeding season. These El Niño events have a significant effect with higher water levels and deeper water depths in the core foraging areas. The occurrence of El Niño conditions resulted in a major short-term negative effect on the environmental baseline for wood storks ability to forage and fledge their young in 2016 because of the wetter conditions. It is likely that wood storks started to be affected by El Niño in early February when reported observations of dead and dying storks where showing up in southwest Florida and ENP. By mid-March there was some nesting occurring in south Florida at three colony sites (Paurotis Pond, Broad River, and Cabbage Bay). Within WCA-3A there

were poor conditions for foraging and nesting. As the 2016, wet season approached, recommendations for water management were made to discourage wood stork nesting in the WCA-3A due to the low probability of a breeding colony being able to fledge young.

Weak El Niño effects prevailed in South Florida from late 2018 through 2019, encompassing the 2019 wood stork breeding season. High waters in early 2018 were followed by a general and steady dry down throughout the system until mid-May when significant rain events resulted in atypical water level increases by late May. A steady dry down in late 2018 gave way to dryer than normal conditions by January 2019. Atypical heavy rain occurred in late January and multiple reversals followed in late February, March, and May, with little dry down through May. Wood storks failed to nest in the WCAs in 2019 and had a poor year in ENP with all nests failing (Frederick and Garner 2020).

6.9.6 Summary of Environmental Baseline

Wood storks nest during the dry season and are dependent on drying wetlands as an environmental cue for nest initiation. The reduction of long hydroperiod wetlands known to have occurred from development and over drainage has been postulated as a major cause of late colony formation and a reduction in early nestling survival rates (Fleming et al. 1994). Because of the continual change in water levels during the stork nesting period, any one site may only be suitable for wood stork foraging for a narrow window of time when water levels within wetlands have sufficiently receded to begin concentrating prey and making water depths suitable for wood storks to access the wetlands. Degradation of water quality, particularly runoff of phosphorus from agricultural and urban sources, is a concern, because it can cause rapid encroachment of cattail (*Typha* sp.) and other undesirable invasive and exotic species reducing the habitat suitability. Dense growth of these plants also has the potential to reduce the ability of wood storks to locate prey. Furthermore, an invasive exotic animal such as the Burmese python can affect the success of wood storks during the breeding season.

6.10 Effects of the Action

Effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (50 CFR 402.02).

6.10.1 Factors to be considered

The purpose of the COP is to define the water management operations for the WCA-3A and WCA-3B outlets, structures in the L-31N and C-111 basins constructed as part of the C&SF Project, and the recently constructed components of the MWD and C-111 SD Projects. The components of the COP that may affect the wood stork include the water management operations

for WCA-3A, ENP, and the SDCS. In addition, the WCA-3A PSC will continue to provide a mechanism to evaluate hydrological and ecological conditions within wood stork habitat to allow for adaptive management of the system to protect the needs of multiple species, including the wood stork and other wading bird species.

The COP goals are to improve the timing, location, and volume of water and restore natural hydrologic conditions in ENP (Corps 2019a). Through these modifications, the Corps has additional flexibility in releasing water from WCA-3A in order to: (1) better manage recession and ascension rates, (2) alleviate high water conditions, and (3) minimize effects to the wood stork and its habitat.

Water management operations may have a number of consequences on the wood stork and wood stork habitat. These may include: (1) the permanent loss of available habitat for foraging, breeding, and roosting wood storks; (2) changes in hydroperiods of wetlands that affect wood stork foraging, breeding, and roosting; (3) the fragmentation of wood stork habitat; (4) a reduction in the spatial extent of habitat for the species; (5) increases in disturbance frequency, intensity, or severity to wood storks in the project vicinity due to human activities; (6) changes in the wood stork prey base; and (7) changes in the value of wood stork habitat within the action area due to project-related hydrological alterations and water quality.

The analysis discussed below are based on conditions observed within the action area since the initiation of ERTP 2016. The Service anticipates future effects to the wood stork as a result of the proposed action will be similar to those documented within the action during this period. Our analysis focuses only on the hydrological variables most closely associated with wood stork foraging behavior, prey base biomass, and nesting success where the Corps has discretionary federal involvement or control. There is limited information on the effects of invasive and exotic species, water quality, and disturbance from human activities (*i.e.*, outdoor recreation, airboat operations, etc.).

The action area contains wood stork foraging habitat and is located within the CFA of 27 wood stork colonies that have been active for at least one year since 2009 (Figure 25). The CFAs of these wood stork colonies encompass about 2,163,068 acres of the COP action area. The COP does not impact suitable foraging habitat for the nearby Collier-Hendry, Barron Collier, and the LOX NC-4 colonies, therefore, these colonies were omitted from any further analysis. The COP water management activities will be continuous over either (1) the 7-year period identified in the Integrated Delivery Schedule (IDS); (2) until construction of new CERP infrastructure, including features which would enable increased flow deliveries into the WCAs, ENP, and Florida Bay; or (3) if new information becomes available through implementation of the COP Water Control Plan and/or the COP Adaptive Management and Monitoring Program (AMMP) that would necessitate a need to modify water management operations. Wood storks may be found near the action area year-round, though they may be partially migratory and act as facultative migrants (Picardi et al. 2019). Habitat loss associated with the water operations will result from hydroperiod and vegetation changes in the wetlands currently available to the wood stork for foraging.

The potential effects from the proposed action on wood storks were evaluated using the Wood Stork Foraging Analysis described in Appendix A (Service 2010b). This method combines the effects of canopy cover and prey availability on the relative suitability of these wetlands for wood stork foraging. Potential effects to wood storks are determined based on the calculated spatial changes within each hydroperiod class and estimates of the difference in prey availability (fish and crayfish biomass) between the existing baseline and the proposed action. The biomass estimates are calculated from fish density (Trexler et al. 2002), fish biomass (Kushlan et al. 1986; Turner et al. 1999), crayfish biomass (Acosta and Perry 2002), suitable prey size and base (Ogden et al. 1976; Trexler et al. 2002), and consumption competition (Fleming et al. 1994) for each hydroperiod class (Service 2010b).

6.11 Analysis for Effects of the Action

The implementation of the COP has the potential to affect the wood stork through changes to the hydrology within the action area by (1) moving water further east along the L-29 canal before releasing that water south into Shark River Slough, and (2) moving water further east through operations and infrastructure along the L-28 canal and Tamiami canal. Specifically, maintaining seasonal closures of the S-12A, S-12B, S-343A, and S-343B; removal of the seasonal closures at S-344 and limited adjustments to the S-332D seasonal pump restrictions; increased canal stage in the L-29 canal; increased capacity for flows through S-333; operation of the Decomp Physical Model features; improved connectivity between WCA-3A and WCA-3B; and increased flows to the east will result in changes to the annual stage, hydroperiod, and wood stork foraging conditions within the action area.

A regional hydrologic model (South Florida Regional Simulation Model Glades-LECSA Implementation (RSM-GL)) was used to evaluate system conditions. The COP is the last step to implement operational changes to convey water from WCA-3A to the ENP using the constructed features of the pre-CERP Foundation Projects (*i.e.*, MWD and C-111 SD Project) and would result in a change to the 2012 WCAs, ENP, and ENP-South Dade Conveyance System (SDCS) Water Control Plan. The main component of the COP that improves water deliveries to ENP is the Tamiami Trail Flow Formula (TTFF). The TTFF replaces the 1985 WCA-3A Rainfall Plan. The TTFF uses information from water stages (WCA-3A and NESRS), rainfall (historical median WCA-3A and BCNP inflows with forecast adjustments), potential evapotranspiration (historical median), and recent structure flows to predict upcoming weekly flow target volumes across Tamiami Trail.

The RSM-GL model run that most closely represents the COP for this area is the Round 3 Alternative Q (ALT Q) while the existing condition under the ERTP 2016 baseline were modeled under the run labeled ECB19RR (Corps 2019a). The proposed action (ALT Q+) is largely based on the ALT Q with minor tweaks based on sensitivity runs (Corps 2019a). ALT Q+ was not modeled; however, hydrologic model output from ALT Q and the sensitivity runs on ALT Q were used to evaluate the potential effects of ALT Q+ on federally listed species. In general, ALT Q+ meets all the project objectives and does not violate project constraints.

Additional ecological planning tools developed by the Joint Ecosystem Modeling (JEM) group (https://www.jem.gov) were also identified to be used for purposes of evaluating habitat suitability for fish and wildlife resources (Corps 2019a). Information from the Wader Distribution and Evaluation Modeling (WADEM), Small Fish, and the Everglades Landscape Vegetation Succession (ELVeS) models were used to evaluate potential effects to wood storks. As stated previously, water depth and recession rate are the two most important hydrological variables for wood storks (Gawlik et al. 2004). To have a successful nesting year, wood storks must have access to suitable habitat throughout the dry season, but the location of the suitable habitat can vary across the landscape. Under the selected model runs in the RSM-GL and WADEM models, changes to the annual stage, annual hydroperiod, and mean foraging conditions are predicted to occur primarily within portions of northern and northeastern ENP and throughout WCA-3A and WCA-3B. However, the following results should be interpreted cautiously given the inherent uncertainty associated with the use of models.

The RSM-GL model results for ALT Q indicate that annual hydroperiod will be decreased by up to 30 days in north central WCA-3A and 30 to 45 days in northeast WCA-3B (Figure 26). The model results for WCA-3A and 3B under ALT Q indicate there is a slight to moderate decrease in annual average stage in east central, central, and southern WCA-3A and minor to moderate decreases in annual stage from the baseline conditions within the northeast corner of WCA-3B (Corps 2019a). The annual hydroperiod and annual stage are expected to decrease within portions of wood stork CFAs throughout the majority of WCA-3 (Figure 26).

The RSM-GL model results for ALT Q indicate that in portions of northeastern ENP annual stage and hydroperiod will increase up to 0.25 feet and 90 days, respectively. Annual stage will decrease 0.25 feet and hydroperiod shortened by up to 30 days in northern ENP east of Big Cypress National Preserve and south of the Tamiami canal (Figure 26). The annual hydroperiod and annual stage are expected to increase within portions of wood stork CFAs throughout the majority of ENP (Figure 26). However, some colonies will see a decrease to stage and average annual hydroperiod within their CFA in northern ENP (Figure 26). Grossman Ridge West, Jetport South, Jetport, and Big Cypress Mitchell Landing may experience these decreases in up 12,033 acres, 10,803 acres, 11,422 acres, and 6,657 acres of their respective CFA that is within the COP action area.

The WADEM ecological planning tool was utilized to determine spatially explicit changes in high quality foraging conditions for wading birds for ALT Q relative to ECB19RR. WADEM uses a spatiotemporal species distribution model (SDM) framework to evaluate the foraging responses of wood storks. Using a multi-model approach, a spatial foraging conditions model (SFC) predicts wading bird abundance over time at a fixed spatial scale (400 meter) and a temporal foraging conditions model (TFC) predicts daily abundance across space. The resulting indices represent proxies for different components of patch dynamics: patch quality within suitable depths is reflected by TFC and landscape patch abundance by SFC. The product of these two indices (area × quality; or foraging index) provides a metric to account for both processes. To evaluate the effects of the COP on wading bird patch quality and patch

abundance, mean abundance (TFC) and mean quality (SFC) over the years 1975-2005 was calculated. For more detailed information on WADEM, refer to Beerens et al. (2015a), Beerens et al. (2015b), and Cook and Kobza (2009).

The WADEM model results display the percent change between the COP (ALT Q) and the baseline (ECB19RR) of the wood stork mean spatial foraging conditions index over the months of March and April of 1975-2005. Observed differences between ALT Q and ECB19RR were most often not more than a ±10 percent change across the majority of WCA-3 and ENP. The WADEM model results indicate that foraging conditions will be improved for wood storks over a large area of northern and northeastern ENP, in NESRS, and along the C-111 canal south of the S-177 spillway. Foraging conditions decreased in northeast WCA-3A and along the L-67 canal in WCA-3B (Figure 27). Based on the location of known wood stork colonies, the greatest improvement to foraging conditions is predicted to occur within the CFA of at least seven colonies (*i.e.*, Tamiami Trail East 1, Tamiami Trail East 2, Tamiami Trail West, 3B Mud East, Lower Taylor Slough, Rookery Branch, and Grossman Ridge West). Of these, the Tamiami Trail West and Grossman Ridge West colonies have been active since implementation of the MWD Increment 1.1, 1.2 and Increment 2 field tests (Table 21). At least five colonies will see a decrease to mean foraging conditions within their CFA (Figure 27). Sawgrass Ford, Cypress City, Emerald Estates 1 and 2 Griffin, Kinich, and 3B Mud East may experience negative effects to foraging conditions in up to 42, 34, 42, 33, and 21 percent of their respective CFA that is within the COP action area. 3B Mud East saw both an improvement and decrease in mean foraging conditions in 237,592 acres and 87,207 acres, respectively, due to its CFA location encompassing the NESRS and the area along the L-67 canal.

Water depth and recession rate are the two most important hydrological variables for wood storks (Gawlik et al. 2004). To have a successful nesting year, wood storks must have access to suitable habitat throughout the dry season, but the location of the suitable habitat can vary across the landscape. Gawlik et al. (2004) developed a wood stork suitability index based solely on the physical processes that concentrate aquatic prey and make them vulnerable to capture by wood storks. The index was calculated from the South Florida Water Management Model (SFWMM) and Natural Systems Model (NSM) output for the 2-mile by 2-mile grid cells in the remnant Everglades. At any one time, a highly suitable landscape will likely consist of cells that have not yet reached their peak suitability for the year, cells that have already passed their peak suitability, and cells that are at their highest suitability. According to Gawlik et al.'s (2004) habitat suitability index for wood storks, 23 percent of a core foraging area is occupied at any one time by feeding wood storks during a good nesting year.

In 2010, wood stork-related water management recommendations for ERTP were developed by James Beerens and Dr. Mark Cook of the District. Using average daily stage data in WCA-3A and foraging flock observational data from 2000 to 2005, Beerens and Cook (2010) identified water levels (stages) that provide foraging habitat at the start (January 1) and at the end (May 31) of the breeding season and determined the minimum and maximum water depths for foraging according to the average of the following gauges in WCA-3A: 3A-3, 3A-4, and 3A-28 (3AVG). In addition, they used presence-absence observations of foraging wood storks from systematic

reconnaissance flights conducted during 2000-2009 in conjunction with mean used water depth (*i.e.*, observed water depths where storks were located averaged over each instance of use) and recession rate data (estimated using Everglades Depth Estimation Network [EDEN] and calculated using SAS version 9.3 software [SAS Institute 2003]) to determine the optimal recession rate and site-specific optimal water depths used by wood storks over a 10 year period. This recession rate was then applied to the 3AVG water levels to determine lower and upper thresholds at the start and end of the breeding season, respectively. The resulting range of water levels encompasses short hydroperiod areas in northwest WCA-3A (available early in the season) to longer hydroperiod areas in southeast WCA-3A (which become available later in the season).

The implementation of ERTP 2016 was meant to provide the ability to better manage WCA-3A for multiple species including the wood stork. The Corps and Service, in conjunction with the multi-agency ERTP team, developed performance measures (PMs) and ecological targets (ETs) for each species and their habitats. PMs and ETs contained within ERTP incorporated recommendations found within the Service's Multi-Species Transition Strategy (MSTS) for WCA-3A which was specifically designed to identify water depths and stages within WCA-3A to benefit species and the habitats on which they rely (Service 2010a). The inclusion of these recommendations represented a significant improvement in water management operations.

Specifically, PMs were defined as a set of operational rules that identify optimal WCA-3A water stages and recession rates to improve conditions in WCA-3A for the snail kite, wood stork, wading birds, and tree islands. The two PMs developed specifically for wood storks were:

- (PM-F) - WCA-3A (Dry Season Recession Rate): Strive to maintain a recession rate of 0.07 feet per week, with an optimal range of 0.06 to 0.07 feet per week, from January 1 to June 1.
- (PM-G) - WCA-3A (Dry Season): Strive to maintain areas of appropriate foraging depths (5 to 25 cm) within the Core Foraging Area (CFA) (18.6-mile radius) of any active wood stork colony.

6.11.1 Recession Rate

A recession rate of 0.07 ft per week (1.89 cm per week), with an optimal range of 0.06 to 0.07 ft per week (1.82 to 2.03 cm per week), is recommended from January 1 to June 1 to provide foraging opportunities for breeding wood storks. Based on their analysis of recession rates used by foraging wood storks during the 2000 to 2009 dry seasons, Beerens and Cook (2010) further described recession rates as follows: the "suboptimal rapid" category included rates from 0.07 to 0.17 ft per week (2.03 to 5.11 cm per week); the "too rapid" category included rates from 0.17 to 0.37 ft per week (5.11 to 11.34 cm per week); the "suboptimal slow" category included rates from -0.05 to 0.06 ft per week (-1.40 to 1.82 cm per week); and the "reversal" category included rates from -0.05 to -0.23 ft per week (-1.40 to -7.00 cm per week). Recession rates greater than 0.37 ft per week (11.34 cm per week) and reversals greater than -0.23 ft per week (-7.00 cm per

week) were considered too rapid to support wood stork foraging [Note that negative values indicate increasing water levels (*i.e.*, reversals)].

The optimal recession rate of 0.07 ft per week was used to back-calculate from the minimum 3AVG stage associated with stork use of 8.02 ft NGVD (Figure 28) to the beginning of the breeding season on January 1. This calculation corresponded to a 3AVG stage of 9.5 ft (Figure 28). This same recession rate was applied forward from the maximum 3AVG stage (10.37 ft) associated with wood stork use of WCA-3A (Figure 28) and resulted in a value of 8.86 ft at the end of the breeding season on June1. These two lines represent the ideal range of the 3AVG that provides wood stork foraging in WCA-3A throughout the course of the breeding season.

Under the current WCA-3A Interim Regulation Schedule, recession rates have been too rapid in many years to support successful snail kite nesting and foraging; however, wood storks and other wading birds require a more rapid recession rate to concentrate their prey items into shallow pools for more effective foraging. Conversely, too rapid drying conditions, if repeated year after year, would soon reduce the prey base required for successful wood stork breeding (Fleming et al. 1994).

The COP attempts to avoid recession rates that are unfavorable to wood storks and other wading birds by including a recommended range of recession rates targets (PM-F). The ERTP recommended recession rate for wood storks and other wading birds was 0.06 to 0.07 ft per week from January 1 to June 1. The recession rate for any given period of time was determined based upon recommendations made during the WCA-3A PSC. Results from the SFWMM were evaluated for recession rate and suggested an improvement in recession rates under ERTP implementation. It is important to note that the recession rates can be improved using real time water management operations and incorporation of WCA-3A PSC recommendations. Implementation of the ERTP WCA-3A Interim Regulation Schedule was expected to produce a mosaic of wetland habitats within WCA-3A that would provide favorable foraging opportunities for wood storks. In addition, the incorporation of foraging depth requirements (PM-G) into ERTP addressed wood stork foraging particularly within the highly important marshes of their core foraging area during the breeding season. The COP will continue to avoid recession rates that are unfavorable to wood storks and other wading birds by including a range of recession rate targets (PM-F) that are recommended through the PSC forums and the MSTS. Performance measures from the MSTS are not explicitly included in the COP WCA-3A Regulation Schedule and COP Water Control Plan. Scientific and species input (including the MSTS metrics) will continue to be collected through the PSC forums, and the Corps will utilize the operational flexibility cited in Section 7.1 of the COP Water Control Plan to consider adjustments to the TTFF weekly release targets (Corps 2019a).

6.11.2 Water Depth

Water levels between 9.5 and 10.37 ft NGVD on January 1 at the 3AVG were recommended to provide favorable conditions for wood storks and other wading birds foraging in WCA-3A. Based on their review of wood stork survey data and hydrological data between 2000 and 2005,

Beerens and Cook (2010) found that the maximum 3AVG stage associated with wood storks feeding in WCA-3A (beginning in the northwest) was approximately 10.37 ft NGVD (Figure 28). Their analysis also indicates that wood storks used a mean depth of 0.48 ft (14.63 cm), with the optimal range including the 95 percent confidence interval equal to 0.46-0.50 ft (13.93-15.33 cm). Beerens and Cook (2010) further described high water foraging depths as follows: the "suboptimal wet" category included depths from 0.50 ft (15.33 cm) up to 1.35 ft (41.26 cm); the "too wet" category included depths from 1.35 ft (41.26 cm) up to 2.09 ft (63.67 cm); depths greater than 2.09 ft (63.67 cm) were considered too wet for stork feeding.

Beerens and Cook (2010) also determined minimum 3AVG water levels between 8.00 and 8.86 ft NGVD would provide favorable conditions for wood stork and other wading bird foraging in WCA-3A. Based on their review of wood stork survey data and hydrological data during 2000 to 2005, Beerens and Cook (2010) found that the minimum 3AVG stage associated with wood storks still feeding in southeastern WCA-3A was approximately 8.02 ft (Figure 28). Flock size appeared to increase consistently with a decrease in stage during the breeding seasons during the years 2000-2005. In addition to their categorization of high water foraging depths, Beerens and Cook (2010) further described low water foraging depths as follows: the "suboptimal dry" category included depths from 0.46 ft (13.93 cm) down to -0.31 ft (-9.33 cm); the "too dry" category included depths from -0.31 ft (-9.33 cm) down to -1.63 ft (-49.66 cm); depths less than -1.63 ft (-49.66 cm) were considered too dry for feeding. [Note that negative depths indicate water levels below ground surface based on the 3AVG ground elevation - at such levels there may be water in the southern end of WCA-3A and in deeper pockets throughout the conservation area.]

6.12 Effects on Foraging Habitat

For this action, direct effects include the impacts to wood stork foraging habitat as a result of recession rate and water depth. Without the supply of concentrated prey that results from dry season recessions, adult wood storks are unable to support their offspring. The Service used two performance measures to interpret the potential direct effects to the wood stork from the proposed action: (1) the goal of maintaining a recession rate of 0.07 feet per week from January 1 to June 1 (PM-F), and (2) the goal of maintaining areas of appropriate foraging depths between 5 and 25 cm within the CFA of any active wood stork colony (PM-G).

6.12.1 Recession rate (PM-F)

Observed weekly recession rates in WCA-3A during the four breeding seasons (2016, 2017, 2018 and 2019) in which water management operations were as described within ERTP 2016 are reported in Cook and Barinski (2017, 2018, and 2019) and Frederick and Garner (2020). During WY 2016, despite long periods of rapid recession rates from January to May, the occurrence of multiple extreme water-level reversals meant that depths remained too high for wading bird foraging throughout the nesting season. During WY 2017 and WY 2018, recession rates for wood storks met or minimally exceeded the optimal rate with some minor late reversals. In WY

2019, significant reversal occurred in late January and multiple reversals followed in late February, March, and May, with little dry down through May.

The Corps conducted retrospective reviews in 2017 and 2018 to determine the potential cause(s) of recession rates outside the preferred range experienced during each of the respective dry seasons (*i.e.*, January 1 through June 1) and how future operations could avoid exceeding these thresholds (Corps 2017, Corps 2018). The Corps concluded that WCA-3A outlet structures were opened and closed as per the WCA-3A regulation schedule and reversals during the dry season were attributed to extreme rainfall events. However, there may be some additional opportunities to use operational flexibility to assist in attaining recession rates within the preferred range for wood storks.

6.12.2 Foraging depths (PM-G)

As shown in Table 23, based upon the two-gauge average of 3A-3 and 3A-4, water depths did not exceed 16 inches between March 1 and May 31, 2017; however, during May 2018, water depths exceeded 16 inches for 11 days. Water depths during this time ranged between 16.74 and 26.76 inches, with an average of 21.29 inches. The ERTP 2016 ITS states that allowable incidental take will be exceeded if operations from implementing the RPA results in water depth greater than 16 inches (41 cm) from March 1 through May 31 throughout WCA-3A for two consecutive years.

A series of mid-May storms in 2018 caused conditions to change rapidly from very dry to very wet conditions in South Florida, with Lake Okeechobee, the WCAs, and the eastern coast of Florida accumulating most of the rainfall. The area as a whole received 301 percent of average rainfall. WCA-3 received 12.33 inches in precipitation during May of 2018, which is 285 percent of the average for this time of year. May 2018 was the wettest May on record within the SFWMD Service Area with 11.5 inches of rain recorded. The previous record for May was 9.25 inches in 1895. This record area-wide rainfall caused water stages in the three WCAs to rise above their maximum regulation schedules. The Corps undertook several water management measures in order to reduce high stages within WCA-2A, WCA-3A, and WCA-3B. These measures included three planned temporary deviations, one in WCA-2A, one in WCA-3A, and one in WCA-3B. As part of these planned temporary deviations, the Corps conducted emergency ESA consultation with the Service and documented potential environmental effects within three National Environmental Policy Act documents (EA/FONSI, June 30, 2018).

The RSM-GL model results for the COP indicated the number of times in the period of record (1965-2005) when water depths exceeded 16 inches (41 cm) from March 1 through May 31 throughout WCA-3A in two consecutive years as measured by the two gauge average (based upon a ground surface elevation of 8.4 feet NGVD) at gauges 3A-3 and 3A-4. The model indicates that implementation of the COP can reduced the number of times the threshold was exceeded by six events relative to the baseline condition.

6.13 Effects on Wood Stork Prey Availability

Researchers have shown that wood storks forage most efficiently and effectively in habitats where prey densities are high and the water shallow and canopy open enough to hunt successfully (Ogden et al. 1978, Browder 1984, Coulter 1987). Prey availability to wood storks is dependent on a composite variable consisting of density (number or biomass/m^2) and the vulnerability of the prey items to capture (Gawlik 2002). For wood storks, prey vulnerability appears to be largely controlled by physical access to the foraging site, water depth, the density of submerged vegetation, and the species-specific characteristics of the prey. For example, fish populations may be very dense, but not available (vulnerable) because the water depth is too deep (greater than 30 cm) for storks to forage or the tree canopy at the site is too dense for storks to land. Calm water, about 5-40 cm (2-16 in) in depth, and free of dense aquatic vegetation is ideal (Coulter and Bryan 1993).

We have identified four variables in assessing wood stork foraging:

- the density of vegetation within habitats suitable for wood stork foraging;
- the hydroperiod of the wetland, which includes two subcomponents (1) the fish and crayfish density per hydroperiod, and (2) the fish and crayfish biomass per hydroperiod;
- the suitability of prey size for the wood stork, which provides an adjustment to the fish biomass per hydroperiod and is referenced hereafter as the wood stork suitable prey base; and
- the likelihood the wood stork is the wetland species that actually consumes the concentrated prey and is referenced as the competition factor.

All four of these parameters, when combined, provide us with an estimate of the effect of wetland foraging losses and gains in kilograms of prey in our assessment of the effects of the action on wood storks.

6.13.1 Effects of Density of Vegetation Within Habitats Suitable for Wood Stork Foraging

Wetland suitability for wood stork foraging is partially dependent on vegetation density. Melaleuca is a dense-stand growth plant species, effectively producing a closed canopy and dense understory growth pattern that generally limits a site's accessibility to foraging by wading birds. O'Hare and Dalrymple (1997) indicated that the number of fish species present in a wetland system remains stable at certain levels of melaleuca infestation. However, the number of fish families and fish abundance decreased with increasing melaleuca infestation (Ceilley et al. 2005). Avian species data from wetland-dependent, wading, and mixed habitat use species showed a decrease in the number of species and individuals with increased density of melaleuca, which corresponds with the habitat uses shown by O'Hare and Dalrymple (1997). The availability of the prey base for wood storks and other wetland dependent species is reduced by the restriction of access caused from dense and thick exotic vegetation. Wood storks and other wetland-dependent bird species can forage in these systems in open area pockets (*e.g.*, wind blow-downs), provided multiple conditions are optimal (*e.g.*, water depth, prey density).

Estimates from 2013 digital mapping revealed that melaleuca occurs on more than 5,452 acres in ENP and is primarily concentrated in the East Everglades Acquisition Area (NPS 2006, 2013). Although melaleuca is a difficult species to eradicate, District and NPS efforts, along with those of other governmental agencies and private groups, are containing its spread through an integrated management approach within the ENP and the Everglades Water Conservation Areas (WCAs). Melaleuca has been completely cleared from WCA-2A, -3A, and -3B, south of Alligator Alley (Laroche 1998). These areas are now under "maintenance control". Maintenance control means applying management techniques on a continuous basis to keep an invasive plant population at its lowest feasible level.

In O'Hare and Dalrmyple's study (1997), they identify five cover types (Appendix A, Table WSM1) and provide information on the number of wetland dependent bird species and the number of individuals observed within each of these vegetation classes (Appendix A, Table WSM2). The Service used this approach to develop an exotic foraging suitability index (Appendix A, Table WSM3) that assesses wetland acreages and their relationship to prey densities and prey availability. We consider wetland dependent bird use to be a general index of food availability. Using this approach, we can assign a Foraging Suitability Value of 100 percent due to the current low overall percent coverage of melaleuca in the COP action area (5,452 acres of melaleuca / 2,163,068 acres of the COP CFA = 0.003).

6.13.2 Effects on Wetland Hydroperiod

The hydroperiod of a wetland can affect the prey densities in a wetland. For instance, research on Everglades fish populations using a variety of quantitative sampling techniques (pull traps, throw traps, block nets) has shown that the density of small forage fish increases with hydroperiod. Marshes inundated for less than l20 days of the year average ± 4 fish/m^2; whereas, those flooded for more than 340 days of the year average ±25 fish/m^2 (Loftus and Eklund 1994, Trexler et al. 2002).

The Service (1999) described a short hydroperiod wetland as wetlands with between 0 and 180-day inundation, and long hydroperiod wetlands as those with greater than 180-day inundation. However, Trexler et al. (2002) defined short hydroperiod wetlands as systems with less than 300 days per year inundation. In our discussion of hydroperiods, we are considering short hydroperiod wetlands to be those that have an inundation of 180 days or fewer. The most current information on hydroperiods in south Florida was developed by the SFWMD for evaluation of various restoration projects throughout the Everglades Protection Area (Appendix A, Table WSM4). The SFWMD characterizes hydroperiods into seven distinct classes based on the number of days a year a wetland is inundated as follows: Class 1 0-60 days inundated; Class 2 60-120 days inundated; Class 3 120-180 days inundated; Class 4 180-240 days inundated; Class 5 240-300 days inundated; Class 6 300-330 days inundated; and Class 7 330-365 days inundated. These hydroperiod classes were used to assess effects of the project on wood stork foraging habitat (Table 22).

The RSM-GL results for the COP (ALT Q) indicate that the hydroperiod class will be changed in 55,095 acres in wood stork CFAs (Table 22). This total is the sum of the individual changes within each hydroperiod class. Some changes may be positive whereas others may be negative. Most notably is the reduction of 17,269 acres of floating emergent marsh (Class 7 hydroperiod wetlands) and 9,795 acres of willow shrub/cattail and marl prairie (Class 1,2, and 3 hydroperiod wetlands) (Table 22). The COP will increase the Class 5 and 6 hydroperiod sawgrass wetland acreage by 1,162 and 26,385, respectively (Table 22). The ELVeS model simulated the dominant vegetation community output in response to the COP (ALT Q) against the existing conditions baseline (ECB19RR) for an average (Figure 19), dry (Figure 20), and wet (Figure 21) years. In average and dry years, the vegetation community response to these hydrologic changes reduced the spatial extent of floating emergent marsh, willow shrub/cattail, and marl prairie. It increased the extent of sawgrass and swamp shrubland in all water year types (Figures 19-21) and cypress shrub_sawgrass in wet years (Figure 21).

The proposed action will result in a conversion of 9,795 acres of short hydroperiod wetland to long hydroperiod wetland. Within the project action area, short hydroperiod wetlands are estimated at 278,590 acres and long hydroperiod wetlands are estimated at 1,884,194 acres (see Table 22). The short hydroperiod wetland loss represents an estimated 3.5 percent of the short hydroperiod wetlands in the action area (9,795 acres lost/278,590 acres of short hydroperiod wetland = 0.035). The corresponding long hydroperiod wetland increase represents less than one percent (9,795 acres gained/1,884,194= 0.005).

The loss of 3.5 percent of short hydroperiod wetlands in the project action area is a significant change over baseline conditions. Moreover, as discussed previously, the acreage loss consists primarily of wetlands dominated by either willow shrub/cattail and marl prairie and their foraging biomass contribution to wood storks provide an important pre-nesting food source and a greater effect on early nesting survival.

6.13.3 Fish Density

For the COP, an ecological planning tool was also available to evaluate potential effects on small sized fish density (defined as less than eight centimeters adult standard length) within the study area (Donalson et al. 2010). The ecological planning tool or prey based freshwater fish density model estimates the densities of small-sized freshwater fish, primarily livebearers (poeciliids) and killifishes (cyprinodontids and fundulids). High densities of these fish characterized the pre-drainage central Everglades ecosystem. Maximizing densities is an objective of many restoration scenarios. Because prey fish dominate the prey community in both biomass and abundance, they are an important energy source for higher-trophic levels, such as wading birds. Thus, ecological planning tool estimates of prey fish can be used as a general measure of trophic conditions within the central Everglades. The mean percent change in total fish density for the COP (ALT Q) relative to the baseline conditions under ERTP 2016 (ECB19RR) for each year in the period of record (1965 - 2005) showed an overall improvement across the landscape with annual increases ranging from 1 to 20 percent (Corps 2019a). The observed differences in mean total fish density at individual points across the action area between ALT Q and ECB19RR were

most often not more than a ±10 percent change in average, dry, or wet years. Negative percent changes ranging from -10.1 to -32.6 percent fish density were observed in a number of locations in portions of WCA-3A and WCA-3B and northern ENP, particularly in dry years in central WCA-3A and along the L-67A (Corps 2019a).

In the Service's assessment of project related impacts to wood storks, the importance of fish data specific to individual hydroperiods is the principle basis of our assessment. In order to determine the fish density per individual hydroperiod, the Service relied on the number of fish per hydroperiod developed from throw-trap data in Trexler et al.'s (2002) study. The Trexler et al. (2002) throw-trap data represents a surrogate assessment tool to predict the changes in total fish density and the corresponding biomass per hydroperiod for our wood stork assessment. Turner et al. (1999) provided an estimated fish biomass of 6.5 g/m^2 for all fish for a Class 7 hydroperiod and used the number of fish per square-meter per hydroperiod from Trexler et al.'s data to extrapolate biomass values per individual hydroperiods. We based our prey fish evaluation on the assessment of Trexler et al.'s (2002) and Turner et al.'s (1999) study results described in Appendix A.

Trexler et al.'s (2002) studies in the Everglades provided fish densities, calculated as the square-root of the number of fish per square meter, for only six hydroperiods; although these cover the same range of hydroperiods developed by the SFWMD described in Section 6.13.2 (Appendix A, Table WSM5). For our assessment, we squared these numbers to provide fish per square meter, a simpler calculation when other prey density factors are included in our evaluation of adverse effects to listed species from the proposed action. We also extrapolated the densities over seven hydroperiods, which is the same number of hydroperiods characterized by the SFWMD. For example, Trexler et al. (2002) had one hydroperiod classification for wetlands inundated for 0 to 120 days while the SFWMD model broke this out into a Class 1 hydroperiod (0-60 days) and a Class 2 hydroperiod (60-120 days). We then used linear interpolation to determine the squared density value of the SFWMD Class 2 hydroperiod wetland from the values associated with a SFWMD Model Class 1 and Class 3 hydroperiod wetland of 2 and 9 $fish/m^2$, respectively. Based on the above discussion, the mean annual fish densities were extrapolated to the seven SFWMD Model hydroperiods as shown in Appendix A, Table WSM6.

6.13.4 Fish and Crayfish Biomass

A more important parameter than fish per square-meter in defining fish densities is the biomass these fish provide. We estimated the mean annual biomass densities per hydroperiod using standing stock estimates for ENP and WCA-3 from Turner et al. (1999), Turner and Trexler (1997), Trexler et al. (2002), and Carlson and Duever (1979). Dry weights were converted to wet weights following procedures referenced in Kushlan et al. (1986) and Turner et al. (1999). The mean annual fish biomass per hydroperiod class were extrapolated to the seven SFWMD Model hydroperiods as shown in Appendix A, Table WSM7. The wood stork forage analysis also needs to consider the suitable prey base and the biomass consumption related to competition with other wetland dependent species. To estimate the fraction of the available fish biomass that might be consumed by wood storks, we used an assessment of prey consumption by wood storks

in Ogden et al.'s (1976) study and Trexler et al.'s (2002) throw trap data. The fish biomass per hydroperiod values were adjusted accordingly for size and species composition (Appendix A, Table WSM9).

In 2006, the Service developed an approach using Fleming et al.'s (1994) assessment of prey base consumed versus prey base assumed to be available to wood stork that provided a foraging efficiency estimate of the available biomass that was actually consumed by wood storks (Service 2006d). In 2012, the Service included crayfish biomass in their foraging habitat assessment to account for crayfish in the wood stork's diet (Service 2012b). Acosta and Perry (2002) assessed the biomass of crayfish (*P. alleni*) from seasonal wetlands of various hydroperiods within the Florida Everglades. To estimate the total forage biomass available to the wood stork for each wetland hydroperiod class (Appendix A, Table WSM9), we added the value of mean annual crayfish biomass derived from Acosta and Perry (2002) to the value of mean annual biomass estimated for fish (Appendix A, Table WSM10). This approach was refined, and biomass values adjusted to reflect the competition factor from Service (2006d) and represents the amount of biomass consumed by wood storks and is the basis of our effects analysis (Appendix A, Table WSM11).

We used the hydrologic model outputs for the average annual hydroperiod distribution from the period 1965-2005 to determine the acres in each hydroperiod class under the ECB19RR (baseline) and ALT Q (proposed action). We then subtracted the difference between the baseline and proposed action to determine the change in acres for each hydroperiod class. The equation to calculate the biomass for each hydroperiod class is: the number of acres, converted to square-meters, times the amount of actual biomass consumed by the wood stork (Appendix A, Table WSM11), times the exotic foraging suitability index (Appendix A, Table WSM3), equals the amount of grams lost or gained, which is converted to kg. The acres and the biomass lost or gained for each hydroperiod class is shown in Table 22.

The net overall change is an estimated increase of 24,367 kg of prey biomass available for wood stork foraging (Table 22). In our assessment of the proposed action, we estimate that hydrological effects in the COP action area are projected to result in a decrease of 9,795 acres of short hydroperiod wetlands and a corresponding gain of 9,795 acres of long hydroperiod wetlands, although the project will result in both positive and negative changes depending on the hydroperiod (Table 22). We also note an estimated net decrease of 12,774 kg of short hydroperiod biomass and a net increase of 37,140 kg of long hydroperiod biomass. Even though the overall net change in biomass is positive, a decrease to short hydroperiod biomass is significant due to its impact on pre-nesting foraging food sources, early nestling survivorship, and nest productivity of wood storks (Flemming et al. 1994; Ceilley and Bortone 2000).

6.13.5 Wood Stork Nest Production

Based on Kahl's (1964) estimate that 201 kg (443 lbs) of fish, crustaceans, and other prey are needed for the success of a nest and that 50 percent of the foraging base is needed in the middle third of the nesting cycle when chicks are about 23 to 45 days old (Kahl 1962), it is estimated

about 50 kg are needed to meet the foraging needs of the adults and nestling in the first third of the nesting cycle. Because of the consistent pattern of drying that normally occurs during the stork nesting season, the short hydroperiod wetlands would also be the ones used for foraging early in the season, when long hydroperiod wetlands remain too deep for storks to forage effectively or sufficient prey concentration has not yet occurred as a result of drying. Therefore, in our analysis of nest gains or losses by hydroperiod, we defined these changes as a composite of either short, long, and/or total biomass values as follows:

- Short hydroperiod wetlands include hydroperiod classes 1, 2, and 3. Nest production is based on the 50 kg of prey biomass needed in the first third of the nesting cycle when short hydroperiod wetlands are suitable for foraging.
- Long hydroperiod wetlands include hydroperiod classes 4, 5, 6, and 7. Nest production is based on the 151 kg of prey biomass needed in the final two thirds of the nesting cycle when long hydroperiod wetlands are suitable for foraging.
- Total hydroperiods includes the sum of short hydroperiod classes 1, 2, 3 and long hydroperiod classes 4, 5, 6, and 7. Nest production is based on the 201 kg of prey biomass needed for nesting success.

Using the hydroperiod biomass difference between the COP and ECB19RR in Table 22, we calculated the short hydroperiod nest production loss that may occur under the COP as -255.5 nests = -12,774 kg total short hydroperiod biomass / 50 kg of biomass needed per nest. The loss of 255.5 nests due to short hydroperiod wetland changes represents a 4.4 percent reduction from the baseline (ECB19RR) condition ((-255.5 nests x 50 kg)/(288,547 kg of short hydroperiod biomass available during ECB19RR) = -0.044). The long hydroperiod nest production gains of 245.9 nests = 37,141 kg total long hydroperiod biomass /151 kg of biomass needed per nest represents 0.5 percent ((245.9 nests x 151 kg of biomass)/(8,022,758 kg of long hydroperiod biomass) = 0.0046) of the long hydroperiod nest production (Table 22).

In our assessment of nest production, we provided an analysis of all the individual gains and losses by hydroperiod class, which, based on Table 22, shows that over the 7-year life of the COP, a projected loss of nest production of 67.2 nests (-9.6 nests per year x 7 years = -67.2 x 1.29 nestlings per nest = 86.7) or 87 nestlings is expected. We utilized the average fledglings per nest value of 1.29 that was reported by Rodgers and Schwikert (1997) to calculate the number of nestlings. This loss represents 12 percent (67.2 nests/(80.9 average nests per year x 7 years) = 0.12) of the total estimated nest production of the affected wood stork colonies in Table 21.

6.13.6 Nutrients

The duration of the proposed action is expected to last until implementation for the Central Everglades Planning Project (CEPP) currently scheduled for 2027. The main indirect effect considered by the Service includes the potential increased nutrient loading into ENP by a redistribution of flows through the S-333 and S-12 structures. Degradation of water quality, particularly runoff of phosphorus from agricultural and urban sources, is a concern, because it can cause rapid encroachment of cattail (*Typha* sp.) and other undesirable invasive and exotic

species that reduce the habitat suitability. Dense growth of these plants also has the potential to reduce the ability of wood storks to locate prey. However, the increased risk of habitat change to the wood stork resulting from the proposed action is difficult to predict and assess.

6.14 Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the Action Area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Most of the wetlands within the Action Area for the wood stork are subject to Corps' jurisdiction and permitting under Section 404 of the CWA. In some instances, wetlands may be determined to be outside the Corps' jurisdiction. For an unknown percentage of these Federal exemptions, it is expected that the State, or county if delegated wetland permitting by the State, will claim jurisdiction and require the process of minimization of, and compensation for, wetland impacts, which should assist in minimizing impacts.

Lands surrounding or adjacent to wetlands used by the wood stork that do not require Federal involvement are where the majority of the cumulative effects are likely to occur. These lands may be developed resulting in disturbance, habitat degradation, reduction in prey availability, isolated hydrologic changes, or permanent habitat loss. Land management activities conducted by State agencies may also have detrimental impacts to the wood stork.

Some wetlands and the areas adjacent to those and other wetlands may be adversely affected by actions without Federal involvement, resulting in a decrease in habitat quality and quantity, prey availability, and productivity for wood storks. For evaluation of the cumulative effects, the Service is considering the wood stork action area to include the following counties: Broward, Collier, Miami-Dade, and Monroe. Loss of wetland foraging habitat for wood storks within these counties may have adverse effects to individual colonies found within the Action Area.

6.15 Conclusion

Water depths and recession rates are the two most important evaluation criteria for analyzing any impacts the COP may have on wood storks. A variety of water conditions have been experienced since the implementation of ERTP 2016. Weekly recession rates within the action area were in the "poor" category for the majority of WY 2016 due to extreme water-level reversals that caused water depths to remain high throughout the nesting season. In WY 2017 and WY 2018, recession rates and water depths met or minimally exceeded the optimal rate for wood stork foraging with reversals occurring in May. In WY 2019, a significant reversal occurred in late January and multiple reversals followed in late February, March, and May, with little dry down through May. Based upon the two-gauge average of 3A-3 and 3A-4, water depths did not exceed 16 inches between March 1 and May 31, 2017; however, during

May 2018, water depths exceeded 16 inches for a period of 11 days. Water depths during this time ranged between 16.74 and 26.76 inches, with an average of 21.29 inches.

Recession rates that are considered "too rapid" and reversals due to extraordinary rainfall events during the onset of the wet season or prior to nest initiation have occurred under ERTP operations. Reversals occurring early in the dry season reduce foraging opportunities for adult wood storks and delay nest initiation. Wood stork colonies that initiate late during the dry season (February/March) are affected by reversals when trying to fledge nestlings, and concentrated prey becomes unavailable.

Despite long periods of time within the most recent breeding seasons where foraging depths were unfavorable to wood storks as measured at individual gauges, no obvious correlation between wood stork nesting effort and the foraging depth measured at a particular gauge was apparent in the wading bird monitoring data collected during these years. This is likely due to the availability of suitable water depths (optimal/sub-optimal) throughout much of these wood stork breeding seasons as measured at other gauges throughout the action area. Nesting effort by wood storks was above average within the WCAs in both WY 2017 and WY 2018. However, in WY 2019 there was no nesting activity by wood storks in the WCAs, and the only active wood stork colonies within the COP action area were in ENP (Frederick and Garner 2020).

Wetlands located within the core foraging area of wood stork colonies may be affected by non-federal actions not subject to Service review. The additional loss of these wetlands may result in impacts to wood storks that are expressed in terms of reproductive output or productivity. However, the potential impacts to wetlands not subject to Service review and the loss or reduction of foraging value to the wood storks associated with these systems is not likely to be significant.

Impacts to wood stork foraging and nesting are likely to occur under the COP as a result of reduced foraging habitat suitability and increased potential risk of depredation for some wood stork colonies. These effects are not expected to appreciably reduce the likelihood of survival and recovery of the species in the wild.

Due to general uncertainties related to model results, the Service has determined that the implementation of the COP is not likely to have significantly different effects to the wood stork than those that have been observed under the ERTP 2016. In addition, the temporal distribution of the changes to foraging conditions, hydroperiod, and stage described above is unknown.

After reviewing the status of the wood stork, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that the COP, as proposed, is not likely to jeopardize the continued existence of the wood stork. No critical habitat has been designated for this species; therefore, none will be affected.

7.0 INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to, and not intended as part of the agency action, is not considered to be prohibited taking under the Act provided such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are nondiscretionary and must be undertaken by the Corps so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this Incidental Take Statement. If the Corps (1) fails to assume and implement the terms and conditions or (2) fails to adhere to the terms and conditions of the Incidental Take Statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. To monitor the impact of incidental take, the Corps shall report the progress of the action and its impact on the species to the Service as specified in the Incidental Take Statement.

7.1 Surrogate Measures for Monitoring

For the CSSS, Everglade snail kite, and wood stork, detecting take that occurs incidental to the Action is not practical. The reasons for each species, (*e.g.*, individuals are small, cryptic, displaced from the Action Area to other areas where death or injury would occur, etc.) are described below in the subsequent sections.

In accordance with 50 CFR §402.14(i)(1)(i), when it is not practical to monitor take in terms of individuals of the listed species, the regulations indicate that an ITS may express the amount or extent of take using a surrogate (*e.g.*, a similarly affected species, habitat, or ecological conditions), provided that the Service also:

- describes the causal link between the surrogate and take of the listed species; and
- sets a clear standard for determining when the level of anticipated take has been exceeded.

We have identified surrogate measures in our analyses of effects that satisfy these criteria for monitoring take of the species named above during Action implementation. We estimated the

amount of take caused by the habitat modifications and determined that it was not practical to monitor take-related impacts and/or the level of anticipated take exceedance in terms of individuals of the listed species. Therefore, in accordance with 50 CFR 402.14(i)(1)(i), the surrogate measures based on species habitat will be used to measure when the level of anticipated take has been exceeded. Table 24 lists the species, life stage, surrogate measure, and the section of the BO that explains the causal link between the surrogate and the anticipated taking. We describe procedures for this monitoring in section 7.4.

7.2 Amount or Extent of Take Anticipated

This section specifies the amount or extent of take of federally listed wildlife species that the Action is reasonably certain to cause, which we estimated in the "Effects of the Action" sections of this BO. The Service acknowledges that it may sometimes be difficult to separate the effects of water management operations conducted under the COP from the effects of weather-related factors that affect hydrologic conditions, such as the amount, patterns and timing of rainfall, hurricanes, and drought. Thus, when exceedance criteria trigger(s) are reached, the Service will use the Corp's report and the best available data to reasonably determine if the exceedance triggers have been reached as a result of the COP or uncontrollable weather events, before determining if reinitiation is recommended.

7.2.1 Cape Sable Seaside Sparrows

While many components of the COP will contribute to the conservation of the CSSS in the long run, it does not avoid all adverse effects of water management operations.

Incidental take of individuals, especially nestlings or eggs, resulting from water operations is likely, either by direct drowning when routing water into CSSS habitats during the nesting season, or indirectly by making nests more susceptible to predation and other threats. High water levels can also stress adult birds reducing their fitness and making them more susceptible to predation and other causes of mortality.

Incidental take of CSSS resulting from water operations will be difficult to detect. The sparrow's reclusive habits and the general inaccessibility of its preferred habitat have long discouraged critical comprehensive life history studies (Lockwood et al. 1997). Seasoned observers typically have difficulty seeing individuals and usually rely on the chirping sound of singing adult males defending their breeding territory and vocalizing to attract females to determine presence or absence in an area. Detection by sound prompts more intensive searching that sometimes results in visually locating individuals and nests. Compounding these detection difficulties, the sparrow's distribution is patchy and temporally dynamic (Pimm et al. 2002).

Previous court opinions and court-ordered reviews of the Service's biological opinions have concluded that the standardized method used to estimate population abundance, known as the extensive survey method, is an insufficient basis for predicting or monitoring the amount or extent of incidental take of sparrows resulting from water management actions, because several

other factors influence the species' population dynamics. However, because the species' range is fully within areas that are influenced by the Corps' water management operations, and hydrologic conditions are strongly linked to reproductive success and the persistence of the sparrow's habitat, this method can serve as the starting point for predicting the amount of incidental take that is reasonably certain to occur, and as an indicator of the amount that has occurred. Potentially all adult birds are encompassed by the extensive survey method, and the previous year's reproductive success and productivity are reflected in the current year's survey results since CSSS are capable of breeding in the year after hatching.

The extensive survey method to estimate sparrow populations uses a helicopter to place observers at remote sites within sparrow habitat. The remote locations are determined by overlaying a 1 km grid over a map of sparrow habitat. The observers then record the number of sparrows seen or heard. To estimate the number of sparrows from the number observed (seen or heard), a correction factor is used. Kushlan and Bass (1983) were the first to develop and use a correction factor for their sparrow observations and it is still used today. A value of 15.87 (rounded to 16.0) is used based on the range at which observers can detect the sparrow's distinctive song, and on the assumption that each singing male is accompanied by one female. An individual male sparrow's territory is roughly 5 acres in size and the correction factor of 16 assumes that observers will count all birds within 656 ft of the observation station. Therefore, the correction factor of 16 is based on the fraction of total area sampled and detection probability, such that the area sampled multiplied by the detection probability equals 1/16 (Pimm et al. 2002; Walters et al. 2000). For that reason, one singing male heard or one individual seen is corrected to equate to a total of 16 individuals. This assumes statistically that an additional 15 individuals were also present in the area sampled, but due to factors governing the probability of detection, were not seen or heard during the time of observation. It has been statistically determined that under good survey conditions, the chance or probability of detection is better than 60 percent using this method. The correction factor methodology has been the subject of two external reviews. The most recent review (1999/2000) was conducted as a result of a recommendation by the American Ornithologists Union (AOU) external peer review committee. The outcome of the second review resulted in a determination by the AOU committee that the methodology employed is a reliable and accurate measure of abundance (Walters et al. 2000). However, this is not to say that it is a reliable method to track and count individual sparrows, rather it provides a reliable trend in population estimates comparable over time.

For the ERTP 2010 BO, the Service computed the mean total population estimate and standard deviation of these estimates (the customary statistical measure of variance for a set of measurements) for the years 2001-2009, which represented the timeframe under which operations for the protection of the CSSS had been implemented. Though the range of population estimates over this time frame varied due to water management and other factors, the Service determined that the mean population estimate from 2001 to 2009 had been relatively stable. Lacking methods that could separate the effects of water management from the effects of other factors, the Service used the standard deviation of the 9-year mean annual population estimate as a measure of all effects contributing to population variability. Subtracting the standard deviation of the population size estimates of previous years from the population size

estimate of the current year represented a conservative basis for estimating the amount of incidental taking due to water management. The amount of incidental take anticipated in the ERTP 2010 BO was exceeded in 2014, and consultation was reinitiated when the total estimated population fell to 2,720 (threshold was 2,915) individuals.

Through this reinitiated consultation, the Service revised the amount of anticipated take associated with ERTP 2016. The preliminary population estimate was 2,416 individuals at the time the 2016 BO was written. To compute the variability in annual population size as was done for the 2010 BO and establish the starting point for estimating anticipated take, the Service used the most recent years to reflect the current trend and variability. For this purpose, the Service used the previous 10-year period (2007-2016).

The mean population estimate for the period 2007-2016 was 2,727 sparrows with a standard deviation of 271. Rather than using one (1.0) standard deviation as the basis for estimating anticipated take as was done in the 2010 BO, ERTP 2016 used one half (0.5) of the standard deviation (271 x 0.5 = 135 birds) for this 10-year period, because (a) the estimated population had declined during that time; and (b) the Service believed that the RPA would have less adverse effects than ERTP, due to the additional conservation measures it incorporated. The Service concluded at that time that take of 135 sparrows represented the amount of incidental take that would result from implementing the RPA. Therefore, a decline from the 2016 population estimate of 2,416 sparrows to less than 2,281 sparrows (2,416 – 135 = 2,281) at any time during the course of the action would warrant a reinitiation of consultation. This threshold was not surpassed during the years 2016-2019.

The CSSS estimated population from 2016-2019 was 2,416, 3,280, 3,184 and 2,688 respectively. Although the 2019 estimate represented a decline of 496 birds, it did not trigger the ERTP 2016 reinitiation threshold (2,281). The Service believes that with the implementation of the proposed water management operations under the COP, the slow decline in population numbers should end and the population should begin to stabilize or increase. Therefore, the reinitaion threshold for the duration of the COP should be higher than that used in 2016. To this end, the Service calculated the 10-year (2010-2019) mean of the total population estimate (2,981) with associated standard deviation (SD) of 301. Subtracting this SD from the 2019 population estimate (2,688 – 301 = 2,387) sets the reinitiation threshold for the COP at 2,387 birds.

7.2.1.1 Exceedance Criteria for Incidental Take

A decline from the 2019 population estimate of 2,688 sparrows to less than 2,387 sparrows (2,688 – 301 = 2,387) at any time during the course of the action would warrant a reinitiation of consultation.

7.2.1.2 Monitoring and Reporting

Survey results for CSSS populations are not instantaneous since it may take several months to analyze the data and develop an estimate in any given year. Therefore, the Service has also

identified hydrologic parameters, described below, for monitoring to provide an earlier indication of conditions resulting from water management that may cause incidental take. These parameters, if exceeded, would indicate that the effects of the action are greater than anticipated in this BO, and would signal a potential for exceeding the amount of incidental take measured by the population estimate described above. If these parameters are exceeded, the adaptive management procedures in Section 7.4.1 should be initiated. Exceedance of these parameters alone does not trigger reinitiation of consultation. The Interagency Coordination Team (ICT) established for ERTP 2016, as a part of the adaptive management procedure, will examine causation of the exceedance and whether the exceedance resulted from water operations or natural events. The ICT will inform the Service and Corps leadership group of their findings.

CSSS build their nests near the ground surface at an average height of only 16 cm (6 inches) between the soil surface and the base of the nest. Accordingly, they are especially vulnerable to flooding caused by rising water levels due to rainfall or water management actions. Incidental take in the form of harm is anticipated to occur to individual sparrow eggs or nestlings as a result of high water levels during the breeding season. Therefore, during the breeding season, the monitoring of water levels within occupied sparrow habitat will provide an additional measure of incidental take of sparrow eggs and young not yet capable of flight. We do not anticipate the loss of adult sparrows since the water levels in question are not known to directly harm adult sparrows.

In addition to the exceedance criteria for incidental take described above based on the estimated total population of sparrows and recent variability in these estimates, the following targets should also be monitored by the Corps in the eastern and western subpopulations. These targets have been developed to improve the conditions for the CSSS and contribute towards the survival and recovery of the species. Based on current model output, the Service acknowledges that these targets are not technologically feasible for all subpopulations in every year at this time. Exceedance of the targets should be addressed in the reporting mechanisms included in this BO and do not require re-initiation of consultation.

As discussed in previous sections, the Service tracks two important hydrologic metrics that pertain to the availability of suitable nesting habitat during the breeding window and the annual discontinuous hydroperiod which affects vegetation composition and overall habitat suitability. The Sparrow Viewer can track the status of these metrics on a real-time basis so conversations can take place early and often if conditions are not staying within the bounds of these metrics.

7.2.1.3 Dry Nesting Conditions

1. Subpopulation Ax - At least 24,000 acres of suitable habitat within and adjacent to CSSS subpopulation Ax must have 90 consecutive dry days between March 1 and July 15 (CSSS breeding season) every year.

2. Subpopulations B through F – At least 40 percent of each designated CSSS critical habitat unit must have 90 consecutive dry days between March 1 and July 15 (CSSS breeding season) every year.

7.2.1.4 Habitat Criteria (Discontinuous Hydroperiod)

1. Subpopulation Ax – At least 24,000 acres of suitable habitat within and adjacent to CSSS subpopulation Ax must show a 4-year running average discontinuous hydroperiod range of 90 to 210 days, with no 2 consecutive years failing to meet this target.

2. Subpopulations B through F – At least 40 percent of each designated CSSS critical habitat unit must show a 4-year running average discontinuous hydroperiod range of 90 to 210 days, with no 2 consecutive years failing to meet this target.

7.2.1.5 Eastern Marl Prairie

Operation of the S-332 structures may result in flooding of sparrow nests that occur within 0.6 mile of the S-332 Detention Areas, either because of increased water levels resulting from seepage or from overflow from the detention areas directly into sparrow habitat within ENP. This will result in loss of the contents of all nests within 0.6 mile of S-332 structures. Operation of the detention areas that raise water levels from a groundwater condition to a surface water condition beyond 0.6 mile from the detention areas prior to July 15 could result in incidental take. Specific instructions for monitoring and reporting this habitat surrogate for incidental take in the eastern marl prairies are provided in section 7.4.4.

7.2.1.6 Western Marl Prairie

Information from various sources identifies different amounts of potential and available habitat in the western marl prairies. To date, there is still limited detailed information about the condition and susceptibility to flooding within all portions of this area; therefore, we rely upon the data that were presented in the Service's 1999 Biological Opinion.

The Service anticipates that a maximum of 74 square-miles (47,333 acres) of potential and historic sparrow habitat for the extended Subpopulation Ax is subject to flooding during the nesting season due to water releases. This area corresponds to 60 percent of potential sparrow habitat for Subpopulation Ax. Any adult birds that have territories within the 74 square miles would be impacted by water levels too high to allow breeding or by lower fecundity associated with nest abandonment. Likewise, injury or death to juvenile sparrows or eggs could result from discharges that raise the water level above existing nests. Specific instructions for monitoring and reporting this habitat surrogate for incidental take in the western marl prairies are provided in section 7.4.4.

7.2.2 Everglade Snail Kite

As previously explained in section 4.12 Summary and Analysis of Effects of the Action of this BO, based on best available data, the COP is reasonably certain to result in take of the Everglade snail kite. We estimate that a total of nine (9) Everglade snail kites will be harmed as a result of the COP during its 7-year operational period.

However, even though this is a reasonable conclusion, based on the best available data, we realize that there is significant uncertainty surrounding this estimate due to the following reasons:

- A reduction in the number of snail kites in WCA-3A or ENP in one year would not necessarily indicate a loss of snail kites due to the action if the unaccounted snail kites were elsewhere in the larger system. For example, if adult snail kites that encounter high water levels in WCA-3A subsequently nest in the STAs, KCOL, or Lake Okeechobee, that disturbance does not necessarily indicate harm has occurred;
- It is impractical to monitor each individual snail kite and snail kite nest;
- It is impractical to discern the number of individual snail kites that are incidentally taken as a result of habitat impacts from other demographic and environmental parameters that will be occurring at the same time as the action, even if it was practical to monitor each individual snail kite;
- Current methodologies for tracking population trends are insufficient to document the incidental taking of individual snail kites (Service 2010a).

7.2.2.1 Exceedance Criteria for Incidental Take

Incidental take of snail kites will be considered exceeded if any of the following three exceedance criteria are not met during the COP operations:

<u>Dry Season High Water Timing: by April 15</u>
Trigger: stage >9.2 ft NGVD at gauge 3AS3W1
Frequency: 2 consecutive years

<u>Wet Season High Water Timing: June 1 – December 31</u>
Trigger: stage >10.5 ft at gauge 3AS3W1 for 60 days
Frequency: 2 consecutive years

<u>Recession: Dry Season Amplitude</u>
Timing: January 1 – May 31 (or onset of wet season, whichever is sooner)
Trigger: stage difference >1.7 ft as measured at gauge(s) closest to kite nesting, as determined by the Service
Frequency: 2 consecutive years

For all exceedance criteria, if the trigger is reached in any single year the Corps is to conduct a review of water management operations that may have contributed to the hydrologic condition(s) of concern and provide this report to the Service within 60 days of the exceedance. These incidental take surrogates are in accordance with Service policy in that they set a clear standard for determining when take has been exceeded and there is a causal link between the surrogate and the take of the species.

7.2.2.2 Monitoring and Reporting

Due to these factors of uncertainty, in accordance with 50 CFR 402.14(i)(1)(i), we re-affirm the evaluation criteria, performance measures, and exceedance criteria that were developed for the ERTP 2016 BO. The evaluation criteria and performance measures were used to inform the exceedance criteria and provide a mechanism to report on the effects of the COP. The exceedance criteria are linked to habitat quality as a surrogate for incidental take of snail kites. Those evaluation criteria and performance measures are-stated below. Exceedances of the evaluation criteria and performance measures should be addressed in the reporting mechanisms included in this BO and do not require re-initiation of consultation.

7.2.2.3 Everglade Snail Kite Evaluation Criteria and Performance Measures

Prolonged High Water Criteria

Based on the potential for adverse effects to snail kites, apples snails, and their habitats as described in the Environmental Baseline section, the Service developed recommendations in the MSTS to guard against extended high water levels during the pre-breeding season (approximately January) and to provide favorable water levels associated with improved snail kite and apple snail productivity in the breeding (dry) season. These recommendations established the following criteria, as expressed as part of the following ERTP PMs:

<u>Performance Measure B (Snail Kites) – Pre-breeding Water Levels</u>: Strive to reach water levels measured by 3AVG between 9.8 and 10.3 ft NGVD by December 31. These water levels, measured by 3AVG when coupled with the recommended recession rate (0.05 ft per week, as described below), are recommended to provide favorable conditions in southwest WCA-3A for optimal snail kite nest success during the peak breeding season (March-June). The Service determined it was most important to apply snail kite and apple snail PMs to conditions in southwestern WCA-3A, the area most frequently used by kites in recent years (Figure 24) and where adverse impacts to snail populations should be avoided or minimized.

<u>Performance Measure C (Apple Snails) – Pre-breeding Water Levels:</u> Strive to reach water levels between 9.7 and 10.3 ft NGVD by December 31. These water levels are based on reaching maximum water depths of 40 cm to 60 cm at the 3AVG average GSE of 8.34 ft NGVD. When coupled with a slow, gradual recession rate (approximately 0.05 ft per week), these water depths were recommended to provide favorable conditions (*i.e.*, water depths ≤40 cm, as

discussed below) for apple snail egg production beginning in March, and to prevent delayed or reduced apple snail egg production.

Performance Measure C (Apple Snails) – Dry Season Water Levels: Strive to reach water levels between 8.7 and 9.7 ft NGVD between May 1 and June 1. The top end of the specified range (*i.e.*, 9.7 ft, measured using the 3AVG) is related to a depth of 40 cm at the 3AVG average GSE of 8.34 ft NGVD. As discussed above, snail research results suggest that this approximate water depth acts as a threshold in its effects (positive or negative) on apple snail productivity in a given year. It is important to note that, in the MSTS, the Service recognized that the stages will result in deeper water (*i.e.*, >40 cm) in southern WCA-3A, which would negatively impact snail egg production in that area, and consequently reduced the top end of the multi-species recommended dry season range to 9.3 ft NGVD (measured using the 3AVG). Our evaluation took this discrepancy into account.

Low Water Criteria

The intent of low water evaluation criteria was twofold; 1) to assess the potential for frequent and extended extreme low water levels which would result in reduced snail kite reproduction and recruitment, and reduced apple snail productivity and juvenile survival, and 2) to assess the opportunities for lower (but not extreme, frequent, or extended) water levels which are essential to restoration and maintenance of wet prairie habitat, and which species experts believe are necessary, at least in the transition period, to return WCA-3A to a productive kite area. Based on the information described in the snail kite Environmental Baseline section, the Service developed recommendations in the MSTS to provide favorable water levels associated with improved snail kite and apple snail productivity in the breeding (dry) season. Recommended water levels were intended to represent the annual minimum stage which typically occurs sometime in May before the onset of wet season rains. These recommendations established the following criteria, as expressed as part of the following ERTP PMs and ET:

Performance Measure B (Snail Kites) – Dry Season Water Levels: Strive to reach water levels between 8.8 and 9.3 ft between May 1 and June 1. These water levels (measured using the 3AVG) are recommended to provide favorable conditions in southwest WCA-3A for optimal snail kite nest success and juvenile survival, balanced with the need for lower water levels during the dry season to avoid negative effects to wet prairie vegetation.

Performance Measure C (Apple Snails) – Dry Season Water Levels: Strive to reach water levels between 8.7 and 9.7 ft between May 1 and June 1. The bottom end of the specified range (*i.e.*, 8.7 ft, measured using the 3AVG) is related to a depth of 15 cm at the 3AVG average GSE of 8.34 ft NGVD. This water level translates to dry season minimum water depths ≥10 cm at GSE <8.36 ft NGVD, and thus, should avoid negative effects to snail movement and reproduction in these areas.

Ecological Target 3 (Wet Prairie): Hydroperiod: In dry years, strive to maintain optimal snail kite foraging habitat by allowing water levels to fall below ground surface level between 1 in

4 and 1 in 5 years (208-260 weeks average flood duration) between May 1 and June 1 to promote regenerations of marsh vegetation. Do not allow water levels below ground surface for more than 4 to 6 weeks to minimize adverse effects on apple snail survival.

Recession Criteria

Based on the information described in the Environmental Baseline section, the Service developed a recession recommendation for snail kites in the MSTS, and this recommendation established the following criteria, as expressed as part of the following ERTP PM:

Performance Measure D (Snail Kites) – Dry Season Recession: Strive to maintain a recession rate of 0.05 ft per week from January 1 to June 1 (or the onset of the wet season). This equates to a stage difference of approximately 1.0 ft between January and the dry season low. The Service defined the onset of the wet season as a sustained increase in water levels associated with increased rainfall frequency, which has occurred prior to June 1 over 50 percent of the time since 1965. The recession rate guideline is most important to follow during the peak snail kite breeding season (March-June). Recession rates >0.05 ft but <0.10 ft per week, while generally more rapid than desired, may be considered acceptable under certain environmental conditions (*e.g.*, unseasonably heavy rainfall). Rates >0.0 and <0.05 ft per week are not associated with direct negative impacts to nesting snail kites, although rates approaching 0.0 ft may result in delayed or reduced snail egg cluster production, depending on water depths at that time (*i.e.*, greater impacts when water is >40 cm deep).

7.2.3 Wood Stork

Although wood storks nest colonially and often in the same site for many years, the ability to count individual wood storks and their young and attribute any changes from year-to-year as an effect of the action is complicated by many factors. First, wood stork colonies are surveyed and results are reported as estimates and do not reflect actual counts, not all wood storks return to the same colony every year even if the colonial site is used again (Kushlan and Frohring 1986), nesting sites may be abandoned if water levels recede too far (Rodgers et al. 1996) or there is disturbance to the site and the colony or individual birds may re-nest elsewhere (Ogden 1991, Borkhataria et al. 2004, Crozier and Cook 2004). In addition, new wood stork colonies are often discovered which may represent a shift from historic colonies due to environmental conditions (Meyer and Frederick 2004).

The annual hydrologic pattern in south Florida is consistent, with water levels rising during the wet season (June through October), then receding gradually during the dry season (November to May). Wood storks nest during the dry season and rely on the drying wetlands to concentrate prey items for optimal foraging. Once the wetland has dried to where water levels are near the ground surface, the area is no longer suitable for wood stork foraging and will not be suitable again until water levels rise and the area is repopulated with fish. Wood storks prefer calm water, approximately 2 to 16 inches deep and free of dense vegetation for foraging (Coulter

and Bryan 1993). More recently, Beerens and Cook (2010) defined a foraging depth range of -0.31 to 1.34 ft (-9.33 to 41.26 cm) for wood storks feeding in WCA-3A.

Accordingly, there is a general progression in the suitability of wetlands for wood stork foraging based on their hydroperiods and the distance of the wetlands from the nest. Short hydroperiod wetlands are used early in the nesting season, the mid-range hydroperiod sites are used during the middle of the nesting season, and the longest hydroperiod areas (typically slough habitat) are used later in the nesting season. Adult wood storks feed farthest from the nesting site prior to laying eggs, forage in wetlands closer to the colony site during incubation and early stages of raising the young, and then farther away again, when the young are able to fly.

The implementation of the COP is expected to influence wetland hydroperiods causing changes in foraging suitability and prey availability for wood storks. If the COP contributes to reduced depth and hydroperiod during the preceding wet season, the effects generally result in decreased productivity and abundance of prey. Additionally, if increased hydroperiod and water depth occurs during the nesting season, such effects generally result in reduced foraging suitability and densities of wood stork prey. Examples of this could include water level manipulations of several inches in and around the colonies which could make it more difficult for wood storks to forage and provide for young as well as increase the availability of wood stork nests to predators. In some years, conditions for wood storks may be favorable under operations. The Service does not anticipate widespread abandonment or nest failures as a result of the COP.

The Service anticipates incidental take in the form of harm, from loss of forage biomass and reductions in foraging habitat suitability, may result in injury or death of 9.6 nests or 12 nestlings each year. We noted that over the 7-year life of the COP, the annual conversion of 9,795 acres of short hydroperiod to long hydroperiod wetlands may result in the loss in nest production of nestlings. As previously explained, detecting direct take of individual storks that occurs incidental to the action is not practical. Therefore, we have identified the following surrogate measures in our analyses of effects for monitoring take of the wood stork:

7.2.3.1 Exceedance Criteria for Incidental Take

Incidental take of wood storks will be considered exceeded if the following criteria occur during the COP operations:

- Water depth greater than 16 inches (41 cm) from March 1 through May 31 throughout WCA-3A for two consecutive years as measured by the two gauge average (based upon a ground surface elevation of 8.4 feet NGVD) at gauges 3A-3 and 3A-4. A water depth greater than 16 inches (41 cm) across WCA-3A during the nesting season (January 1 to June 1) would lower the suitability of foraging habitat to the point where the ability for wood storks to forage would be severely impaired and most likely result in widespread abandonment of nests and fledglings within the affected colony (Gawlik et al. 2004, J.M. Beerens, FAU, personal communication 2010).

For exceedance criteria, if the trigger is reached in any single year the Corps is to conduct a review of water management operations that may have contributed to the hydrologic condition(s) of concern and provide this report to the Service within 60 days of the exceedance. These incidental take surrogates are in accordance with Service policy in that they set a clear standard for determining when take has been exceeded and there is a causal link between the surrogate and the take of the species.

7.2.3.2 Monitoring and Reporting

Due to these factors of uncertainty, in accordance with 50 CFR 402.14(i)(1)(i), we re-affirm the performance measures, and exceedance criteria that were developed for the ERTP 2016 BO. The performance measures were used to inform the exceedance criteria and provide a mechanism to report on the effects of the COP. These measures, listed below, are linked to habitat quality as a surrogate for incidental take of wood storks. Exceedances of the performance measures should be addressed in the reporting mechanisms included in this BO and do not require re-initiation of consultation.

7.2.3.3 Recession criteria

Based on the information described in Beerens and Cook (2010), the Service developed PMs and a recession recommendation for wood storks in the MSTS. These PMs are used to monitor and inform the exceedance criteria in Section 7.2.3.2. Exceedances of these PMs should be addressed in the reporting mechanisms included in this BO and do not require re-initiation of consultation.

Performance Measure F (PM-F) - WCA-3A (Dry Season Recession Rate): Maintain a recession rate of 0.07 feet per week, with an optimal range of 0.06 to 0.07 feet per week, from January 1 to June 1.

Performance Measure G (PM-G) - WCA-3A (Dry Season): Maintain areas of appropriate foraging depths (5 to 25 cm) within the Core Foraging Area (CFA) (18.6-mile radius) of any active wood stork colony.

In addition to the two Performance Measures cited above, the Service has included two additional Performance Measures that we believe should be monitored.

Performance Measure 1 (PM-1) - Recession rates greater than 0.37 ft per week (11.34 cm per week) and reversals greater than -0.23 ft per week (-7.00 cm per week) in WCA-3A during the nesting season (January 1 to June 1) are considered too rapid to support wood stork foraging. The methodology used to estimate recession rates in WCA-3A are described in Bereens and Cook (2010). (Note that negative values indicate increasing water levels [*i.e.*, reversals]).

Performance Measure 2 (PM-2) – Maintain sufficient short hydroperiod wetlands for wood stork foraging. The effects analysis determined that the COP would result in an annual average impact to 9,795 acres of short hydroperiod wetlands with appropriate foraging depths (5-25 cm) within the Core Foraging Area (CFA) (18.6-mile radius) of active wood stork colonies. Daily water surface changes over time should be measured from the Everglades Depth Estimation Network (EDEN) and reported on to determine average annual changes to short hydroperiod wetlands (*i.e.*, wetlands inundated 0 to 180 days per year).

Survey results for wood stork nesting are not instantaneous since it may take several months to analyze the data and develop an estimate in any given year. Therefore, the Service identified hydrologic criteria, described above, for monitoring to provide an earlier indication of conditions resulting from water management that may cause incidental take. These criteria, if exceeded, would indicate that the effects of the action are greater than anticipated in this BO, and would signal a potential for exceeding the amount of incidental take measured in our analysis. If these criteria are exceeded, the adaptive management procedures in Section 7.4.1 should be initiated.

7.3 Reasonable and Prudent Measures

As part of the proposed action, the Corps has committed to implementing a series of conservation measures, which are continued from the ERTP 2016 Biological Opinion. For clarity, the Service has incorporated these measures as Reasonable and Prudent Measures (RPM) and believes they are necessary and appropriate to minimize impacts of incidental take of Cape Sable seaside sparrows, Everglade snail kites and wood storks.

- Continue to use operational flexibility during the implementation of the COP to minimize impacts related to hydrology. During periods when water regulations are not restricted by constraints, the Corps will work with the Service and other partners to identify operations that minimize detrimental impacts or reduce the future risk of detrimental impacts to the CSSS, Everglade snail kite, wood stork or their habitats.

- Under the COP, species and habitat monitoring currently being conducted in compliance with the ERTP 2016 BO (Service 2016) will continue to identify population trends for the CSSS, snail kite, wood stork and the vegetation characteristic of their habitats.

- Under the COP, the Corps will continue to implement Periodic Scientist Calls (PSC) to provide real-time assessment of conditions within the action area to ensure wildlife recommendations are considered during the water management decision process.

- The Corps will continue to evaluate how water management operations within the flexibility available to water managers under the water control plan, may be conducted to maximize beneficial effects for the CSSS.

- The Corps will continue to utilize best available methods to monitor and estimate the spatial and temporal extent of hydrologic conditions (water above or below ground surface) relative to the CSSS habitat targets (*i.e.*, dry nesting days and annual discontinuous hydroperiod).

- The Corps will continue discussions with the Service in the event of operational modifications of the COP if such modifications are proposed to occur in the future. The Corps will track implementation of the COP and communicate the status of all actions to the Service as appropriate through regular interagency discussions (*i.e.*, COP PSC, COP AMMP Meetings).

7.4 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the Corps must comply with the following terms and conditions, which implement the reasonable and prudent measures, described above and outline required reporting/monitoring requirements. These terms and conditions are nondiscretionary.

7.4.1 Species-wide Terms and Conditions

- Operational flexibility will be identified through the COP AMMP, Ecosystem Based Management multispecies meetings, and Periodic Scientist Calls. Implementation of these operational flexibilities may result in operational changes throughout the COP study area for CSSS, snail kites and wood storks. This will help reduce the hydrologic effects of the COP and prepare for full implementation of CEPP. Operational flexibility will be used to avoid consecutive years of adverse hydrologic conditions for the three avian species and their habitat. Details of the operational flexibility will be adjusted in coordination with cooperating agencies as additional CERP project components are implemented. Additional detail regarding the information needed to assess and implement operational flexibility can be found in the individual species sections below.

7.4.2 Everglade Snail Kite

1. In order to assure the effects of these actions do not exceed the level of impacts anticipated in this Biological Opinion, obtain information on:

    a. The annual status of the Everglade snail kite population and apple snail populations within the action area;
    b. The reproductive effort of the Everglade snail kite population and apple snail populations within the action area, including:

        i. The number of Everglade snail kites initiating nesting in the action area, the success rate and productivity of those nesting efforts, and subsequent recruitment resulting from those nesting efforts each year; and

ii. The amount of apple snail egg cluster production in the action area each year;

c. Impacts of hydrologic changes caused by the action on the Everglade snail kite, its prey, and its habitat. For all exceedance criteria, if the trigger is reached in any single year the Corps is to conduct a review of water management operations that may have contributed to the hydrologic condition(s) of concern and provide this report to the Service within 60 days of the exceedance; and
d. The effects of operational changes at specific structures related to these actions and their operations on hydrology in the habitats occupied by the Everglade snail kite.

Monitoring plans designed to obtain the information above must be developed by the Corps and approved by the Service within 90 days of this signed Biological Opinion, and snail kite and apple snail monitoring programs must be in place prior to the beginning of the nesting season. Range wide snail kite monitoring (as required under ERTP) must be continued under the COP in order to obtain estimates of the snail kite population and related breeding parameters, and to allow sufficient time for other funding arrangements to be made.

7.4.3 Wood Stork

1. In order to assure the effects of these actions do not exceed the level of impacts anticipated in this Biological Opinion, the Corps must obtain information on:

   a. The annual status of wood stork populations in the action area;
   b. Determine annually the number of wood storks initiating nesting in the action area and the success rate of those nesting efforts each year;
   c. Impacts of hydrologic changes caused by the action on the wood storks and their habitat. For all exceedance criteria, if the trigger is reached in any single year the Corps is to conduct a review of water management operations that may have contributed to the hydrologic condition(s) of concern and provide this report to the Service within 60 days of the exceedance; and
   d. The effects of operational changes at specific structures related to these actions and their operations on hydrology in the habitats occupied by the wood stork.

7.4.4 Cape Sable Seaside Sparrow

In order to monitor the impacts of incidental take, the Federal agency must report the progress of the action and its impact on the species to the Service as specified in the Incidental Take Statement (50 CFR 402.14(i)(3)).

1. Annual Population Surveys – To determine how water management is affecting the CSSS and to monitor population size and trends, the Corps will ensure that appropriate annual population surveys are conducted in all CSSS subpopulations. The Corps will confer with the Service, Everglades National Park, and USGS to determine whether to modify

the current survey protocol. The Corps will provide a report on the results of the surveys annually to the Service by December 31.

2. Eastern Marl Prairies – To determine whether water management is causing incidental take of CSSS in the eastern marl prairies in excess of that anticipated in the BO, the Corps will utilize the USGS EDEN TransectPlotter program (Corps 2014) or similar analysis, in combination with the USGS SparrowViewer for plotting daily water level surfaces and extent of dry CSSS habitat. Regular reporting on this metric will be included in the Periodic Science Calls.

3. Western Marl Prairies – To determine whether water management is causing incidental take of CSSS in the western marl prairies in excess of that anticipated in the BO, the Corps will utilize the USGS Sparrow Viewer for determining daily water levels over the expanded Subpopulation Ax. Regular reporting on this metric will be included in the Periodic Science Calls.

7.5 Reporting Requirements

1. The Interagency Coordination Team (ICT), established during the ERTP, will continue to meet twice each year, once prior to the CSSS nesting season (~February) and once after the CSSS nesting season (~September) to discuss details of the operations and monitoring results for each species and to make recommendations for the upcoming seasons.

2. The Corps will incorporate the Conservation Measures, as previously discussed in their BA into their reporting requirements.

3. The Corps will continue to implement provisions of the ERTP 2016 BO which require the Corps to provide a report to the Service on the results of CSSS monitoring at least twice annually to evaluate progress toward meeting the performance targets (Service 2016). Bi-annual reports will evaluate nesting season conditions and include information such as the operations that occurred and their effectiveness, and the spatial and temporal extent of hydrologic conditions within each CSSS subpopulation (Service 2016).

4. Upon locating a dead, injured, or sick specimen of any threatened or endangered species, initial notification must be made to the nearest Service Law Enforcement Office (U.S. Fish and Wildlife Service, 9549 Koger Boulevard, Suite 111, St. Petersburg, Florida 33702; 727-570-5398). Secondary notification should be made to the Florida Fish and Wildlife Conservation Commission, South Region, 3900 Drane Field Road, Lakeland, Florida, 33811-1299; 1-800-282-8002. Care should be taken in handling sick or injured specimens to ensure effective treatment and care or in the handling of dead specimens to preserve biological material in the best possible state for later analysis as to the cause of death. In conjunction with the care of sick or injured specimens or preservation of

biological materials from a dead animal, the finder has the responsibility to carry out instructions provided by Service Law Enforcement to ensure that evidence intrinsic to the specimen is not unnecessarily disturbed.

5. The Service will not refer the incidental take of any migratory bird or bald eagle for prosecution under the Migratory Bird Treaty Act of 1918 as amended (16 USC Section 703-712), or the Bald and Golden Eagle Protection Act of 1940, as amended (16 USC Section 668-668d), if such take is in compliance with the terms and conditions specified herein.

8.0 CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to use their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to further minimize or avoid adverse effects of a proposed action on federally listed species or critical habitat, to help implement recovery plans, or to develop information.

1. Continue to monitor the series of existing hydrological gauges to measure hydrologic impacts within the COP project area.

2. In cooperation with the Service and other parties, continue to explore ways to increase the outlet capacity of WCA-3A and 3B, as authorized and envisioned as part of the MWD and CERP projects to benefit listed species.

3. In cooperation with the Service, collaborating researchers and other partners, support the development and application of real-time models to better inform snail kite-related water recommendations in the Everglades by meeting the following objectives:

    a. Develop spatially explicit hydrologic relationships for snail kite reproductive responses and adapt an existing snail kite population model (EverKite) to be run in real-time and near-term forecasts.
    b. Adapt the existing Florida apple snail model (EverSnail) to a real-time/ forecast application.
    c. Code models for online dissemination of software that runs the new models.
    d. Integrate snail kite and apple snail model outputs into a broader multi-species decision support framework.

4. Fund range-wide snail kite monitoring under section 7(a)(1) of the ESA to ensure that robust population estimates continue to be obtained and available to inform proposed projects and management activities conducted by the Corps and other agencies, as well as to inform recovery actions and evaluate progress toward meeting recovery criteria. A unified funding approach would also help ensure that data are collected in a seamless way

and that the scientific integrity of the monitoring is maintained and would increase monitoring efficiencies to leverage limited resources.

5. In cooperation with the Service, collaborating researchers and other partners, develop and implement an apple snail monitoring program across the range of the Everglade snail kite in Florida.

6. In cooperation with the Service and collaborating researchers, provide technical assistance to develop methods to restore marl prairie vegetation that has been impacted by high water levels.

7. The expectation from COP modeling, as assessed in this document, is that hydroperiods in the vicinity of CSSS-Ax could be shortened by up to 30 days. If this does not occur or the hydroperiod increases after four years of COP operations, then the Corps in conjunction with ENP and the Service should seek to investigate all sources of flow into this area to determine the cause.

8. In coordination with ENP and the Service, increase the Corps' contribution to CSSS population surveys and habitat conservation practices.

9. Investigate the potential for automating the S-12A and S-12B structures. Automating the S-12A/B would allow for more rapid responses to changes in conditions in WCA-3A and CSSS-A. If this is feasible, and hasn't already been completed, then modify the structures as appropriate.

10. In addition to those actions mentioned above, the Service feels that the Corps should exercise their capabilities as outlined under section 7(a)(1) of the Endangered Species Act. The Service, in cooperation with our DOI partners, has developed an MOU outlining a variety of actions that we feel would provide benefits to the CSSS in the near term. We would welcome the Corps' active participation in the activities outlined in the DOI MOU for the Cape Sable seaside sparrow.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

9.0 REINITIATION NOTICE

This concludes formal consultation on the action outlined in the Corps' BA on the COP. As provided in 50 CFR Section 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if:

1. the amount or extent of incidental take is exceeded;

2. new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion;
3. the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this Opinion; or

Measures of anticipated incidental take relative to criterion #1 above are provided in sections 7.2.1, 7.2.2, and 7.2.3, for the CSSS, Everglade snail kite, and wood stork, respectively. Specific instructions for monitoring and reporting are provided in section 7.4.

The Corps may request an extension of the BO if and when it is determined that operations under the COP will continue beyond 2027. At that time, the Service will evaluate if the level of take authorized by this BO has been exceeded, or if an extension can be granted.

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11.0Tables

Table 1. CSSS Helicopter Survey Bird Count and Population Estimates 1981-2019. Population estimate fluctuation from ERTP Reinitiation Trigger (2001-2009 Ave. - 1 Std. Dev. Or 3,145 - 230 = 2,915) and ERTP 2016 Reinitiation Trigger (2016 to present; 2,416 – 135 = 2,281) is shown in final column with exceedances in red.

Population Year	A		B		C		D		E		F		Total		
	BC	**Est**	**BC**	**Est**	**BC**	**Est**	**BC**	**Est**	**BC**	**Est**	**BC**	**Est**	**BC**	**Est**	**Δ ERTP Trig.**
1981	**168**	**2,688**	**147**	**2,352**	**27**	**432**	**25**	**400**	**42**	**672**	**7**	**112**	**416**	**6,656**	**3,741**
1992	**163**	**2,608**	**199**	**3,184**	**3**	**48**	**7**	**112**	**37**	**592**	**2**	**32**	**411**	**6,576**	**3,661**
1993	**27**	**432**	**154**	**2,464**	**0**	**0**	**6**	**96**	**20**	**320**	**0**	**0**	**207**	**3,312**	**397**
1994*	**5**	**80**	**139**	**2,224**	**NS**	**NS**	**NS**	**NS**	**7**	**112**	**NS**	**NS**	**151**	**2,416**	**-499**
1995	**15**	**240**	**133**	**2,128**	**0**	**0**	**0**	**0**	**22**	**352**	**0**	**0**	**170**	**2,720**	**-195**
1996	**24**	**384**	**118**	**1,888**	**3**	**48**	**5**	**80**	**13**	**208**	**1**	**16**	**164**	**2,624**	**-291**
1997	**17**	**272**	**177**	**2,832**	**3**	**48**	**3**	**48**	**52**	**832**	**1**	**16**	**253**	**4,048**	**1,133**
1998	**12**	**192**	**113**	**1,808**	**5**	**80**	**3**	**48**	**57**	**912**	**1**	**16**	**191**	**3,056**	**141**
1999a	**25**	**400**	**128**	**2,048**	**9**	**144**	**11**	**176**	**48**	**768**	**1**	**16**	**222**	**3,552**	**637**
1999b	**12**	**192**	**171**	**2,736**	**4**	**64**	**NS**	**NS**	**60**	**960**	**0**	**0**	**247**	**3,952**	**1,037**
2000a	**28**	**448**	**114**	**1,824**	**7**	**112**	**4**	**64**	**65**	**1,040**	**0**	**0**	**218**	**3,488**	**573**
2000b	**25**	**400**	**153**	**2,448**	**4**	**64**	**1**	**16**	**44**	**704**	**7**	**112**	**234**	**3,744**	**829**
2001	**8**	**128**	**133**	**2,128**	**6**	**96**	**2**	**32**	**53**	**848**	**2**	**32**	**204**	**3,264**	**349**
2002	**6**	**96**	**119**	**1,904**	**7**	**112**	**0**	**0**	**36**	**576**	**1**	**16**	**169**	**2,704**	**-211**
2003	**8**	**128**	**148**	**2,368**	**6**	**96**	**0**	**0**	**37**	**592**	**2**	**32**	**201**	**3,216**	**301**
2004	**1**	**16**	**174**	**2,784**	**8**	**128**	**0**	**0**	**40**	**640**	**1**	**16**	**224**	**3,584**	**669**
2005	**5**	**80**	**142**	**2,272**	**5**	**80**	**3**	**48**	**36**	**576**	**2**	**32**	**193**	**3,088**	**173**
2006	**7**	**112**	**130**	**2,080**	**10**	**160**	**0**	**0**	**44**	**704**	**2**	**32**	**193**	**3,088**	**173**
2007	**4**	**64**	**157**	**2,512**	**3**	**48**	**0**	**0**	**35**	**560**	**0**	**0**	**199**	**3,184**	**269**
2008	**7**	**112**	**NS**	**2,512**	**3**	**48**	**1**	**16**	**23**	**368**	**0**	**0**	**34**	**3,056**	**141**
2009	**6**	**96**	**NS**	**2,512**	**3**	**48**	**2**	**32**	**27**	**432**	**0**	**0**	**38**	**3,120**	**205**
2010	**8**	**128**	**119**	**1,904**	**2**	**32**	**4**	**64**	**57**	**912**	**1**	**16**	**191**	**3,056**	**141**
2011	**11**	**176**	**NS**	**1,904**	**11**	**176**	**1**	**16**	**37**	**592**	**2**	**32**	**62**	**2,896**	**-19**
2012	**21**	**336**	**NS**	**1,904**	**6**	**96**	**14**	**224**	**46**	**736**	**4**	**64**	**91**	**3,360**	**445**
2013	**18**	**288**	**112**	**1,792**	**8**	**128**	**1**	**16**	**45**	**720**	**1**	**16**	**185**	**2,960**	**45**
2014	**4**	**64**	**114**	**1,864**	**7**	**112**	**2**	**32**	**42**	**672**	**1**	**16**	**170**	**2,720**	**-195**
2015	**13**	**208**	**120**	**1,920**	**7**	**112**	**4**	**64**	**55**	**880**	**2**	**32**	**201**	**3,216**	**301**
2016	**3**	**48**	**112**	**1,792**	**7**	**112**	**5**	**80**	**24**	**384**	**0**	**0**	**151**	**2,416**	**-499**
2017	**1**	**16**	**121**	**1,936**	**3**	**48**	**4**	**64**	**75**	**1,200**	**1**	**16**	**205**	**3,280**	**688**
2018	**2**	**32**	**120**	**1,920**	**9**	**144**	**16**	**256**	**50**	**800**	**2**	**32**	**199**	**3,184**	**592**
2019	**0**	**0**	**96**	**1,536**	**5**	**80**	**11**	**176**	**55**	**880**	**1**	**16**	**168**	**2,688**	**96**

NS = Not Surveyed

Includes Subpopulation B most recently conducted survey data for years not surveyed.

Table 2. USGS Sparrow Viewer data showing the percent area of habitat meeting the ≥90-day dry nesting window for each subpopulation from 1991-2019. The target is to achieve 90 or more days in at least 40 percent of each subpopulation. Red shaded numbers indicate where the target has not been met.

Year	AX	B	C	D	E	F
1991	1.40%	32.30%	82.60%	19.50%	27.90%	78.80%
1992	41.00	90.70	100.00	80.90	99.10	100
1993	0.40	60.10	97.50	58.50	62.40	100
1994	8.00	73.00	82.20	22.80	70.20	100
1995	0.00	44.70	89.80	20.30	19.10	99.30
1996	9.80	42.00	43.20	34.10	48.90	86.80
1997	21.40	55.10	81.40	70.70	35.40	100
1998	8.60	47.50	95.30	17.50	44.70	100
1999	15.20	71.00	100	72.00	79.60	100
2000	23.00	73.80	95.80	40.20	65.20	100
2001	52.60	100	100	89.00	99.50	100
2002	40.40	62.30	100	68.70	59.70	100
2003	5.70	25.50	58.90	18.30	23.80	10.60
2004	44.20	93.30	100	84.10	90	100
2005	39.30	83.00	100	55.70	93.40	100
2006	47.80	43.70	100	57.30	64.70	100
2007	17.60	35.60	97.50	18.70	36.40	100
2008	37.00	69.60	99.20	20.30	74.80	100
2009	33.30	67.00	86.90	20.30	15.80	100
2010	18.70	58.60	94.50	22.80	66.30	60.30
2011	70.40	99.60	100	93.50	100	100
2012	20.30	22.60	8.50	0.80	8.00	35.80
2013	1.60	13.00	8.90	2.00	0.00	100
2014	35.60	67.80	100	46.30	74.90	100
2015	47.60	30.50	97.50	6.50	45.60	100
2016	4.80	31.90	3.40	3.70	5.20	0.00
2017	46.80	69.20	100	59.80	79.60	100
2018	1.80	18.00	14.40	5.70	5.60	80.80
2019	33.70	55.10	100	40.70	79.90	100
Ave.	25.10	56.43	80.60	39.68	54.33	88.01
1991-2008 Ave.		61%	90%	47%	61%	93%
2009-2019 Ave.		48%	65%	27%	44%	80%

Table 3. Percentage of each subpopulation displaying 0 to 89, 90 to 210 (target) or greater than 211-day hydroperiod for the years 1991-2019. Green sahded cells indicate where the target was met.

	AX Annual			B Annual			C Annual			D Annual			E Annual			F Annual		
Year	0 to 89	90 to 210	≥ 211	0 to 89	90 to 210	≥ 211	0 to 89	90 to 210	≥ 211	0 to 89	90 to 210	≥ 211	0 to 89	90 to 210	≥ 211	0 to 89	90 to 210	≥ 211
1991	0%	24.80%	75.20%	27.40%	50.70%	21.90%	91.90%	8.10%	0%	12.60%	57.70%	29.70%	35.70%	59.40%	4.90%	94.70%	5.30%	0%
1992	0%	38.40%	61.60%	26.80%	56.90%	16.40%	91.50%	8.50%	0%	32.90%	44.30%	22.80%	32.60%	67.20%	0.20%	100%	0%	0%
1993	0%	0.60%	99.40%	34.80%	26.90%	38.30%	44.10%	54.70%	1.30%	8.50%	52.40%	39%	31.20%	34.50%	34.30%	92.70%	7.30%	0%
1994	0%	6.90%	93.10%	20.90%	52.20%	26.90%	16.10%	80.10%	3.80%	3.70%	51.60%	44.70%	4.90%	75.40%	19.70%	68.20%	31.80%	0%
1995	0%	0%	100%	6.40%	31.20%	62.40%	8.50%	50%	41.50%	0%	5.70%	94.30%	0%	5.50%	94.50%	49.70%	27.20%	23.20%
1996	0%	0.20%	99.80%	32.80%	27%	40.10%	57.20%	41.50%	1.30%	5.70%	52.40%	41.90%	17.40%	26.30%	56.30%	88.70%	11.30%	0%
1997	0%	6%	94%	18.70%	30.80%	50.50%	14.40%	85.60%	0%	3.70%	54.90%	41.50%	7.40%	28.20%	64.40%	88.70%	11.30%	0%
1998	0%	2.20%	97.80%	25.10%	13.80%	61.10%	59.30%	33.10%	7.60%	6.50%	19.90%	73.60%	14.60%	16.50%	69%	94.70%	5.30%	0%
1999	0%	0.20%	99.80%	24.50%	22.10%	53.40%	8.50%	80.10%	11.40%	2.80%	29.30%	67.90%	2.70%	31%	66.30%	55%	44.40%	0.70%
2000	2.20%	15.60%	82.20%	32.60%	28.30%	39.10%	8.50%	91.50%	0%	3.70%	33.70%	62.60%	20.40%	28.50%	51.10%	95.40%	4.60%	0%
2001	0%	40.60%	59.40%	24.90%	64.40%	10.80%	8.90%	91.10%	0%	3.70%	76.40%	19.90%	14.30%	81.30%	4.40%	86.10%	13.90%	0%
2002	0%	11.90%	88.10%	26.40%	29.60%	44.10%	25.40%	74.60%	0%	9.30%	49.20%	41.50%	13.60%	25.20%	61.10%	84.80%	15.20%	0%
2003	0%	10.90%	89.10%	20.60%	24.30%	55.10%	10.20%	80.90%	8.90%	3.70%	27.60%	68.70%	5.80%	26.20%	68%	4.60%	68.90%	26.50%
2004	0%	11%	89%	35.90%	34.60%	29.50%	41.10%	58.90%	0%	19.90%	39.80%	40.20%	19.60%	33.20%	47.20%	89.40%	10.60%	0%
2005	0%	11%	89%	22.50%	59.60%	18%	3%	96.20%	0.80%	2.80%	52.40%	44.70%	3.10%	57.50%	39.30%	2.60%	97.40%	0%
2006	0.10%	15%	84.90%	29%	47.20%	23.80%	90.30%	9.70%	0%	17.50%	50.80%	31.70%	29.90%	32.90%	37.10%	100%	0%	0%
2007	11.50%	25.10%	63.40%	28.60%	41.50%	29.80%	66.50%	33.50%	0%	6.50%	52.80%	40.70%	37%	34.80%	28.20%	100%	0%	0%
2008	0%	48.60%	51.40%	29%	56.70%	14.30%	4.70%	95.30%	0%	3.70%	72.80%	23.60%	2.40%	95%	2.70%	16.60%	83.40%	0%
2009	0.40%	13.40%	86.10%	23.30%	33.60%	43.10%	6.40%	58.10%	35.60%	3.70%	16.70%	79.70%	5.30%	24.30%	70.40%	52.30%	47.70%	0%
2010	0%	24.10%	75.90%	26.50%	27.60%	45.90%	11.40%	87.70%	0.80%	3.70%	22.80%	73.60%	9.70%	39.30%	50.90%	19.20%	80.80%	0%
2011	8.10%	30.80%	61.20%	31.70%	42.60%	25.70%	36.90%	63.10%	0%	11.80%	57.70%	30.50%	26.50%	59.90%	13.60%	96%	4%	0%
2012	0%	12%	88%	17.40%	19.70%	62.90%	0.80%	25%	74.20%	0.40%	5.70%	93.90%	0%	18%	82%	2.60%	74.80%	22.50%
2013	0%	5.60%	94.40%	20.50%	20.60%	58.90%	2.10%	57.20%	40.70%	2%	12.60%	85.40%	1.70%	17.40%	80.90%	4%	89.40%	6.60%
2014	1.20%	17.60%	81.30%	38.80%	17.60%	43.60%	38.10%	58.10%	3.80%	6.50%	13%	80.50%	25.10%	21.30%	53.60%	79.50%	20.50%	0%
2015	11.30%	34.90%	53.80%	31.10%	42.30%	26.70%	80.10%	19.90%	0%	11%	51.20%	37.80%	35.10%	51.60%	13.30%	100%	0%	0%
2016	0%	2.20%	97.80%	18.10%	17.40%	64.50%	0.80%	7.60%	91.50%	0.40%	3.30%	96.30%	0%	6.70%	93.30%	0%	29.80%	70.20%
2017	0%	16.40%	83.60%	8.80%	43.50%	47.70%	0.40%	96.20%	3.40%	0%	20.30%	79.70%	0%	42.60%	57.40%	0%	100%	0%
2018	0%	12.80%	87.20%	18.30%	17.40%	64.30%	2.50%	21.20%	76.30%	2%	2.40%	95.50%	0%	8%	92%	9.90%	78.80%	11.30%
2019	9.30%	18.10%	72.60%	23.40%	30.30%	46.30%	14%	58.90%	27.10%	2.80%	20.70%	76.40%	9.70%	28.40%	61.90%	49%	51%	0%
Ave.	2%	16%	83%	25%	35%	40%	29%	56%	15%	7%	36%	57%	14%	37%	49%	59%	35%	6%

Table 4. One and four-year rolling average annual hydroperiods for each subpopulation from 1991–2019. The target range is 90–210 days and the color coding on averages indicate whether the target was met (green) or the severity of missing the target (yellow and red).

Year	AX		B		C		D		E		F	
	1-yr	4-yr	1-yr	4-yr	1-yr	4-yr	1-yr	4-yr	1-yr	4-yr	1-yr	4-yr
1991	228		139		31		171		120		15	
1992	251		145		34		145		117		16	
1993	347		165		95		207		156		22	
1994	315		163		127		230		160		63	
1995	365	285	239	153	190	72	291	188	308	138	112	29
1996	329	319	173	178	89	112	207	218	209	185	31	53
1997	315	339	189	185	135	126	208	234	205	208	29	57
1998	320	331	201	191	95	136	261	234	226	220	20	59
1999	316	332	188	200	151	127	230	242	223	237	85	48
2000	291	320	164	188	149	118	239	226	193	216	33	41
2001	237	311	135	185	137	132	170	235	151	212	61	42
2002	275	291	179	172	120	133	197	225	212	198	43	50
2003	289	279	204	166	155	139	231	209	218	195	177	56
2004	278	273	134	170	102	140	168	209	172	194	48	78
2005	275	269	156	163	174	128	208	191	196	188	178	82
2006	279	279	145	168	66	138	168	201	161	199	16	112
2007	257	280	158	160	66	124	208	194	141	187	5	105
2008	241	272	128	148	126	102	188	188	169	168	111	62
2009	274	263	174	147	180	108	232	193	220	167	84	77
2010	289	263	182	151	137	110	263	199	211	173	119	54
2011	227	265	136	160	99	128	179	222	137	185	37	80
2012	289	256	198	154	215	136	265	215	244	184	186	88
2013	312	268	206	172	190	158	264	235	249	203	156	106
2014	274	278	155	179	106	160	249	243	183	210	60	124
2015	224	275	150	172	64	152	193	239	131	203	26	110
2016	345	275	233	177	288	144	346	243	333	202	259	107
2017	277	289	212	186	183	162	249	263	218	224	131	125
2018	292	280	224	188	246	160	298	259	284	216	146	119
2019	269	285	197	205	165	195	264	272	217	241	95	140
2020		296		217		220		289		263		158
Ave.	286	287	175	174	135	137	225	226	199	201	81	83

Table 5. Average annual flow in thousand-acre-feet for select structures and transects along the Tamiami Trail as modeled for the period of record (1965-2005). Results for ECB, ALT Q and the difference between the two are displayed. Positive numbers in the difference column represent reductions in flow from ECB19RR to ALT Q while negative numbers represent increases (Corps 2019a).

Structure or Transect	ECB19RR	ALT Q	Difference ECB19RR - ALT Q
S-343 A/B	14.9	4.1	10.8
S-344	7.0	2.1	4.9
S-12A	29.8	21.4	8.4
S-12A Weir*	5.9	5.0	0.9
S-12B	34.9	24.9	10
S-12B Weir*	4.7	4.0	0.7
S-12C	142.9	93.1	49.8
S-12D	218.6	172.9	45.7
Total	-	-	131.2
T17	239	172	67
T18	332	561	-229
T20	118	245	-127
TSH1	20	24	-4
TSH2	21	24	-3
T23A	24	24	0
T23B	86	92	-6
T23C	113	143	-30

Table 6. Partial reproduction of Corps' table (Corps 2019a) showing the percentage of CSSS-Ax that meets the 90-day nesting window target for the modeled ECB19RR, ALT Q and the overlapping period of Sparrow Viewer observed data (first column). It is unusual to compare observed data with modeled data, however, in this case the comparison between ALT Q and the ECB19RR may be masking benefit to the hydrology in CSSS-Ax.

Year	Observed	ECB19RR (CSSS-Ax)	ALT Q (CSSS-Ax)
1991	1.4%	17.8%	17.9%
1992	41.0%	60.9%	50.7%
1993	0.4%	15.4%	16.5%
1994	8.0%	32.4%	28.2%
1995	0.0%	0.0%	0.0%
1996	9.8%	21.8%	19.2%
1997	21.4%	40.5%	36.3%
1998	8.6%	13.4%	13.8%
1999	15.2%	21.9%	18.3%
2000	23.0%	22.3%	17.9%
2001	52.6%	94.9%	95.3%
2002	40.4%	56.4%	50.4%
2003	5.7%	27.9%	27.7%
2004	44.2%	80.8%	76.8%
2005	39.3%	94.9%	95.8%
Average (Difference from ECB19RR)	**20.7%** (-19.3%)	**40%**	**37.6%** (-2.4%)
Number of times target (40%) met in 15-year POR	**4**	**6**	**5**

Table 7. Partial reproduction of Corps' table (Corps 2019a) showing the percentage of CSSS-E that meets the 90-day nesting window target for the modeled ECB19RR, ALT Q and the overlapping period of Sparrow Viewer observed data (first column). It is unusual to compare observed data with modeled data, however, in this case the comparison between ALT Q and the ECB19RR may be masking impacts to the hydrology in CSSS-E.

Year	Observed	ECB19RR (CSSS-E)	ALT Q (CSSS-E)
1991	27.9%	10.0%	10.7%
1992	99.1%	74.9%	46.7%
1993	62.4%	32.8%	25.1%
1994	70.2%	28.8%	12.1%
1995	19.1%	0.2%	0.0%
1996	48.9%	43.4%	22.6%
1997	35.4%	14.7%	8.8%
1998	44.7%	8.8%	13.6%
1999	79.6%	71.8%	54.2%
2000	65.2%	51.6%	29.0%
2001	99.5%	100.0%	100.0%
2002	59.7%	79.0%	58.6%
2003	23.8%	54.7%	50.3%
2004	90%	99.7%	96.1%
2005	93.4%	100.0%	100.0%
Average (Difference from ECB19RR)	**61.3%** (+9.9%)	**51.4%**	**44.1%** (-7.3%)
Number of times target (40%) met in 15-year POR	**11**	**9**	**7**

Table 8. Partial reproduction of Corps' table (Corps 2019a) showing the percentage of CSSS-D that meets the 90-day nesting window target for the modeled ECB19RR, ALT Q and the overlapping period of Sparrow Viewer observed data (first column). It is unusual to compare observed data with modeled data, however, in this case the comparison between ALT Q and the ECB19RR may be overestimating impacts to CSSS-D.

Year	Observed	ECB19RR (CSSS-D)	ALT Q (CSSS-D)
1991	19.5%	1.5%	1.2%
1992	80.9%	89.6%	63.8%
1993	58.5%	47.3%	25.4%
1994	22.8%	12.3%	7.3%
1995	20.3%	10.4%	4.6%
1996	34.1%	63.8%	21.9%
1997	70.7%	92.7%	91.5%
1998	17.5%	66.2%	51.5%
1999	72.0%	89.2%	68.8%
2000	40.2%	86.9%	77.3%
2001	89.0%	88.1%	93.8%
2002	68.7%	89.2%	50.8%
2003	18.3%	14.2%	15.8%
2004	84.1%	93.5%	92.7%
2005	55.7%	89.6%	89.6%
Average (Difference from ECB19RR)	**50.2%** (-12.1%)	**62.3%**	**50.4%** (-11.9%)
Number of times target (40%) met in 15 yr POR	**9**	**11**	**9**

Table 9. Modeled average annual hydroperiod for ECB19RR and ALT Q (1965 – 2005) plus the observed data (gray column) from the Sparrow Viewer from 1991-2019.

Subpopulation	Observed (1991-2019)	ECB19RR	ALT Q
CSSS-Ax	286 ± 37	242 ± 56	243 ± 57
CSSS-B	175 ± 31	146 ± 52	148 ± 52
CSSS-C	135 ± 60	102 ± 57	109 ± 55
CSSS-D	225 ± 46	188 ± 46	214 ± 50
CSSS-E	199 ± 53	204 ± 64	217 ± 65
CSSS-F	81 ± 65	136 ± 72	152 ± 75

Table 10. Observed data (Gray column) from the Sparrow Viewer displayed next to model data from ECB19RR and ALT Q for the overlapping period of record 1991–2005. The target for the habitat performance metric is 40% of each subpopulation (in this case CSSS-Ax) with an average annual discontinuous hydroperiod of 90 to 210 days (center column under each scenario). Green shading indicates years in which the target was met.

	Observed AX			**ECB19RR AX**			**ALT Q AX**		
Year	0 to 89	90 to 210	≥211	0 to 89	90 to 210	≥211	0 to 89	90 to 210	≥211
1991	0%	24.80%	75.20%	0.10%	25%	74.90%	0.20%	26%	73.80%
1992	0%	38.40%	61.60%	0.10%	18.80%	81.10%	0.50%	16.80%	82.70%
1993	0%	0.60%	99.40%	0.90%	10.20%	89%	2.80%	10.10%	87.10%
1994	0%	6.90%	93.10%	0%	16%	84%	0%	14.90%	85.10%
1995	0%	0%	100%	0%	0%	100%	0%	0%	100%
1996	0%	0.20%	99.80%	0.50%	7.90%	91.60%	1.20%	8.20%	90.60%
1997	0%	6%	94%	0.10%	21.30%	78.60%	0.20%	21%	78.80%
1998	0%	2.20%	97.80%	0.80%	4.80%	94.40%	1.10%	4.90%	94%
1999	0%	0.20%	99.80%	0%	2.30%	97.60%	0%	3.10%	96.90%
2000	2.20%	15.60%	82.20%	6.20%	23%	70.90%	6.40%	21.60%	72%
2001	0%	40.60%	59.40%	2.20%	61.60%	36.10%	2.50%	67.50%	30%
2002	0%	11.90%	88.10%	1.10%	10.40%	88.50%	3.60%	10.80%	85.70%
2003	0%	10.90%	89.10%	3.40%	12.70%	83.90%	4.10%	13.60%	82.30%
2004	0%	11%	89%	13.30%	34.90%	51.80%	13.10%	36.90%	50%
2005	0%	11%	89%	1.50%	65.80%	32.70%	2.50%	71.90%	25.60%
Ave.	0%	12%	88%	2%	21%	77%	3%	22%	76%

Table 11. Observed data (Gray column) from the Sparrow Viewer displayed next to model data from ECB19RR and ALT Q for the overlapping period of record 1991–2005. The target for the habitat performance metric is 40% of each subpopulation (in this case CSSS-E) with an average annual discontinuous hydroperiod of 90 to 210 days (center column under each scenario). Green shading indicates years in which the target was met.

	Observed E			**ECB19RR E**			**ALT Q E**		
Year	0 to 89	90 to 210	≥211	0 to 89	90 to 210	≥211	0 to 89	90 to 210	≥211
1991	35.70%	59.40%	4.90%	0.00%	22%	78.20%	0.00%	16%	83.90%
1992	32.60%	67.20%	0.20%	0.90%	46.20%	52.80%	0.60%	28.10%	71.30%
1993	31.20%	34.50%	34.30%	4.70%	16.30%	79%	3.40%	9.90%	86.70%
1994	4.90%	75.40%	19.70%	0%	38%	62%	0%	22.30%	77.70%
1995	0%	5.50%	94.50%	0%	0%	100%	0%	0%	100%
1996	17.40%	26.30%	56.30%	0.60%	13.20%	86.20%	0.60%	10.50%	88.90%
1997	7.40%	28.20%	64.40%	0.00%	16.50%	83.50%	0.00%	10%	89.80%
1998	14.60%	16.50%	69%	0.30%	5.50%	94.20%	0.20%	5.80%	94%
1999	2.70%	31%	66.30%	0%	7.40%	92.50%	0%	6.10%	93.90%
2000	20.40%	28.50%	51.10%	15.70%	38%	46.40%	10.30%	36.20%	53%
2001	14.30%	81.30%	4.40%	1.40%	97.30%	1.30%	0.90%	95.90%	3%
2002	13.60%	25.20%	61.10%	10.30%	43.60%	46.10%	9.10%	37.00%	53.90%
2003	5.80%	26.20%	68%	16.60%	34.50%	48.90%	15.00%	36.40%	48.60%
2004	19.60%	33.20%	47.20%	51.70%	29.90%	18.30%	43.90%	37.80%	18%
2005	3.10%	57.50%	39.30%	13.20%	77.60%	9.20%	12.70%	79.30%	8.00%
Ave.	15%	40%	45%	8%	32%	60%	6%	29%	65%

Table 12. Observed data (Gray column) from the Sparrow Viewer displayed next to model data from ECB19RR and ALT Q for the overlapping period of record 1991–2005. The target for the habitat performance metric is 40% of each subpopulation (in this case CSSS-D) with an average annual discontinuous hydroperiod of 90 to 210 days (center column under each scenario). Green shading indicates years in which the target was met.

	Observed D			**ECB19RR D**			**ALT Q D**		
Year	0 to 89	90 to 210	≥211	0 to 89	90 to 210	≥211	0 to 89	90 to 210	≥211
1991	12.60%	57.70%	29.70%	1.90%	41%	57.30%	1.90%	13%	85.00%
1992	32.90%	44.30%	22.80%	3.50%	36.90%	59.60%	3.50%	10.40%	86.20%
1993	8.50%	52.40%	39%	8.10%	18.10%	74%	4.20%	11.20%	84.60%
1994	3.70%	51.60%	44.70%	2%	31%	67%	2%	12.30%	85.80%
1995	0%	5.70%	94.30%	0%	10%	89%	0%	5%	95%
1996	5.70%	52.40%	41.90%	3.50%	35.80%	60.80%	3.50%	13.80%	82.70%
1997	3.70%	54.90%	41.50%	1.90%	39.60%	58.50%	1.90%	12%	86.20%
1998	6.50%	19.90%	73.60%	3.50%	23.50%	73.10%	3.50%	3.50%	93%
1999	2.80%	29.30%	67.90%	2%	20.00%	77.70%	2%	12.30%	85.80%
2000	3.70%	33.70%	62.60%	14.60%	50%	35.80%	9.60%	26.20%	64%
2001	3.70%	76.40%	19.90%	4.60%	88.80%	6.50%	3.50%	90.00%	7%
2002	9.30%	49.20%	41.50%	11.90%	75.40%	12.70%	5.00%	32.30%	62.70%
2003	3.70%	27.60%	68.70%	6.90%	47.70%	45.40%	4.60%	22.30%	73.10%
2004	19.90%	39.80%	40.20%	32.70%	61.90%	5.40%	23.50%	70.00%	7%
2005	2.80%	52.40%	44.70%	10.40%	85.80%	3.80%	6.20%	88.80%	5.00%
Ave.	8%	43%	49%	7%	44%	48%	5%	28%	67%

Table 13. Habitat acreage in target 90 to 210-day discontinuous hydroperiod range divided by CSSS population estimate by year and subpopulation).

Habitat Acreage in Target 90 to 210 Day Discontinuous Hydroperiod Range Divided by CSSS Population Estimate by Year and Subpopulation)								
	# Acres/Bird							
	A	B	C	D	E	F		Total
1992	5.2	7.0	14.3	42.3	25.3	0.0		8.5
1993	0.3	4.3		58.4	24.1			8.7
1994	15.7	9.2			149.9			
1995	0.0	5.7			3.5			7.1
1996	0.2	5.6	70.3	70.0	28.3	35.9		9.9
1997	6.2	4.2	144.1	122.3	7.6	35.9		8.2
1998	2.2	3.0	33.5	44.3	4.1	17.0		4.8
1999a	0.1	4.2	44.9	17.8	9.0	142.1		7.7
1999b	0.3	3.2	101.0		7.2			7.0
2000a	10.8	6.1	66.1	56.3	6.1			9.6
2000b	12.1	4.5	115.6	225.2	9.0	2.1		8.9
2001	115.9	11.8	76.8	255.3	21.4	22.3		22.8
2002	38.0	6.1	54.1		9.8	48.9		12.2
2003	29.0	4.0	68.1		9.9	108.2		10.0
2004	190.8	4.8	37.4		11.6	34.1		9.4
2005	29.9	10.2	97.2	116.7	22.3	152.6		18.4
2006	47.0	8.9	4.9		10.4			12.1
2007	160.8	6.4	56.7		13.9			13.4
2008	187.5		160.6	486.5	57.5			27.5
2009	41.8		97.5	55.8	12.6			10.1
2010	70.6	5.7	221.5	38.1	9.6	252.3		13.8
2011	71.4		29.1	385.6	22.5	6.3		18.7
2012	13.2		20.5	2.7	5.4	57.3		6.7
2013	6.6	4.5	36.3	84.2	5.5	275.6		8.2
2014	93.5	3.9	42.1	44.8	7.1	67.8		9.3
2015	67.9	8.6	15.0	82.2	13.1			15.2
Ave.	46.8	6.0	69.9	121.6	19.5	78.7		11.5

Table 14. Acreages within individual sparrow subpopulations that show differences between ALT Q and ECB19RR of the percent to target achieved according to the Marl Prairie Indicator. Categories show whether ALT Q increase or decrease the percentage of target met (in 20 percentage point increments) as compared to the ECB19RR.

	CSSS Subpopulation					
ALT Q – ECB19RR	Ax	B	C	D	E	F
21 to 40	0.0	0.0	0.0	0.0	0.0	0.0
1 to 20	35,469	11,197	6,096	0.0	1,577	2,986
0 (-0.99 to 0.99)	16,032	15,402	864	681	1,775	411
-1 to -20	27,480	12,451	1,098	9,506	18,402	1,411
-21 to -40	0.0	0.0	0.0	513	523	149

Table 15. Sparrow Viewer data of the average annual discontinuous hydroperiod in days for individual subpopulations during 1991-2008 and 2009-2019 of the observed record.

	CSSS-B	**CSSS-C**	**CSSS-D**	**CSSS_E**	**CSSS-F**
1991 - 2008	167 days	113 days	207 days	185 days	59 days
2009 - 2019	188 days	170 days	255 days	221 days	118 days

Table 16. Description of vegetation classes utilized in ELVeS.

Vegetation Class	Description
Sawgrass	Sawgrass (*Cladium jamaicense*) dominated marsh
Sawgrass-Short	Sawgrass dominated marsh with average height less than 2.5 meters.
Open Marsh	Open water dominated freshwater marsh often with a mix of sparse graminoids, herbaceous, and/or emergent freshwater vegetation, such as Spikerush (*Eleocharis spp.*), Panicgrass (*Panicum spp.)*, low stature sawgrass, Cattail (*Typha spp.*), Arrowhead (*Sagittaria spp.*), Pickerelweed (*Pontederia* cordata), Waterlily (Nymphaea spp.), Green Arum (Peltandra virginica), Swamp-Lily (*Crinum americanum*), Spiderlilies (*Hymenocallis spp.*), among others.
Cattail	Greater than or equal to 50% areal coverage of Cattail.
Floating Emergent Marsh	Typically Nuphar or Nymphaea. Also Lemna, Salvinia
Drier Marl Prairie	Short hydroperiod marsh characterized primarily by graminoids that includes low-stature sawgrass, Muhly Grass (*Muhlenbergia capillaris var. filipes*),
Wetter Marl Prairie	Short hydroperiod marsh characterized by a mix of graminoids that includes low-stature sawgrass, Little Bluestem (*Schizachyrium scoparium*), Gulfdune Paspalum (*Paspalum monostachyum*), Beakrush (*Rhynchospora spp.*), Black Sedge (*Schoenus nigricans*), among others.
Swamp Shrubland	Primrose willow and wax myrtle
Willow Shrub Cattail	Willow (*Salix caroliniana*) dominant shrub land with freshwater marsh species. Cattail may be prominent.
Cypress Shrub Sawgrass	Dwarf Cypress (*Taxodium spp.*) with freshwater marsh species. Dwarf cypress may be in a sawgrass matrix.
Bayhead Shrubland	Mix of Cocoplum (*Chrysobalanus icaco*), Swamp Bay (*Persea palustris*), Red Bay (*Persea borbonia*), Dahoon Holly (*Ilex cassine*), Willow (*Salix caroliniana*), Wax Myrtle (*Myrica cerifera*), Sweetbay (*Magnolia virginiana*), Cypress (*Taxodium spp.*), Pond Apple (*Annona glabra*), among others.
Pine Rockland	Pine upland found on low ridges of oolitic limestone. Found on the Miami rock ridge, in the Florida Keys, ENP, and in BCNP.

Table 17. Snail Kite exceedance criteria for ECB19RR and ALT Q.

	ECB19RR	ALT Q
Dry Season High Water	7	4
Wet Season High Water	2	2
Recession: Dry Season Amplitude Gauge 3A28	6	8
Recession: Dry Season Amplitude Gauge 3A4	7	5
Recession: Dry Season Amplitude Gauge 3AS3W1	8	5
Recession: Dry Season Amplitude Gauge W2	4	8

Table 18. Wood stork egg survival per nesting chronology phase.

Age	Percent Survival
Egg-laying to Day 14	80
Egg-laying to Day 28 (hatching)	70
Egg-laying to Day 42	62
Egg-laying to Day 56	56
Egg-laying to Day 70	50
Egg-laying to fledging	46

Table 19. Wood stork nesting data in southeastern United States.

YEAR	TOTAL		FLORIDA		GEORGIA		SOUTH CAROLINA		NORTH CAROLINA	
	Pairs	Colonies	Pairs	Colonies	Pairs	Colonies	Pairs	Colonies	Pairs	Colonies
1981	4,442	22	4,156	19	275	2	11	1		
1982	3,575	22	3,420	18	135	2	20	1		
1983	5,983	25	5,600	22	363	2	20	1		
1984	6,245	29	5,647	25	576	3	22	1		
1985	5,193	23	4,562	17	557	5	74	1		
1986	5,835	36	5,067	29	648	4	120	3		
1987			**		506	5	194	3		
1988			**		311	4	179	3		
1989			**		543	6	376	3		
1990			**		709	10	536	6		
1991	4,073	37	2,440	25	969	9	664	3		
1992			**		1,091	9	475	3		
1993	6,729	43	4,262	29	1,661	11	806	3		
1994	5,768	47	3,588	26	1,468	14	712	7		
1995	7,853	54	5,523	31	1,501	17	829	6		
1996			**		1,480	18	953	7		
1997	5,166	59	2,870	36	1,379	15	917	8		
1998			**		1,665	15	1,093	10		
1999	7,768	71	8,319	50	1,139	13	520	8		
2000			**		566	7	1,236	11		
2001	5,582	44	3,246	23	1,162	12	1,174	9		
2002	7,855	70	5,463	48	1,256	14	1,136	10		
2003	8,813	78	5,804	49	1,653	18	1,356	11		
2004	8,379	93	4,726	63	1,596	17	2,057	13		
2005	5,572	74	2,304	40	1,817	19	1,407	13	32	1
2006	11,279	82	7,216	48	1,928	21	2,010	13	125	1
2007	4,406	55	1,553	25	1,054	15	1,607	14	192	1
2008	6,118	73	1,838	31	2,292	25	1,839	16	149	1
2009	12,720	86	9,428	54	1,676	19	1,482	12	134	1
2010	8,149	94	3,828	51	2,708	28	1,393	14	220	1
2011	9,579	88	5,292	45	2,160	19	2,031	23	96	1
2012	8,452	77	4,539	39	1,905	17	1,827	19	181	2
2013	11,076	100	6,948	57	1,873	19	2,020	21	205	2
2014	11,238	105	5,511	58	2,942	22	2,501	23	284	2
2015	10,058	96	4,705	51	2,496	21	2,496	22	361	2
2016	10,639	104	5,223	55	2,310	22	2,512	25	594	2
2017	11,188	108	6,344	58	2,027	26	2,480	22	337	2
2018	12,105	100	8,525	57	1,594	19	1,858	22	128	2

**Incomplete data set from Florida as all colonies are not surveyed every year.

Table 20. Total number of wood stork nesting pairs within the Everglades and Big Cypress Basins (South Florida), 1996 to 2018. ESA Note: *Data was retrieved from the South Florida Wading Bird Reports from 1996-2018.*

Year	Nesting Pairs	3-Year Running Average	5-Year Running Average
1996	600	-	-
1997	445	-	-
1998	475	507	-
1999	4,549	1,823	-
2000	3,996	3,007	2,013
2001	2,681	3,742	2,429
2002	2,880	3,186	2,916
2003	2,386	2,649	3,298
2004	1,015	2,094	2,592
2005	634	1,345	1,919
2006	2,710	1,453	1,925
2007	770	1,371	1,503
2008	704	1,395	1,167
2009	6,452	2,642	2,254
2010	1,220	2,792	2,371
2011	2,131	3,268	2,255
2012	1,234	1,528	2,348
2013	3,059	2,141	2,819
2014	2,799	2,364	2,089
2015	1,469	2,442	2,138
2016	1,457	1,908	2,004
2017	3,894	2,273	2,536
2018	5,777	3,709	3,079
Average	**2,319**	**2,269**	**2,298**

Table 21. Number of wood stork nests in the COP Action Area as reported in the South Florida Wading Bird Reports from 2009 through 2018.

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Total
Average	168.4	43.5	71.9	34.2	104.6	75.0	30.1	27.5	102.0	152.25	80.9
3-Year Average	0	0	94.6	49.8	70.2	71.3	69.9	44.2	53.2	93.9	54.7
Tamiami East 1 (ENP)	10	15	0	0	5	0	0	0	0	0	30
Tamiami East 2 (ENP)	20	30	0	0	0	0	0	0	0	0	50
Tamiami West (ENP)	1300	350	400	120	400	300	75	0	138	0	3,083
Grossman Ridge West (ENP)	60	75	60	0	50	50	0	0	55	105	455
Paurotis Pond (ENP)	400	325	500	320	500	270	285	230	326	682	3,838
Broad River (ENP)	50	0	30	60	150	300	193	340	545	746	2,414
Cabbage Bay (ENP)	100	0	70	75	150	60	65	10	224	430	1,184
Rogers River Bay Island (ENP)	5	5	0	0	0	0	0	0	25	10	45
Rogers River Bay Peninsula (ENP)	400	165	80	135	200	110	0	0	0	0	1,090
Rookery Branch (ENP)	20	0	25	0	150	0	0	0	0	0	195
Lower Taylor Slough (ENP)	5	0	0	0	50	0	0	0	0	0	55
Cuthbert Lake (ENP)	100	35	90	60	150	130	30	0	0	0	595
Big Cypress Mitchell Landing (ENP)	2	0	0	0	0	0	0	0	0	0	2
Lostmans Creek (ENP)	130	0	0	50	200	40	0	0	0	0	420
Jetport (WCA-3A)	1167	0	0	0	43	60	0	0	129	520	1,919
Jetport South (WCA-3A)	238	0	350	0	463	400	0	0	857	953	3,261
WCA13 (WCA-3A)	0	0	0	0	0	0	0	0	0	72	72
L-28 Crossover South (WCA-3A)	28	0	0	0	0	0	0	0	0	0	28
L-28 Gap (WCA-3A)	0	A	0	0	0	0	0	0	0	0	0
Kinich (WCA-3A)	0	0	120	0	0	0	0	0	0	0	120
Cypress City (WCA-3A)	0	0	0	0	0	0	0	0	23	0	23
Mud East (WCA-3B)	7	0	0	0	0	0	0	0	0	0	7
Sawgrass Ford	0	0	0	0	0	80	74	52	83	80	369
Emerald Estates 1 and 2 Griffin	0	0	0	0	0	0	0	A	43	56	99

Table 22. Estimate of average annual hydrological effects on hydroperiod and wood stork prey biomass between ECB19RR (baseline) and the ALT Q (proposed action).

Hydroperiod Class (Days)	Baseline (ECB19RR)		Proposed Action (ALT Q)		Change		
	Acres	kg	Acres	kg	acres	biomass (kg)	nests**
1 (0-60)	109,366	44,591	109,305	44,566	-61	-25	-0.5
2 (60-120)	54,129	44,139	49,622	40,464	-4,507	-3,675	-73.5
3 (120-180)	115,095	199,817	109,868	190,743	-5,227	-9,074	-181.5
4 (180-240)	198,147	609,826	197,663	608,337	-484	-1,489	-9.9
5 (240-300)	532,657	2,052,666	533,819	2,057,143	1,162	4,477	29.6
6 (300-330)	412,157	1,821,398	438,542	1,937,998	26,385	116,600	772.2
7 (330-365)	741,233	3,538,868	723,964	3,456,420	-17,269	-82,447	-546.0
Short (0 to 180)	278,590	288,547	268,795	275,773	-9,795	-12,774	-255.5
Long (180 to 365)	1,884,194	8,022,758	1,893,989	8,059,898	9,795	37,141	245.9
Total	2,162,784	8,311,305	2,162,784	8,335,671	55,095*	24,367	-9.6

*The total is the sum of the individual changes within each hydroperiod and notes that some changes may be positive whereas others may be negative.
** Hydroperiods 1,2, and 3 are based on 50 kg per nest and 4,5,6, and 7 are based on 151 kg per nest. Total is the sum of all the nests estimated from the biomass change for each hydroperiod.

Table 23. Number of days water depth exceeded 16 inches (41 centimeters) based upon the two-gauge average (3A-3 and 3A-4) between March 1 and May 31 in 2017 and 2018.

Month	March 1 to May 31, 2017	March 1 to May 31, 2018
March	0	0
April	0	0
May	0	11
Total	0	11

Table 24. Surrogate measures for monitoring take of listed wildlife species caused by the Action, based on the cited BO effects analyses. If the trigger is reached in any single year the Corps is to conduct a review of water management operations that may have contributed to the hydrologic condition(s) of concern and provide this report to the Service.

Common Name	Life Stage	Surrogate (units)	Quantity*	BO Effects Analysis Section
Cape Sable seaside sparrow	Egg to Fledgling	Provide at least 90 consecutive dry nesting days over 40% of each subpopulation between March 1 and July 15.	None within two consecutive years	2.11.2
Cape Sable seaside sparrow	All	Provide an average annual discontinuous hydroperiod between 90-210 days over 40% of each subpopulation	None within two consecutive years	2.11.3
Everglade snail kite	Egg to Fledgling	Dry Season High Water Timing: by April 15 Trigger Value: stage >9.2 ft NGVD at gauge 3AS3W1 Frequency: 2 consecutive years	None within two consecutive years	4.13.4
Everglade snail kite	Egg to fledgling	Wet Season High Water Timing: June 1 – December 31 Trigger: stage >10.5 ft at gauge 3AS3W1 for 60 days Frequency: 2 consecutive years	None within two consecutive years	4.13.4
Everglade snail kite	Egg to fledgling	Recession: Dry Season Amplitude Timing: January 1 – May 31 (or onset of wet season, whichever is sooner) Trigger: stage difference >1.7 ft as measured at gauge(s) closest to kite nesting, as determined by the Service Frequency: 2 consecutive years	None within two consecutive years	4.13.4
Wood stork	Egg to fledgling	# of days water depth exceeded 16 inches (41 centimeters) based upon the 2-gauge average (Gauge 3A-3 and 3A-4) between March 1 and May 31	None within two consecutive years	6.11.2

*Due to natural environmental variability, some exceedances will be out of the Corps' control.

12.0Figures

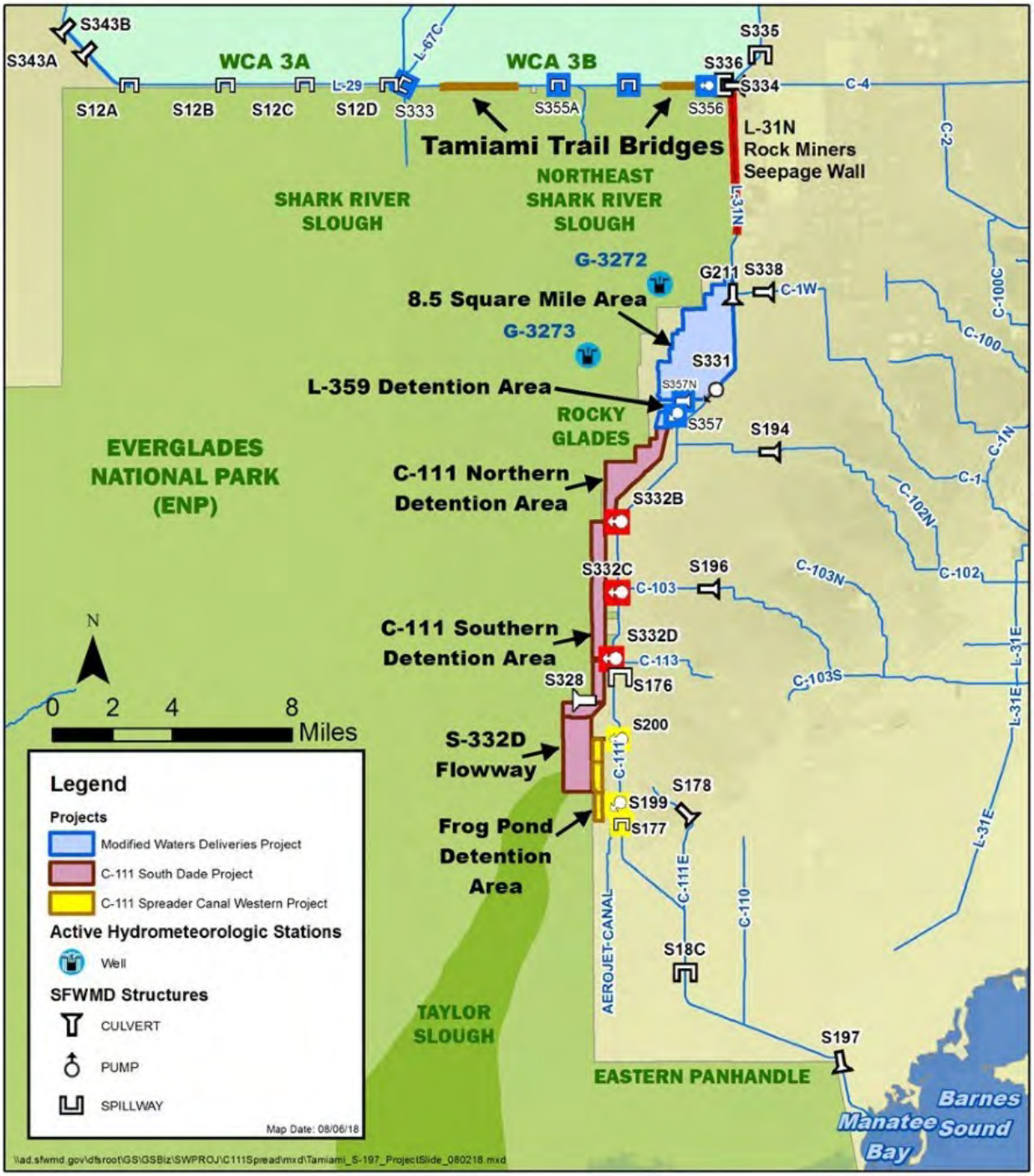


Figure 1. Study area and major project components of the MWD and C-111 Projects.

Figure 2. Overview map of the COP Action Area.

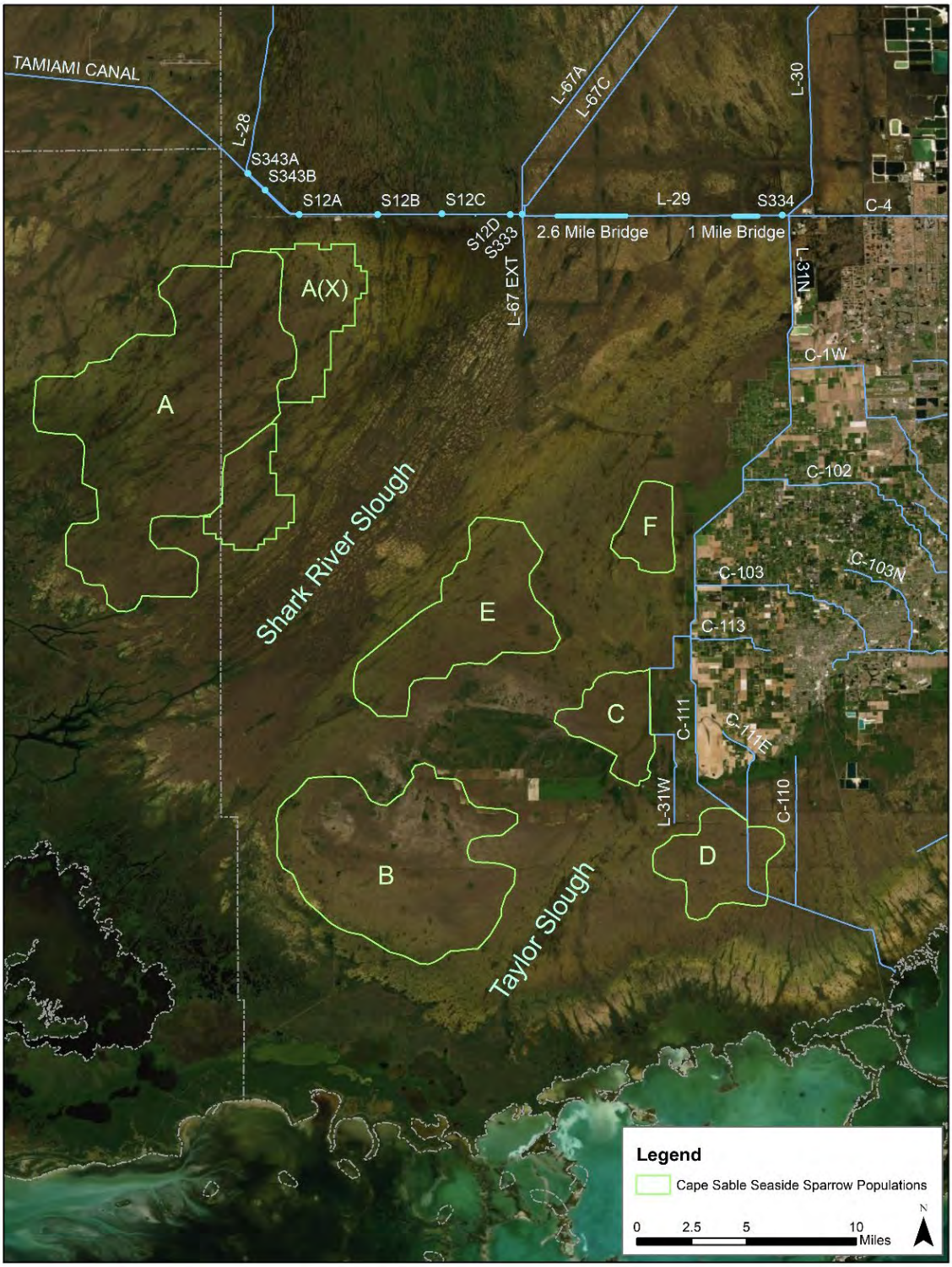


Figure 3. Location of Cape Sable seaside sparrow subpopulations.

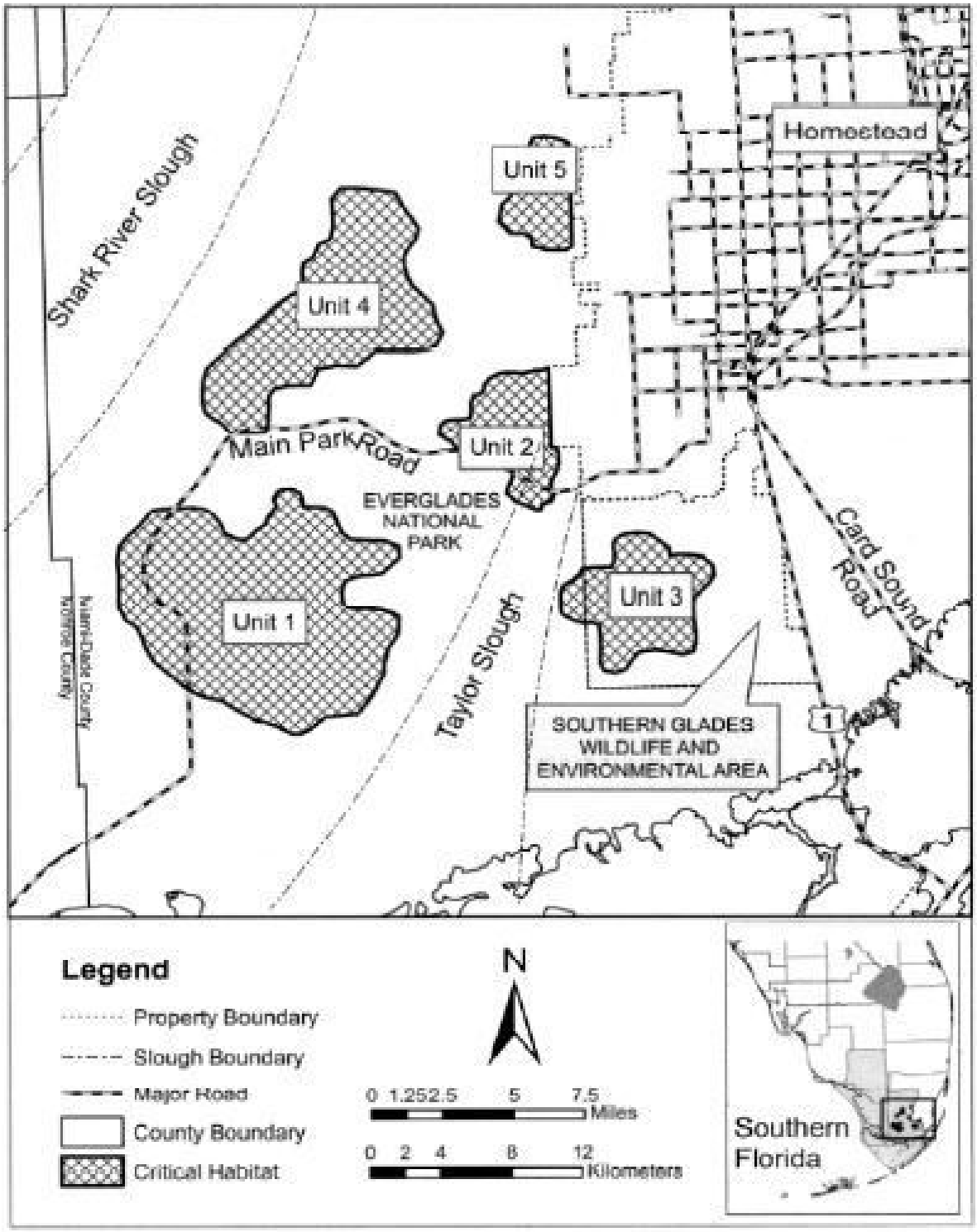


Figure 4. Critical habitat for the Cape Sable seaside sparrow.

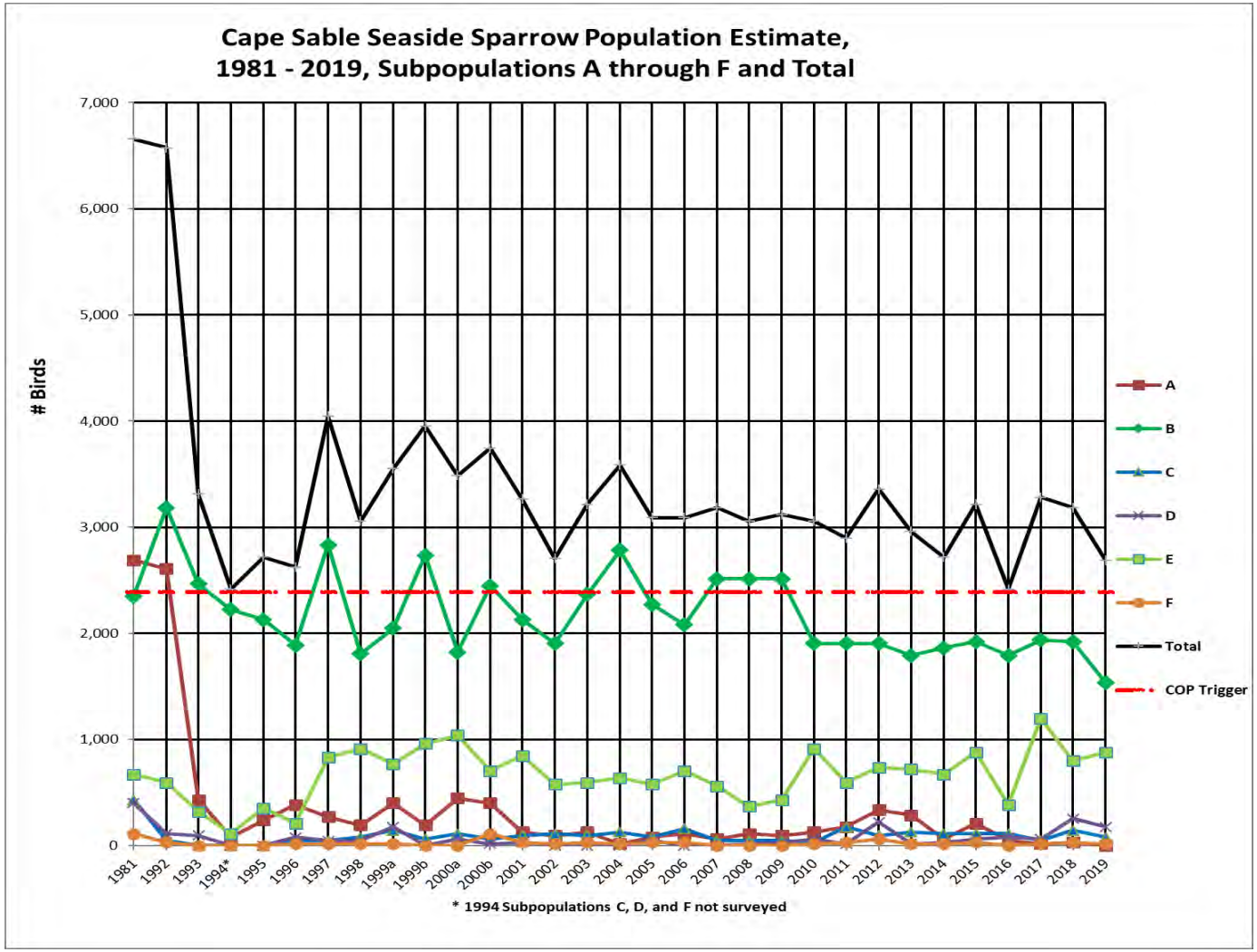


Figure 5. CSSS Population estimate total and by subpopulation for the years 1981-2019. Red line is the COP re-initiation threshold.

Figure 6. Documented locations of invasive constrictor snakes and tegus in the vicinity of CSSS-D and CSSS-C circa 2016. Data source http://www.eddmaps.org/florida/distribution/.

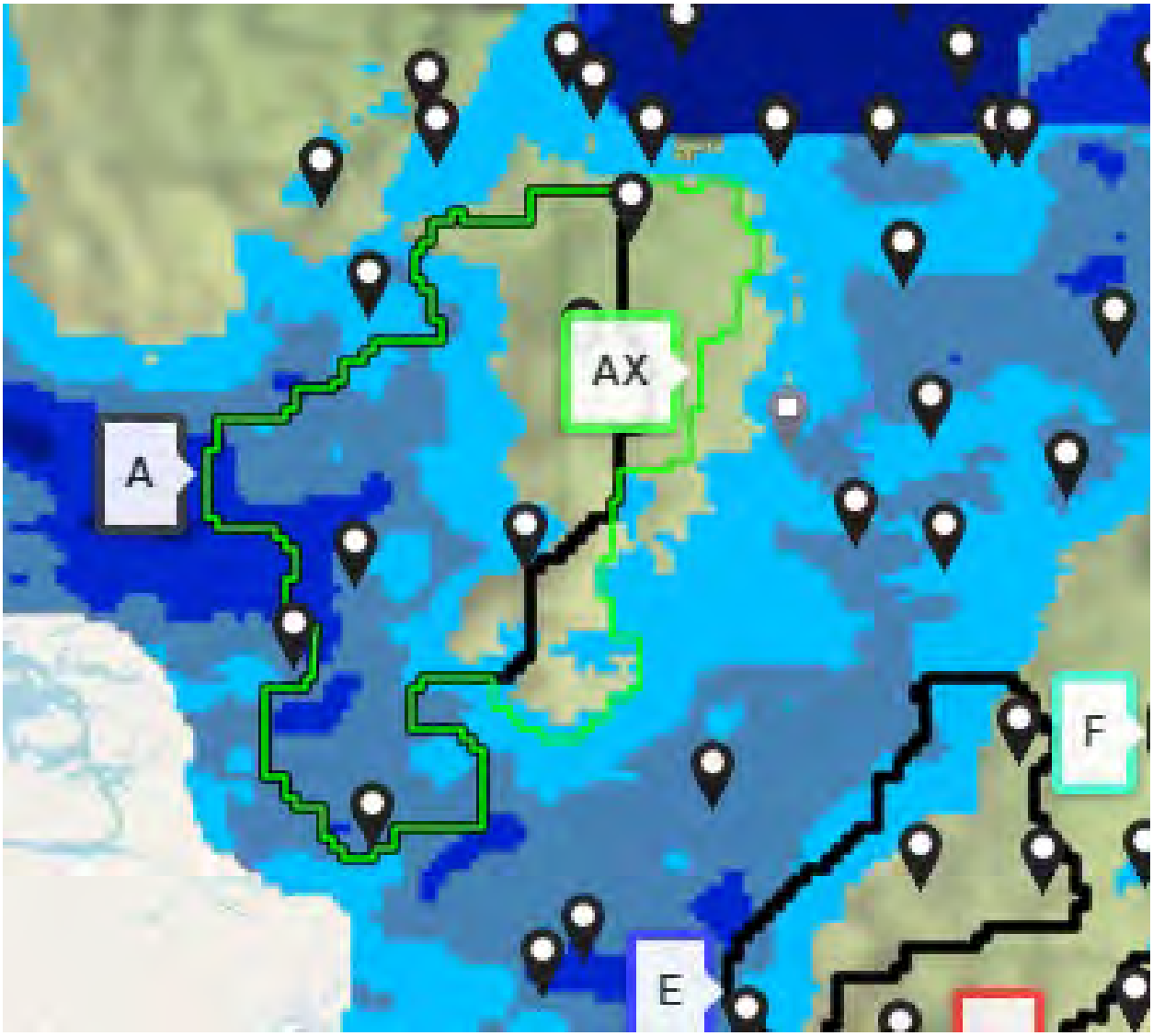


Figure 7. Snapshot of Sparrow Viewer output on January 27, 2020. Original CSSS-A delineated habitat is outlined at center in black (green overlay on some parts). CSSS-Ax which is CSSS-A plus expanded areas in northeast and southeast corners is delineated with green line. Blue areas show water levels above ground and green areas are dry. Note the extent of expanded dry area indicated to the East of the outlined delineated habitat.

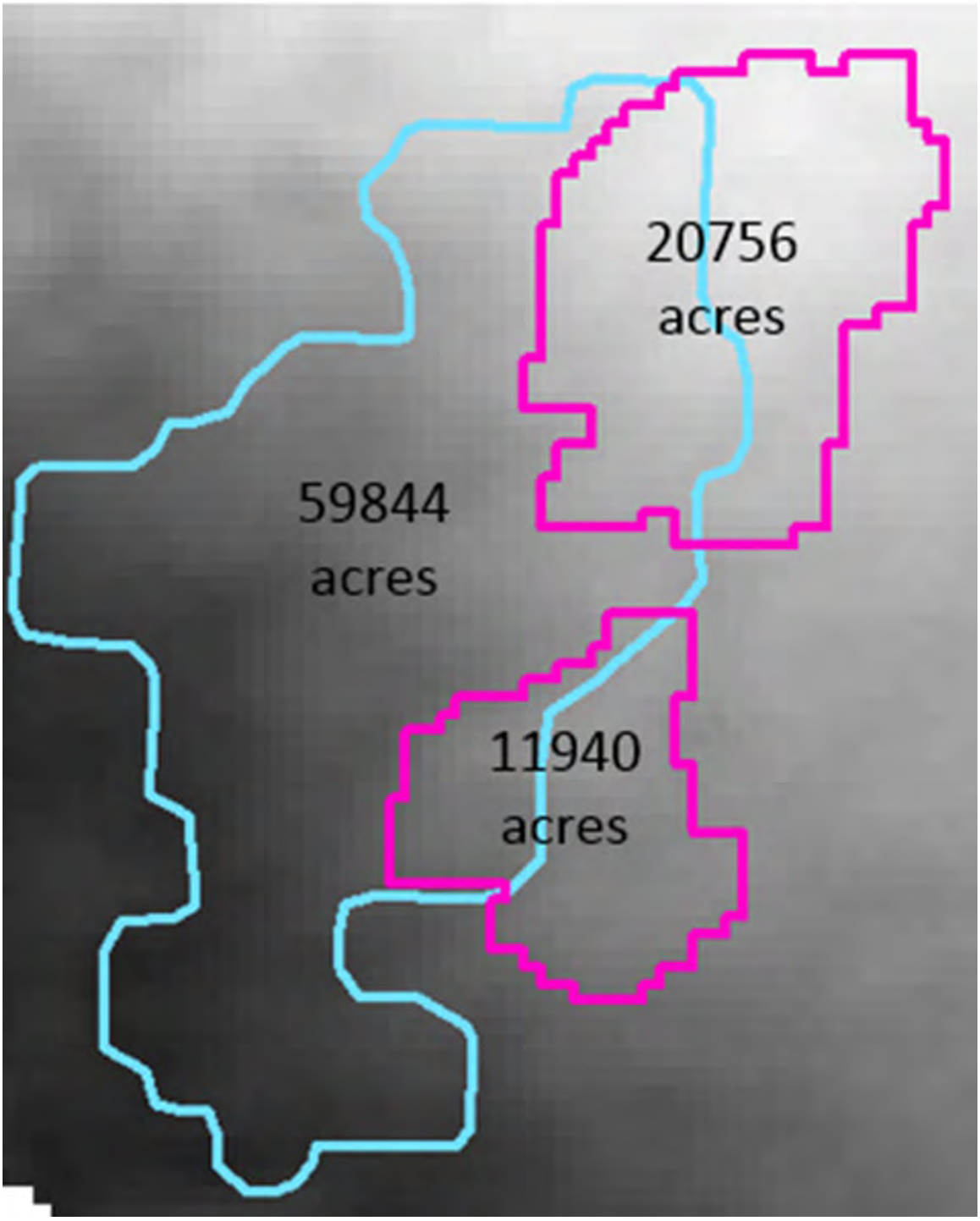


Figure 8. CSSS-A delineated habitat (light blue), and expanded habitat areas (tdN and tdS, purple) to the east and their acreages analyzed as part of the COP RSM modeling. Together, these areas comprise CSSS-Ax and essentially replaces the original A.

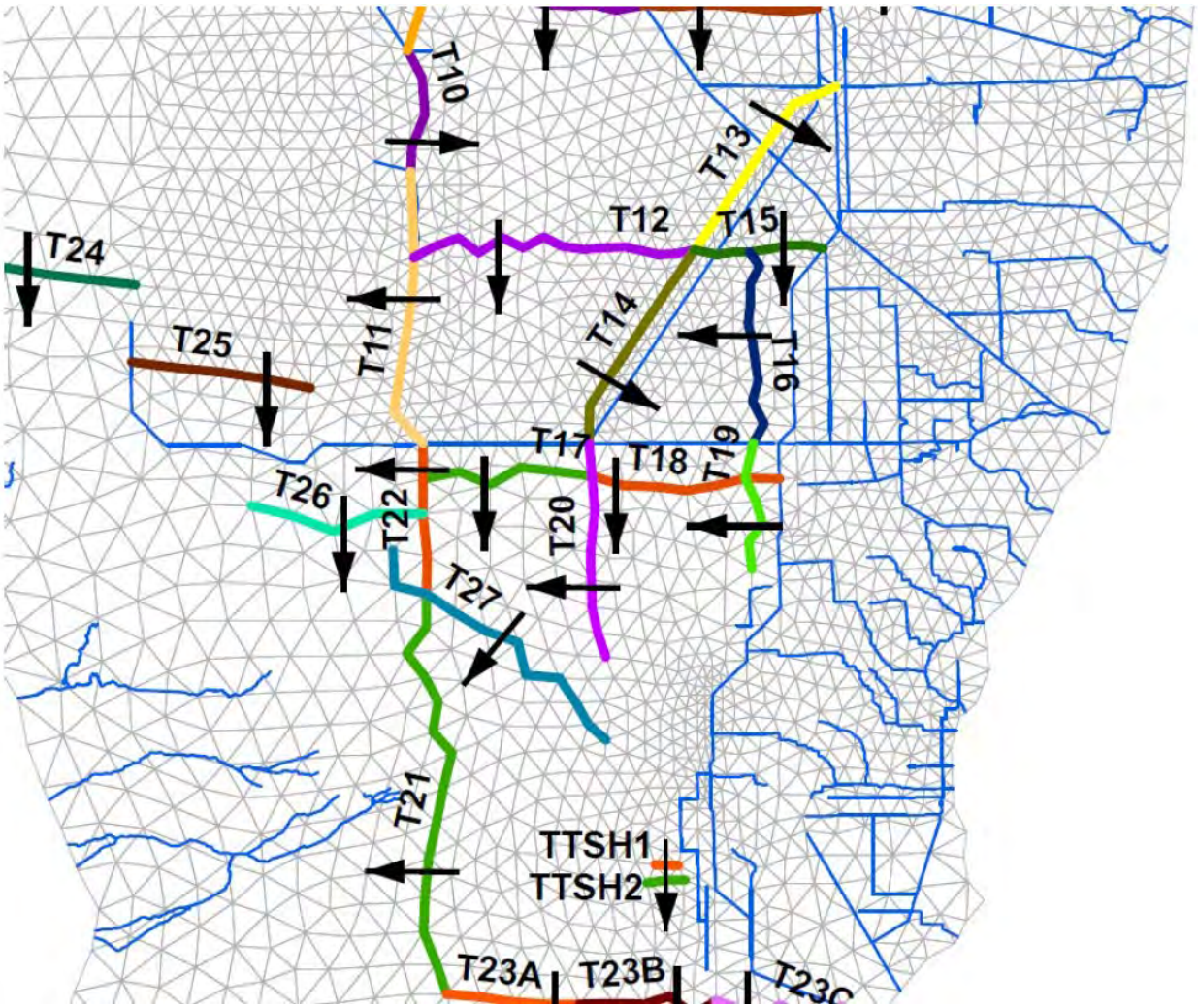


Figure 9. Shows the location and flow direction of transects used to assess modeled flows throughout the action area.

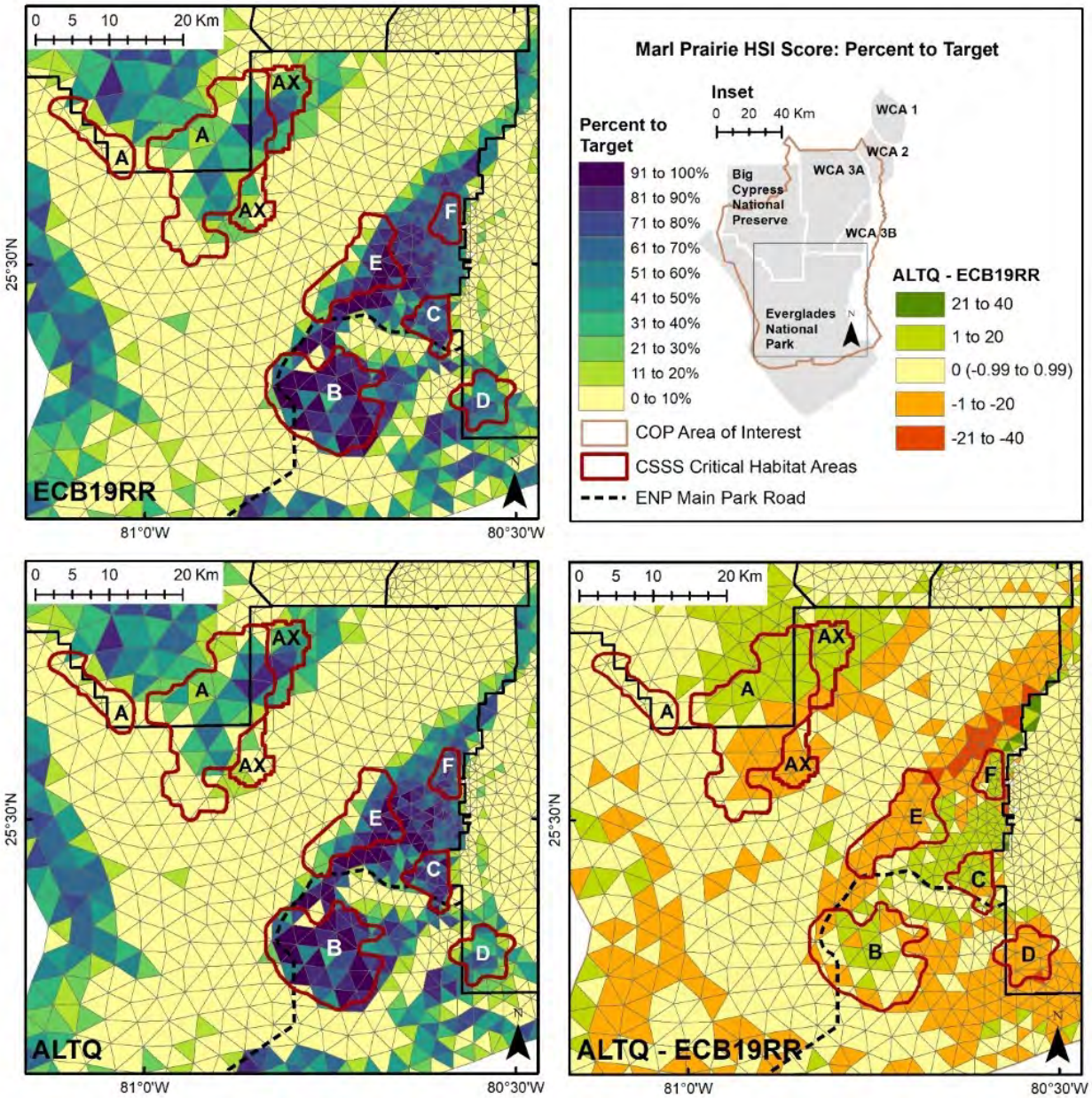


Figure 10. Model output from the Marl Prairie Habitat Suitability Index (Pearlstine et al., 2016). The bottom right map labeled ALT Q – ECB19RR shows the differences between these two runs and uses the color ramp located in the top right corner.

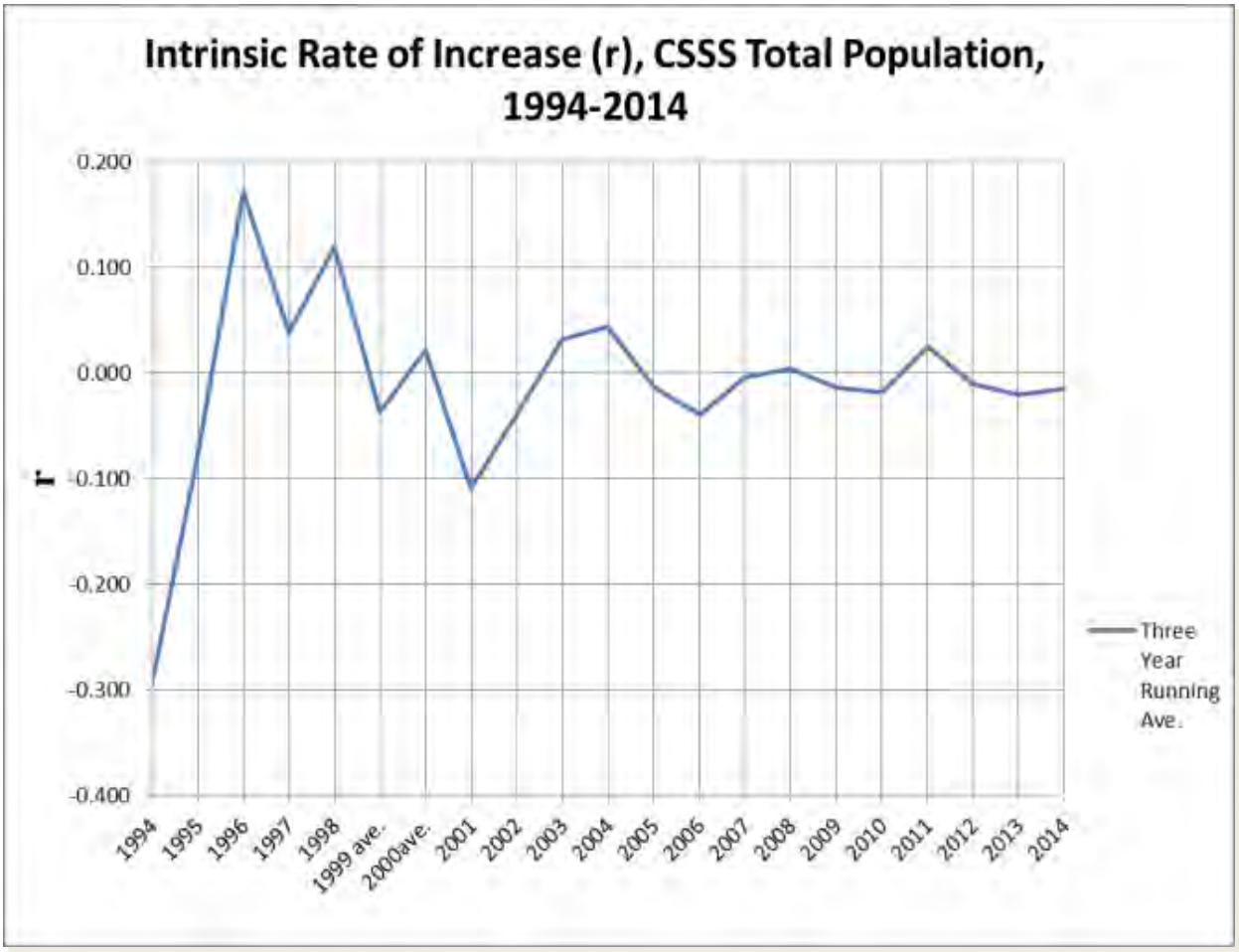


Figure 11. The intrinsic rate of increase of the total Cape Sable seaside sparrow population from 1994 to 2014. An (r) greater than 0 indicates an increasing population; r less than 0 indicates a declining population. From 1994 to 2004, the three-year running average of r was greater than 0 in 6 years, and less than 0 in 4 years. Within the last 10 years, the three-year running average of r was greater than 0 in 2 years, and less than 0 in 8 years.

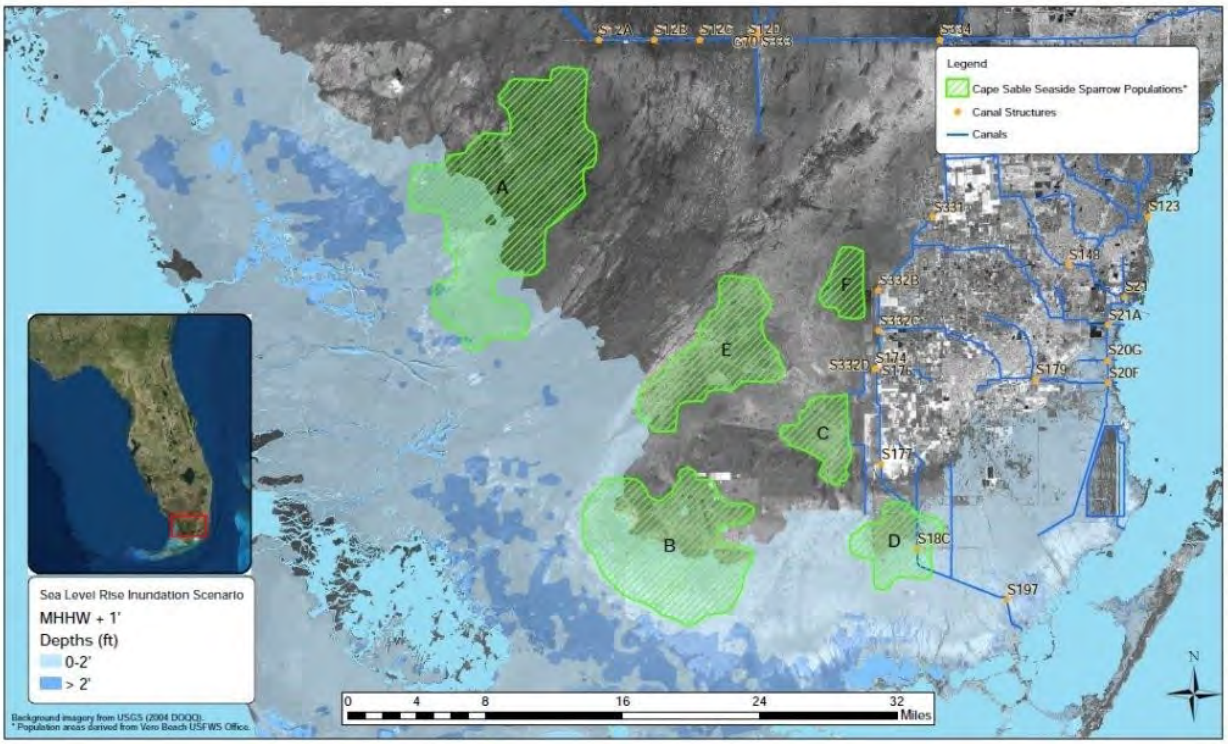


Figure 12. Sea level rise (MHHW +1ft.). Cape Sable seaside sparrow subpopulations are shown in green.

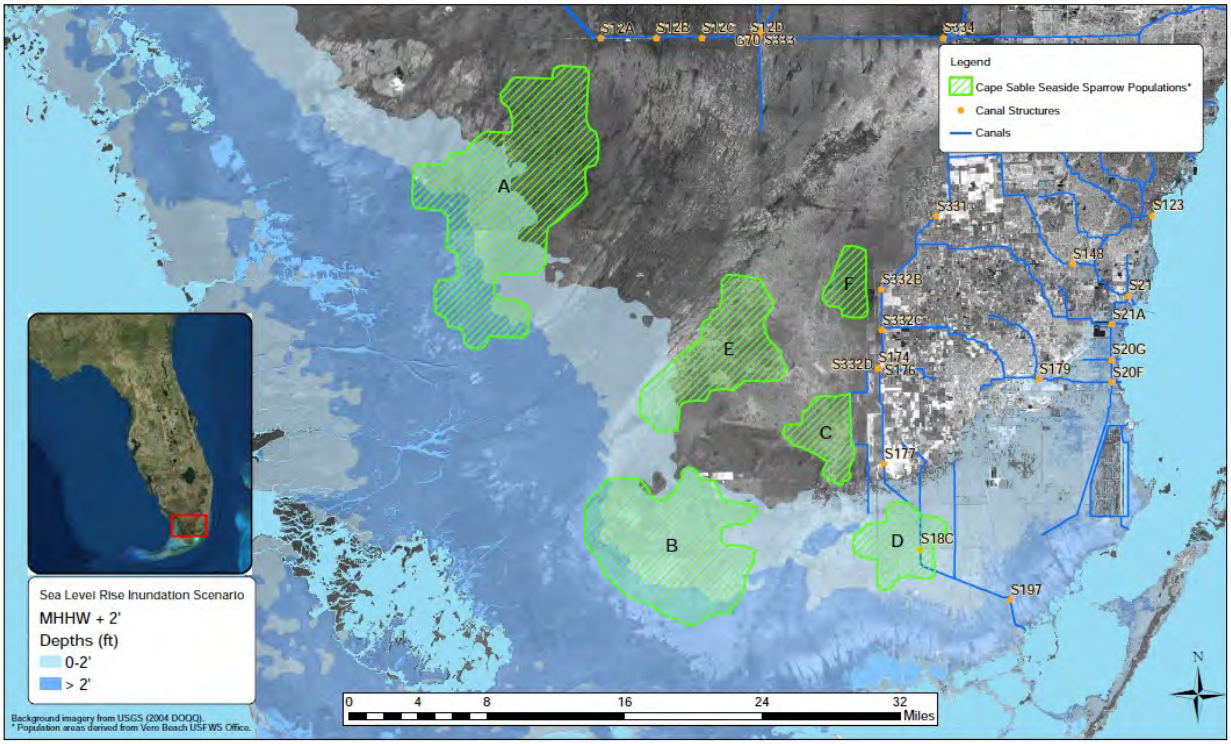


Figure 13. Sea level rise (MHHW +2ft.). Cape Sable seaside sparrow subpopulations are shown in green.

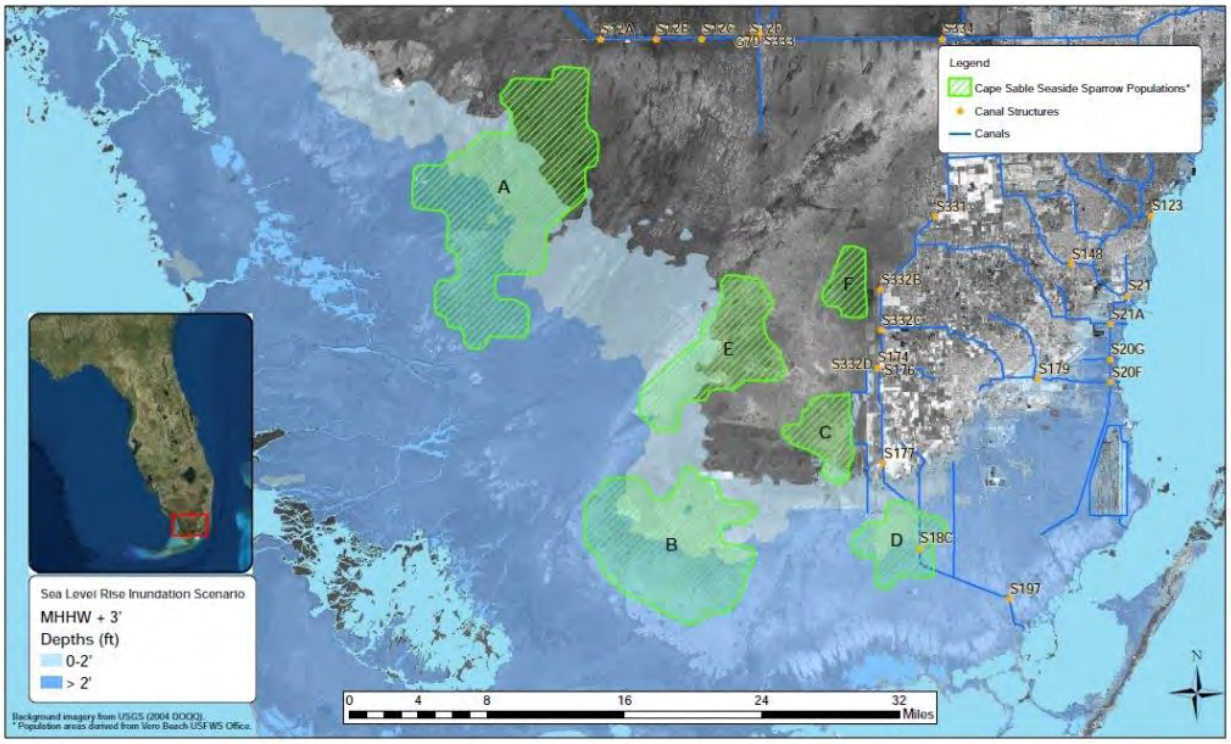


Figure 14. Sea level rise (MHHW +3ft.). Cape Sable seaside sparrow subpopulations are shown in green.

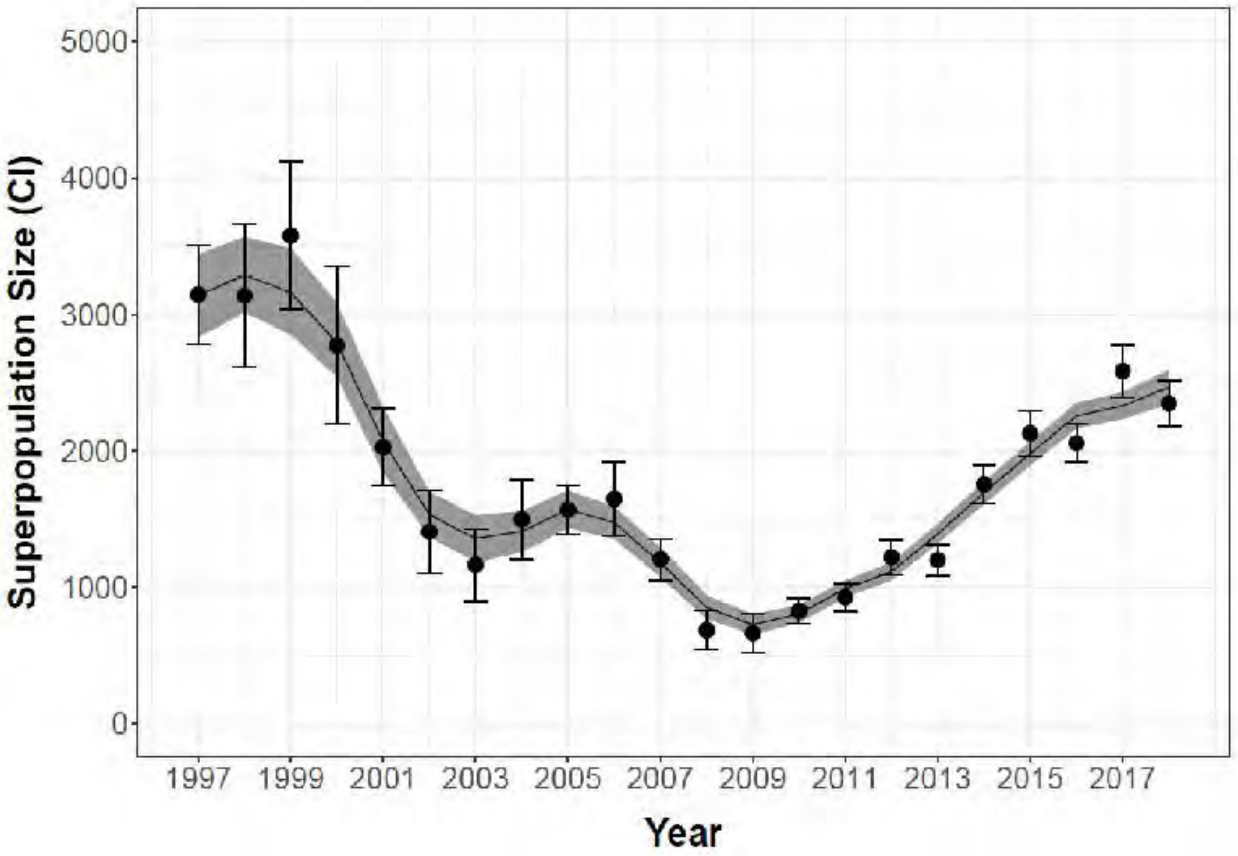


Figure 15. Snail Kite range wide population size and trends: 1997-2018 (Fletcher and University of Florida, 2018).

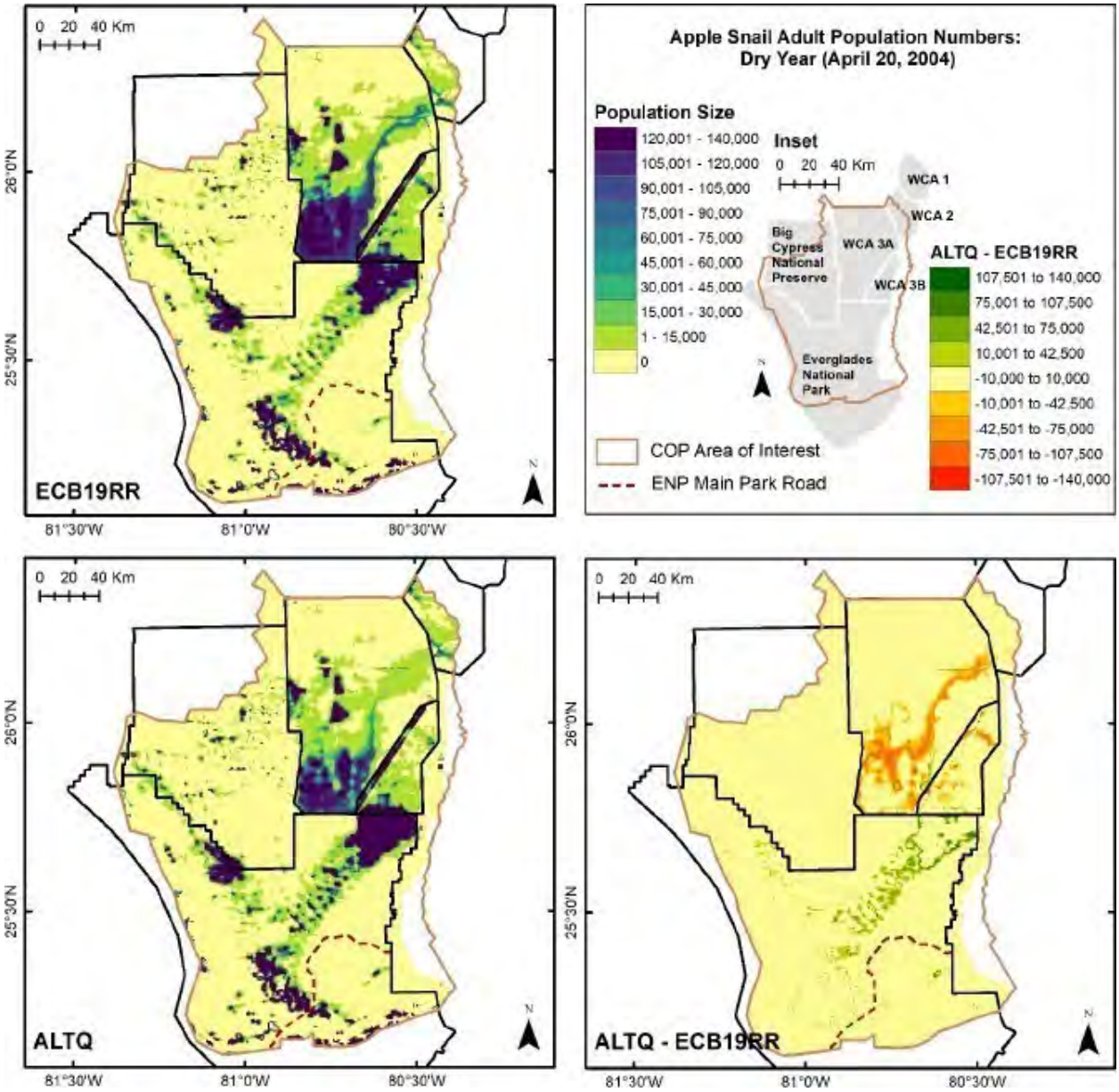


Figure 16. Apple snail adult population numbers for a dry year (April 20, 2004) ALT Q.

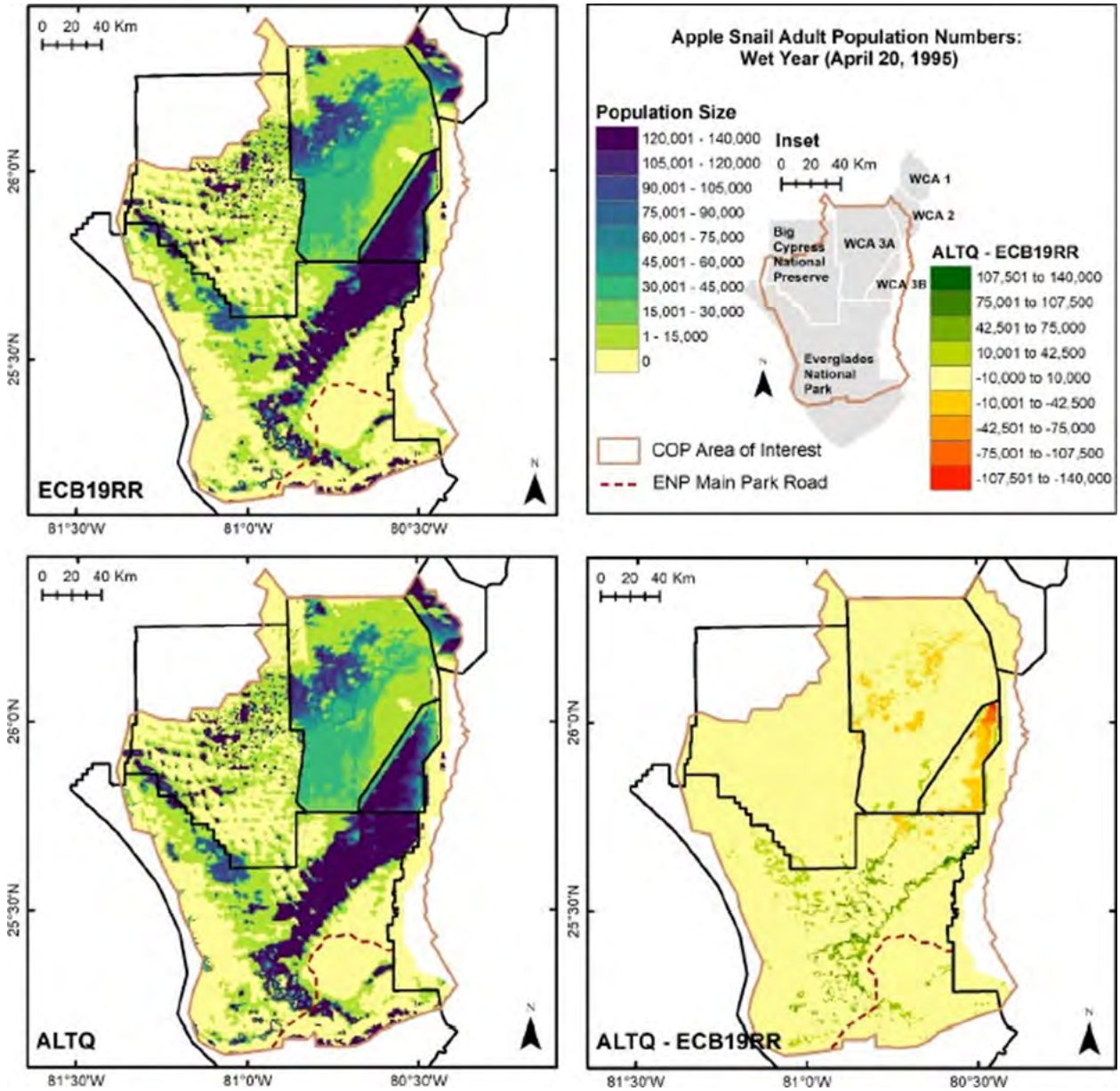


Figure 17. Apple snail adult population numbers for a wet year (April 20, 1995) ALT Q.

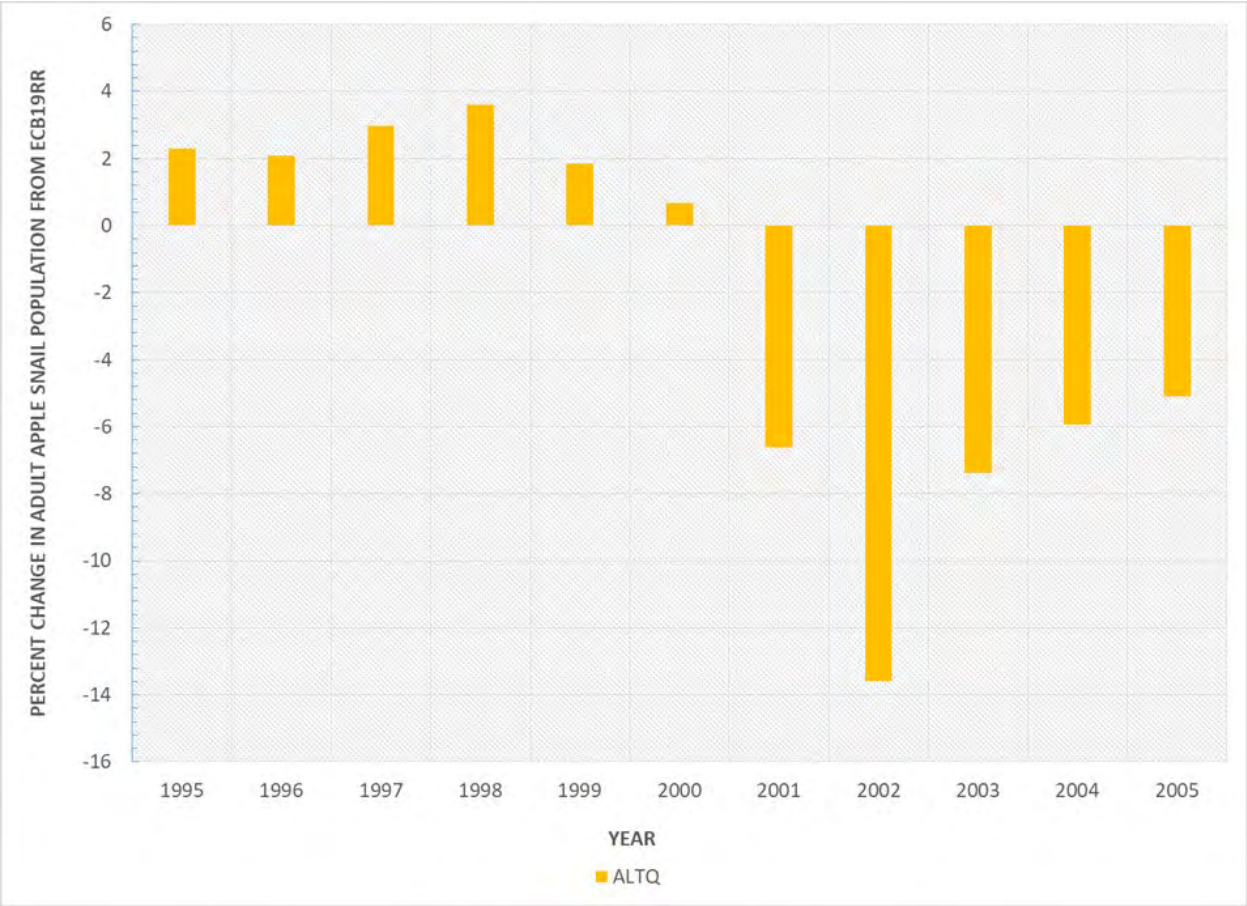


Figure 18. Mean percent change in adult apple snail population for each modeled year.

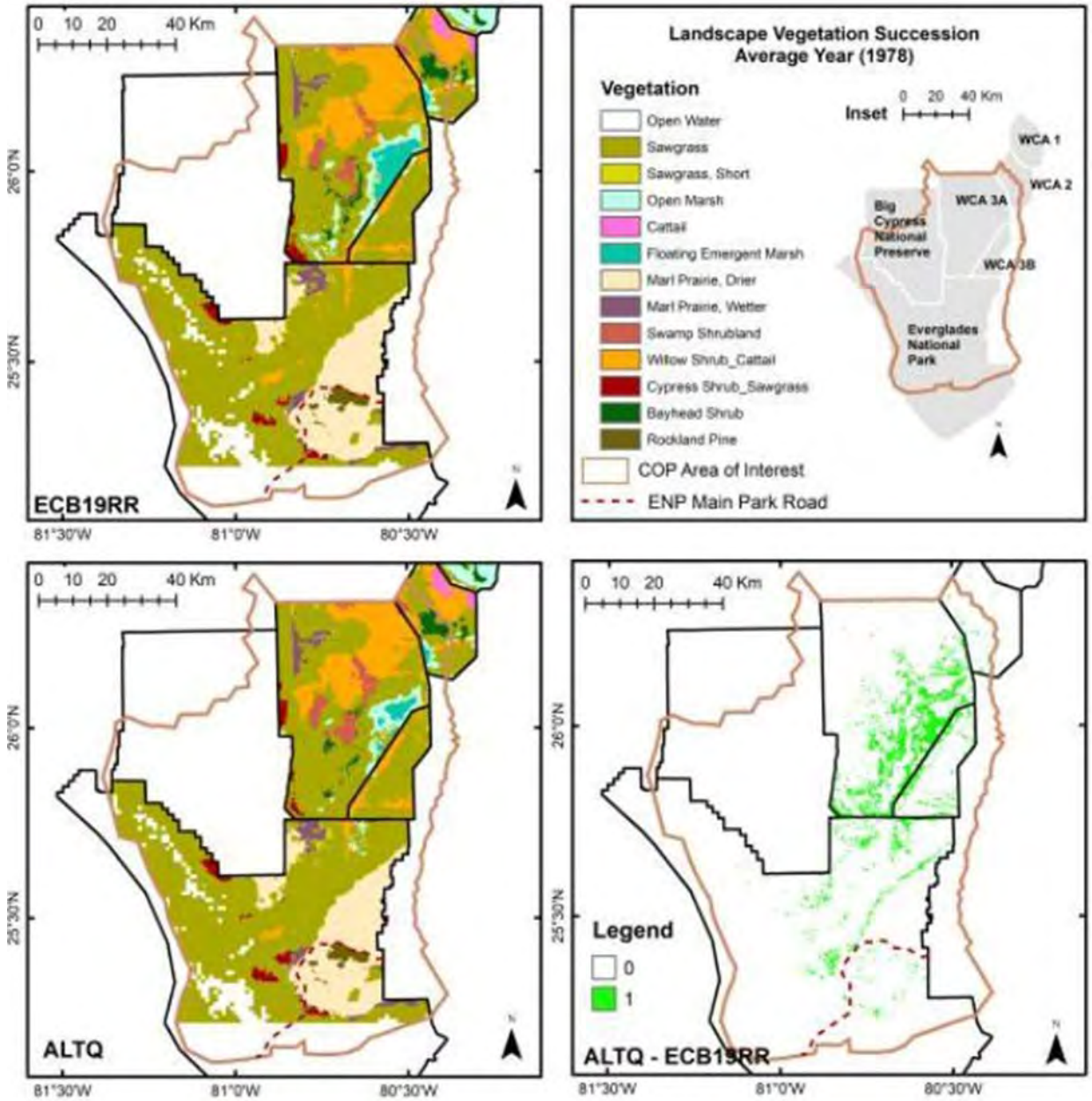


Figure 19. Landscape vegetation succession for an average year (1978) for ALT Q.

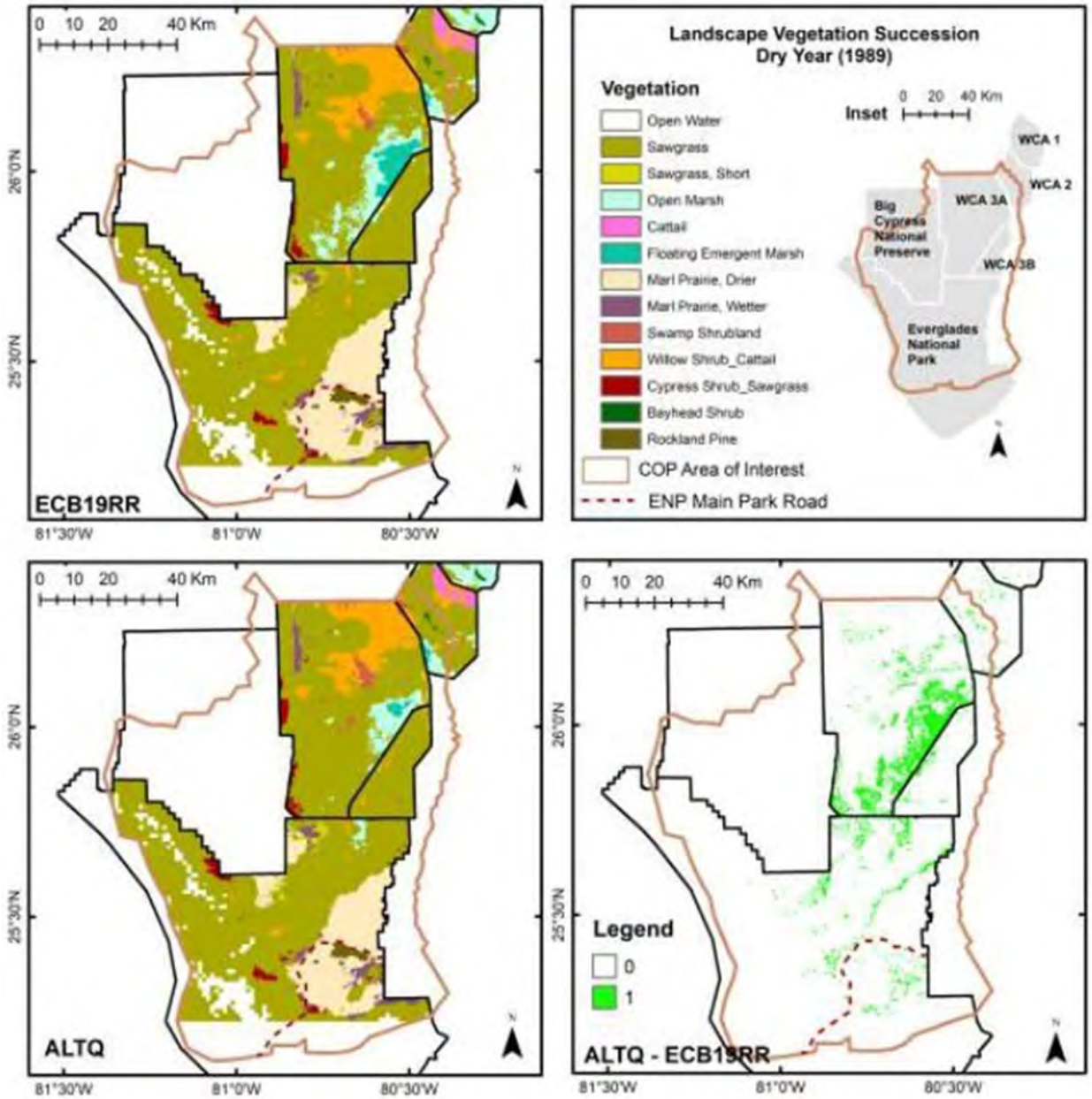


Figure 20. Landscape vegetation succession for a dry year (1989) for ALT Q.

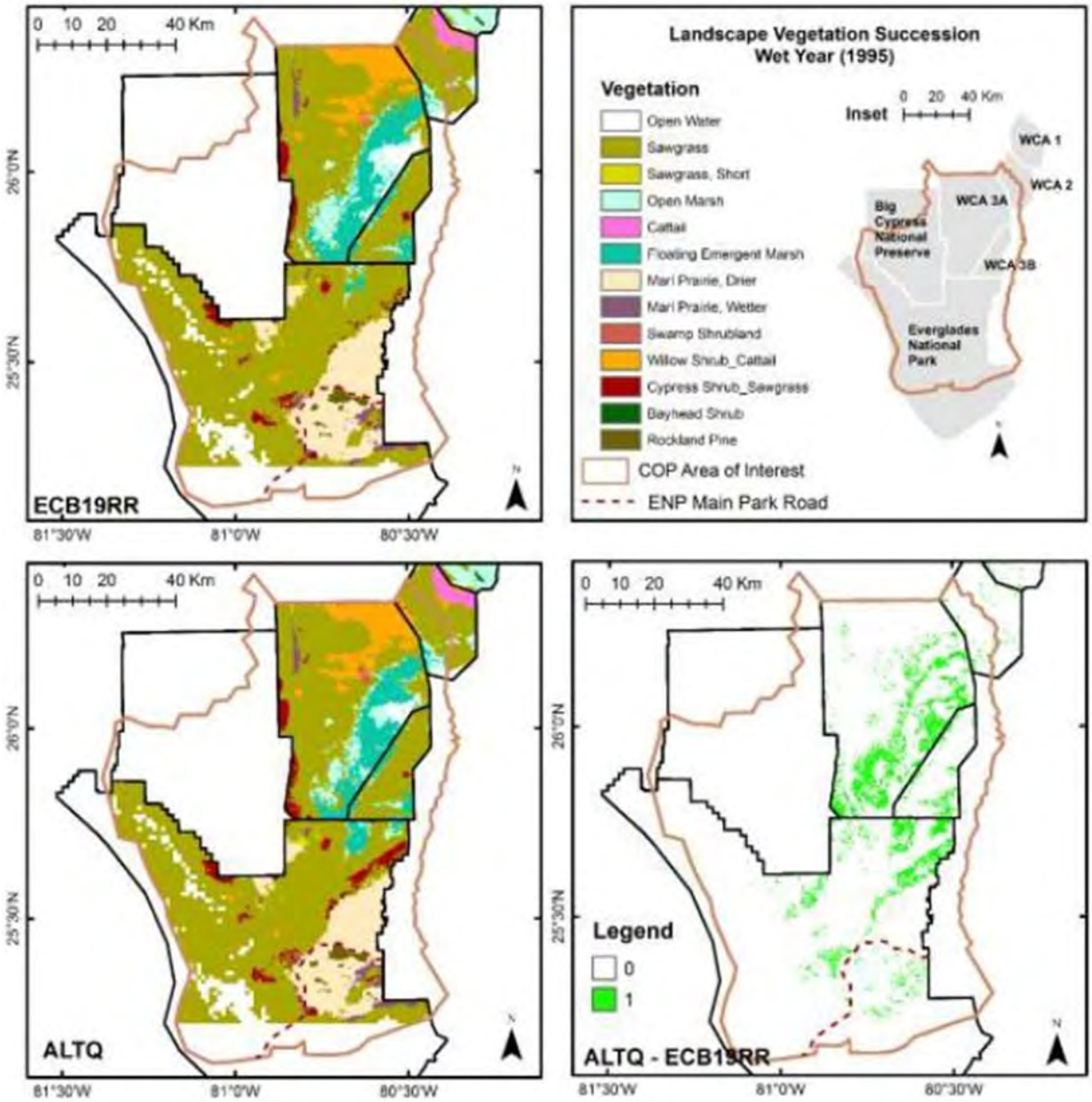


Figure 21. Landscape vegetation succession for a wet year (1995) for ALT Q.

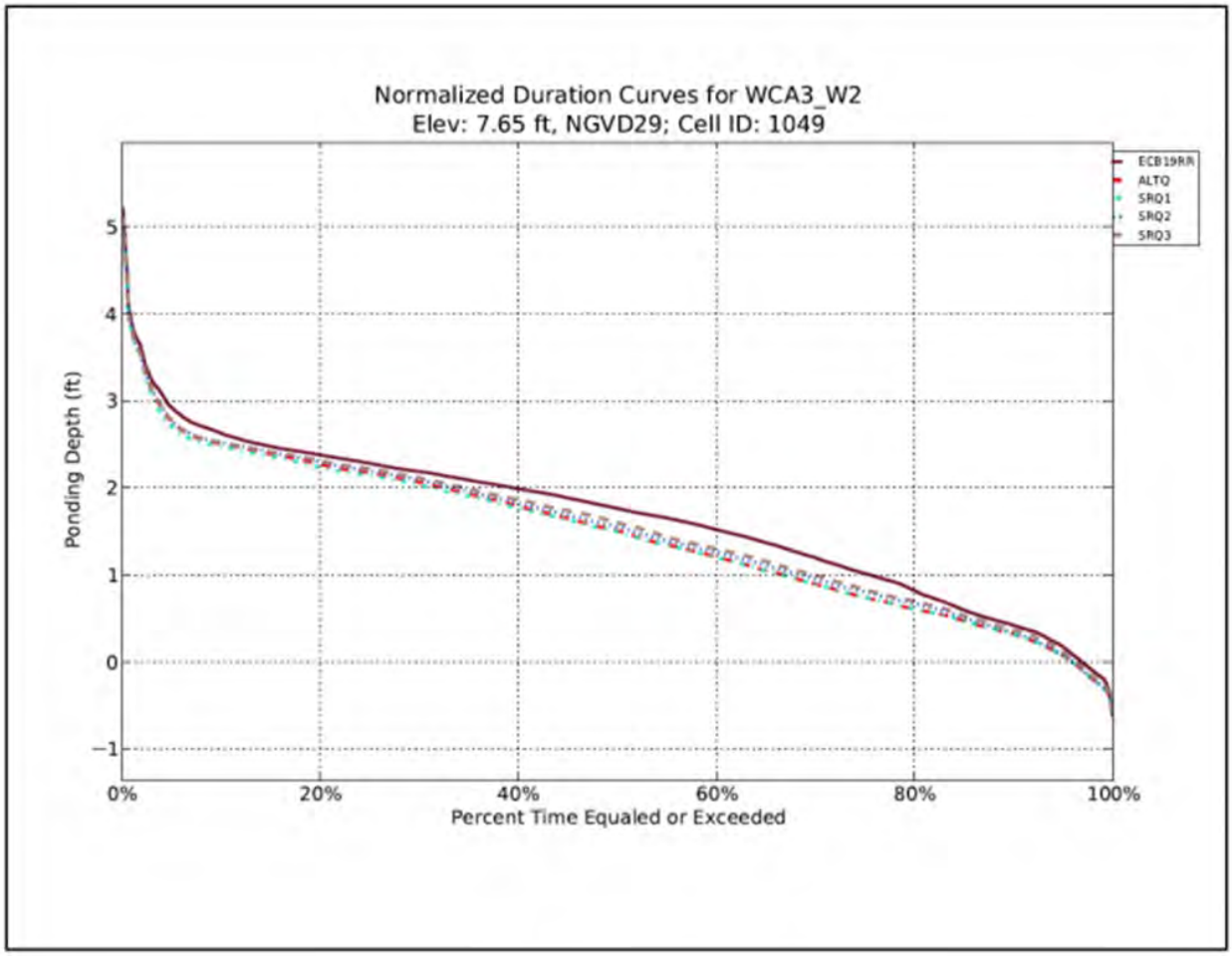


Figure 22. Depth duration curves for gauge WCA-3_W2.

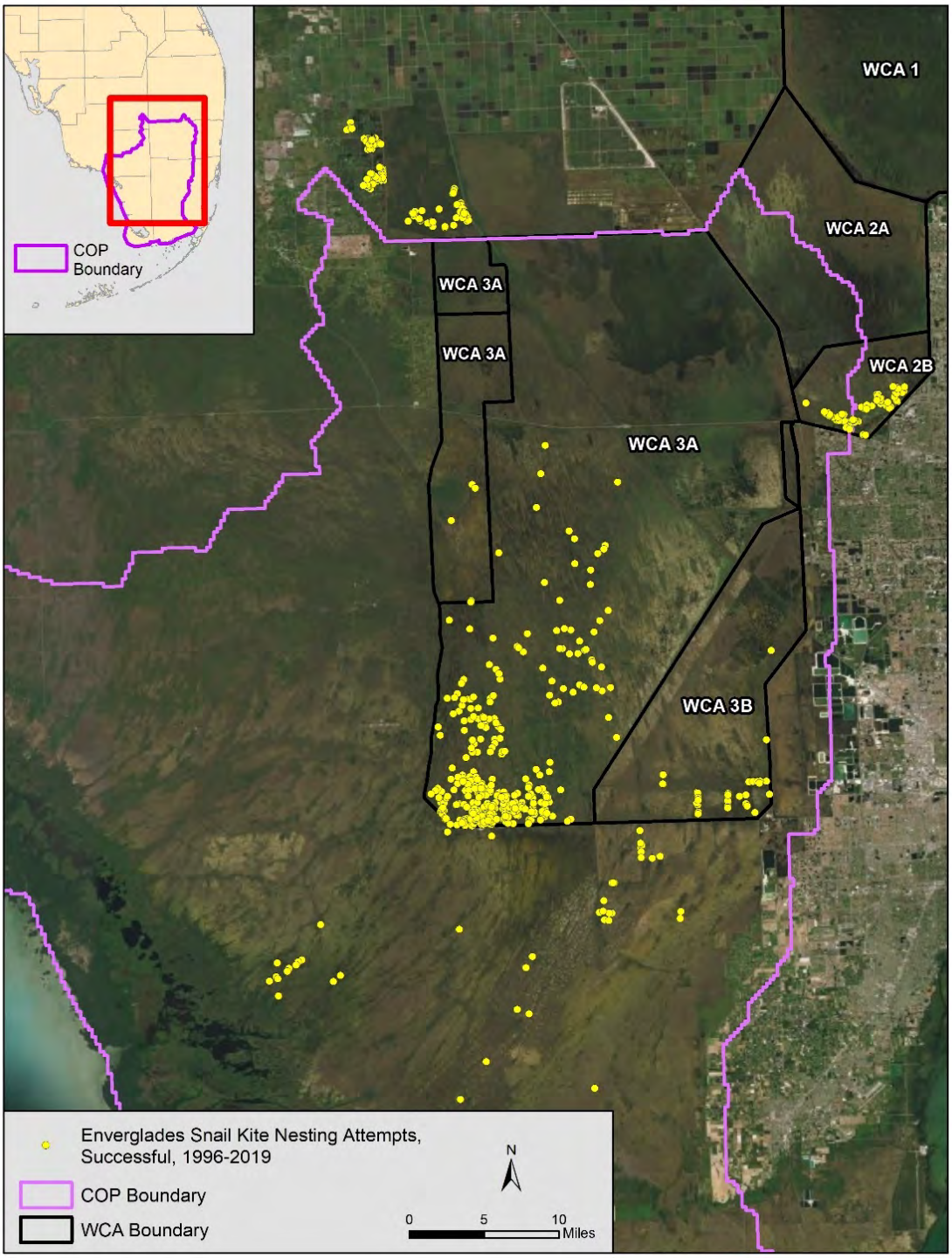


Figure 23. Successful Everglade snail kite nesting attempts within the COP action area from 1996 to 2019.

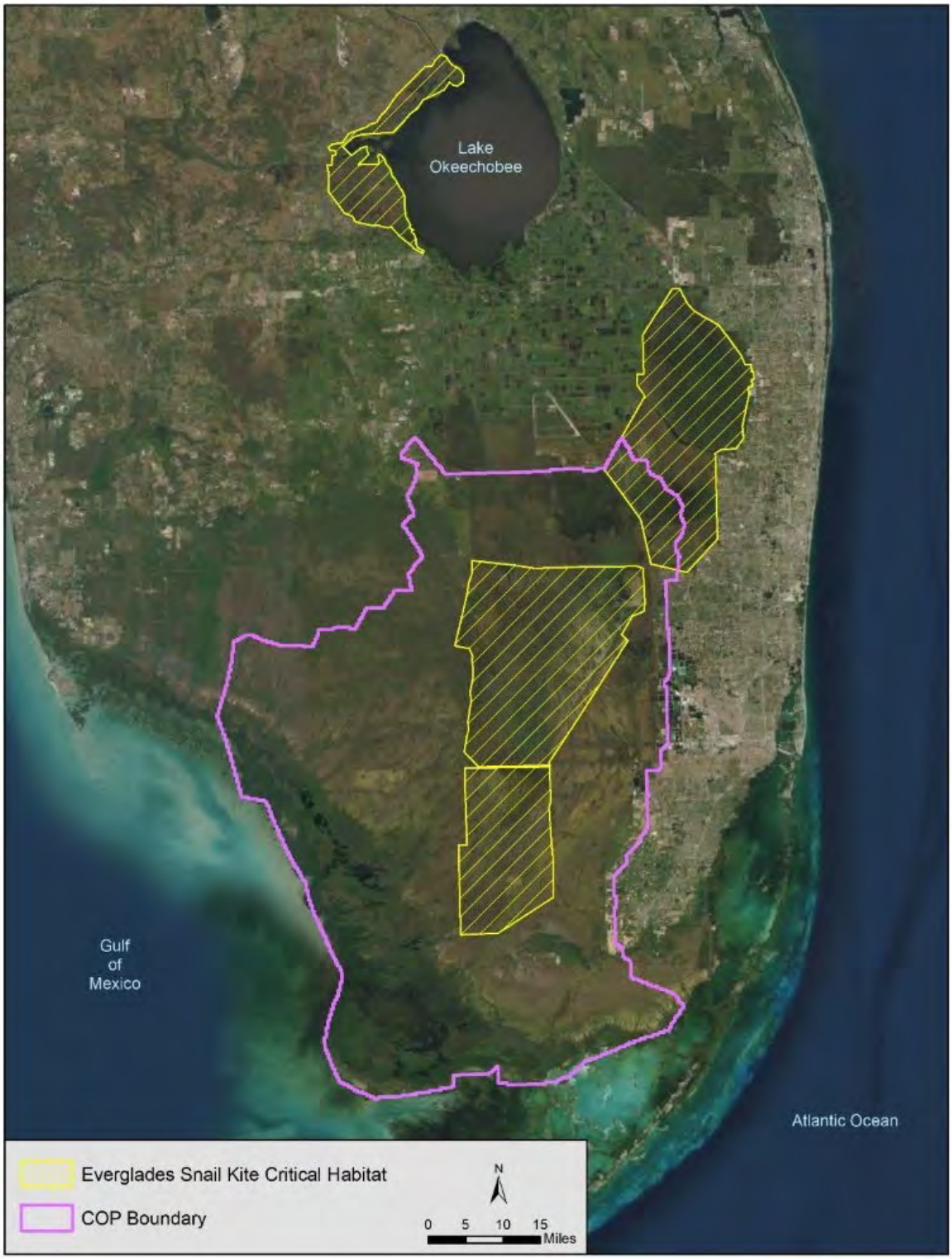


Figure 24. Everglade snail kite critical habitat within the COP action area.

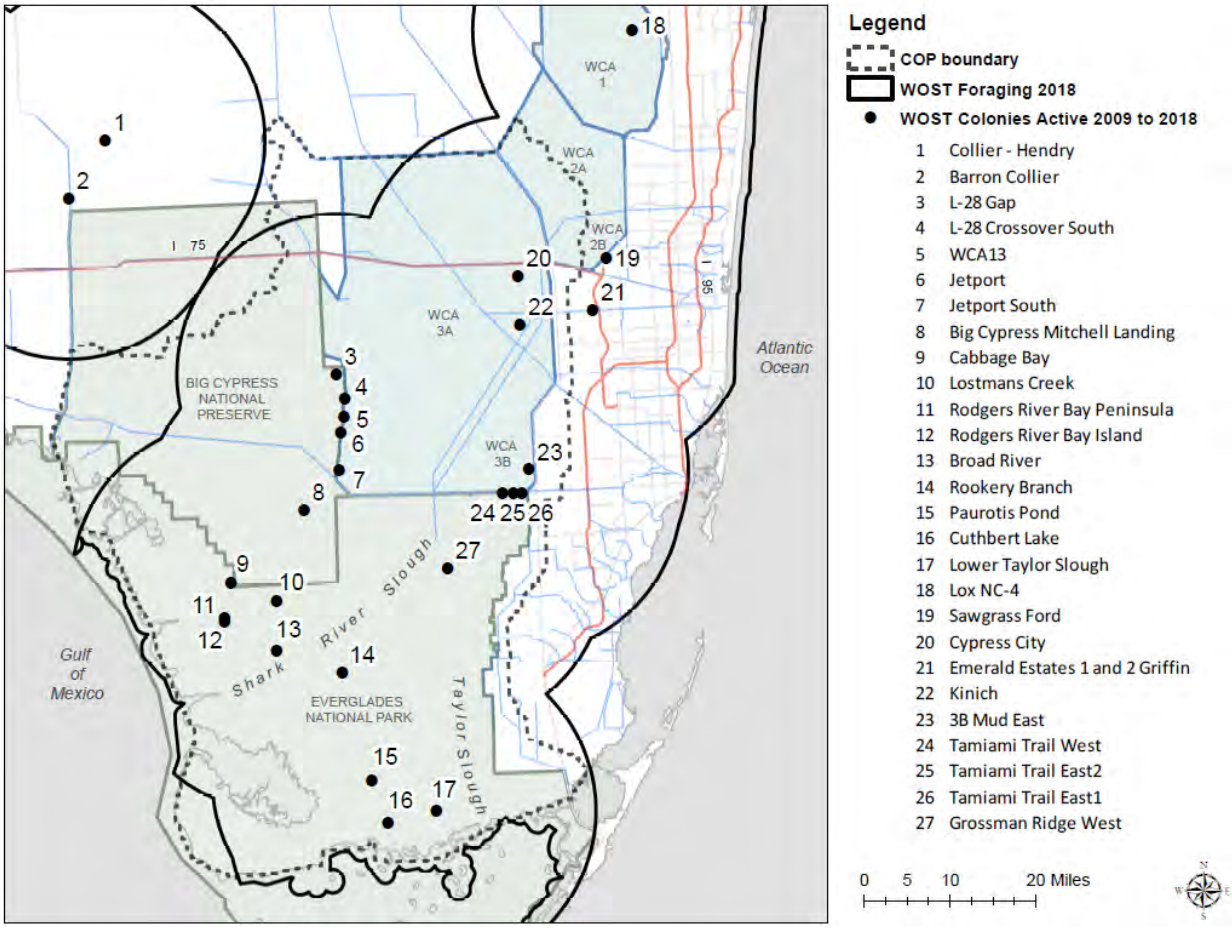


Figure 25. Wood stork (WOST) colonies and Core Foraging Areas (CFA) located within the COP boundary in WCA-3 and Everglades National Park, Florida.

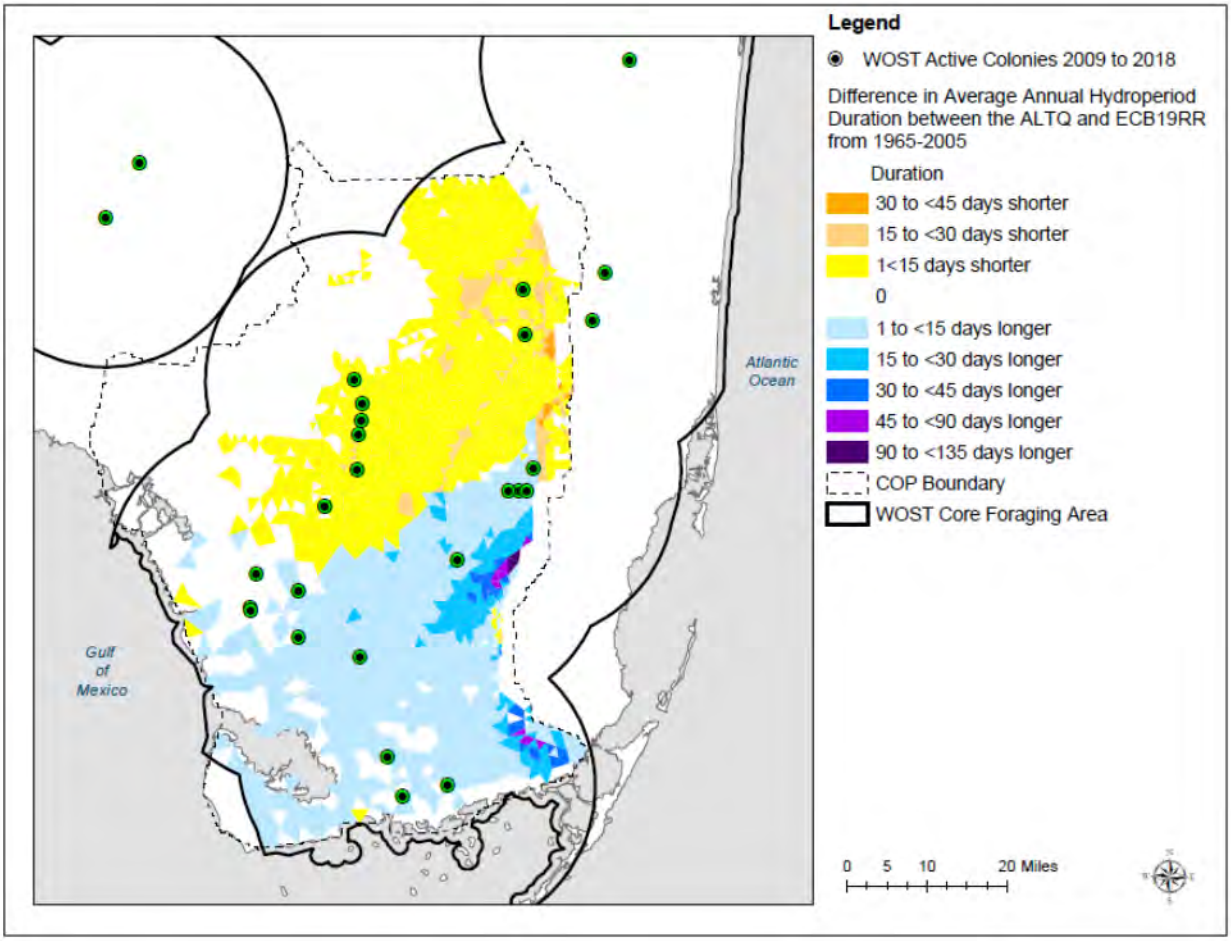


Figure 26. The difference between the COP (ALT Q) and the baseline (ECB19RR) average annual hydroperiod duration from 1965-2005. The average annual extent of reduced hydroperiods for east central and northeastern WCA-3A is shown as well as increased hydroperiods in NESRS and Taylor Slough.

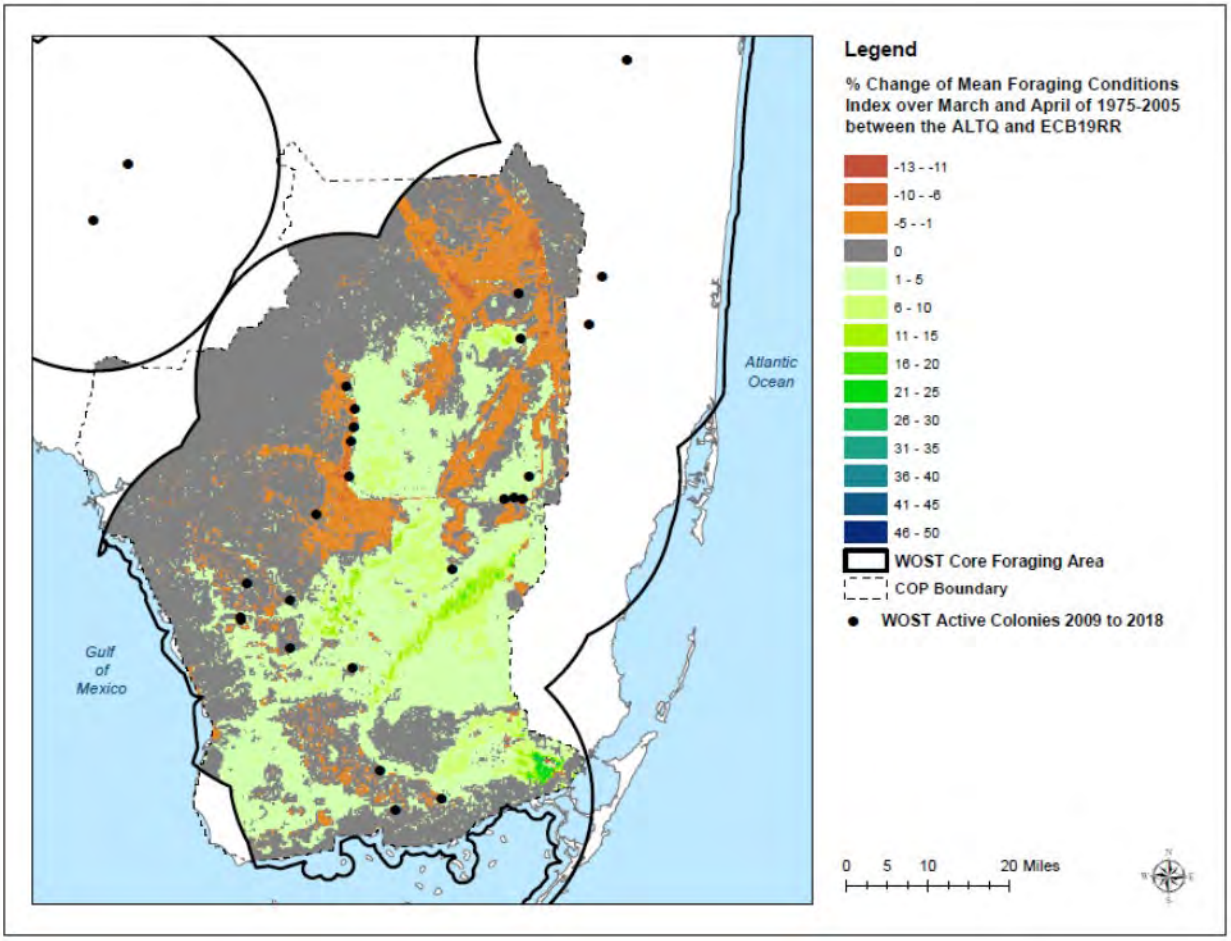


Figure 27. The percent change between the COP (ALT Q) and the baseline (ECB19RR) of the wood stork (WOST) mean spatial foraging conditions index over the months of March and April of 1975-2005. A color ramp is used to show changes in suitability for wood stork foraging across WCA3 and ENP. Observed differences between ALT Q and ECB19RR were most often not more than a ±10 change across the majority of WCA-3 and ENP. Improvements in foraging conditions were observed in NESRS and Taylor Slough while foraging conditions decreased in northeast WCA-3A and along the L-67 canal in WCA-3B under ALT Q.

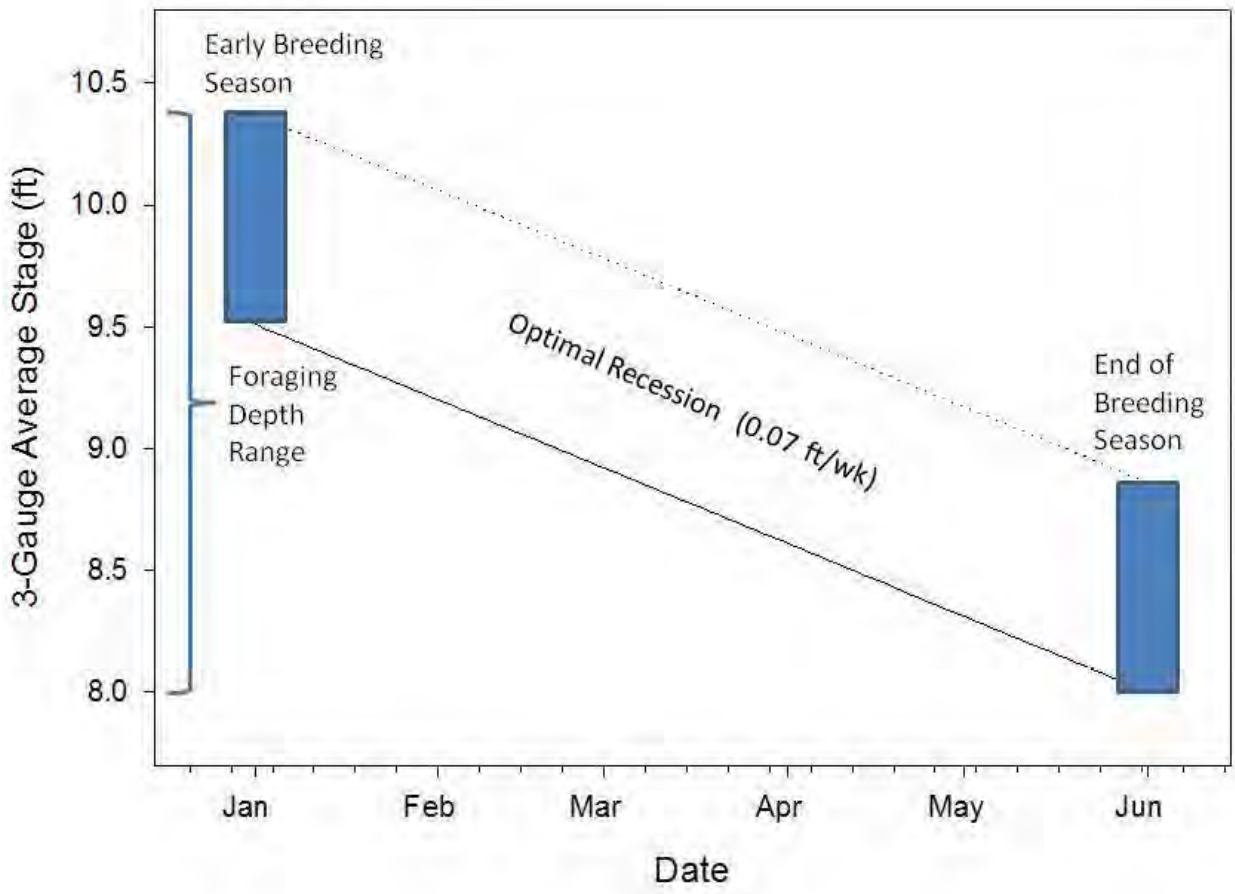


Figure 28. Beerens and Cook (2010) maximum 3AVG stage associated with wood storks feeding in WCA-3A.

Appendix A -
Wood Stork Foraging Habitat Assessment Methodology
July 12, 2012

The decline of the wood stork in the United States is primarily due to the loss of wetland habitats and the concomitant reduction in prey availability. To determine the effect of development actions on the wood stork in south Florida, the Service has chosen to assess the action's effect on wood stork foraging habitat. As such, the Service has developed a functional assessment known as the "Wood Stork Foraging Habitat Assessment Methodology" (Methodology), as described below. The Methodology can be used to estimate the biomass of wood stork forage provided per unit quantity of wetland habitat. The assessment can be applied to both wetlands being lost by a development project and the wetlands proposed as mitigation.

The Service has identified four parameters that can be used in the estimation of wood stork prey biomass:

1. Vegetation Density
2. Wetland Hydroperiod
3. Prey Size Suitability
4. Competition with other wading bird species for forage

Parameter 1 - Density of vegetation

As discussed previously, a wetland's suitability for wood stork foraging is partially dependent on its vegetation density. Coulter and Bryan (1993) found that wood storks prefer to forage in ponds and marshes with little or no canopy. Wood storks have been observed foraging in forested wetlands (*e.g.*, swamps, mesic woodlands etc.), but prefer open areas within these habitat types (Coulter and Bryan 1993; P.C. Frederick, University of Florida, personal communication 2006; J.A. Rodgers, FWC, personal communication 2006). Coulter and Bryan (1993) suggested that wetlands with open canopies may be more readily detected by wood storks and are easier to land at than at closed-canopy sites. Wetlands with sparse canopies also allow wood storks to take flight more quickly to avoid predators.

Parameter 1 - Foraging suitability value (Vegetation Density)

To determine how the presence of invasive exotic vegetation may affect wood stork foraging, we developed foraging suitability indices for wetlands (as described below) using data from O'Hare and Dalrymple (1997). O'Hare and Dalrymple (1997) identified five vegetation classes based on coverage of melalueca (Table WSM1):

Table WSM1. Classes of Melalueca Coverage (from O'Hare and Dalrymple 1997).

75-100 percent mature dense melaleuca coverage (DMM)
75-100 percent sapling dense melaleuca coverage (DMS or SDM)
50-75 percent melaleuca coverage (P75)
0-50 percent melaleuca coverage (P50)
0-10 percent melaleuca coverage (Marsh [MAR])

The number of wetland-dependent bird species and individuals observed per cover type by O'Hare and Dalrymple (1997) are listed in columns 2 and 3 in Table WSM2.

Table WSM2. Foraging suitability indices for wetland-dependent birds species.

Cover type	**No. of species (S)**	**No. of individuals (I)**	**S*I**	**Foraging suitability**
DMM	1	2	2	0.001
DMS	4	10	40	0.025
P75	10	59	590	0.372
P50	11	92	1,012	0.639
MAR	12	132	1,584	1.000

The foraging suitability index for wetlands dependent birds is calculated for each cover type from O'Hare and Dalrymple (1997) (Table WSM2) by multiplying the number of species observed (S) by the number of individuals observed (I). The product (S*I) is then divided by the product of the number of species for MAR and the number of individuals for MAR.

(12 x 132 = 1,584) observed by O'Hare and Dalrymple (1997). Based on the calculations listed above, we developed foraging suitability indices for wetlands used by wood storks based on the coverage of exotic plants (Table WSM3). The Service chose 0.03 (the foraging suitability index for the DMS cover type, rounded up from 0.025) to define foraging suitability for exotic plant coverage ranging from 76 percent to 100 percent.

Table WSM3. Wood Stork Foraging Suitability Indices.

Exotic Plants (percent coverage)	Foraging Suitability Index
0 to 25	1.00
26 to 50	0.64 (rounded up from 0.639)
51 to 75	0.37 (rounded down from 0.372)
76 to 100	0.03 (rounded up from 0.025)

Parameter 2 – Wetland Hydroperiod

<u>Hydroperiod</u>: The hydroperiod of a wetland can affect the density of wood stork prey species. For example, studies of Everglades fish populations using a variety of quantitative sampling techniques (pull traps, throw traps, block nets) have shown that the

density of small forage fish increases with hydroperiod. Marshes inundated for less than 120 days per year average

± 4 fish/meter $(m)^2$, and marshes inundated for more than 340 days per year average ± 25 fish/m^2 (Loftus and Eklund 1994; Trexler et al. 2002).

Kushlan (1990) described short hydroperiod wetlands as wetlands inundated from 0 to 180 days per year, intermediate hydroperiod wetlands as wetlands inundated from 180 to 270 days per year, and long hydroperiod wetlands as wetlands inundated from 270 to 360 days per year.

However, Trexler et al. (2002) defined short hydroperiod wetlands as wetlands with less than 300 days per year inundation. For the purposes of our Methodology, the Service defines wetlands inundated from 0 to 180 days per year as "short hydroperiod" wetlands and wetlands inundated from 180 to 360 days per year as "long hydroperiod" wetlands. In addition, we have adopted the seven wetland hydroperiod classes for wetlands in south Florida used by the SFWMD in their evaluation of various restoration projects throughout the Everglades Protection Area (Table WSM4).

Table WSM4. SFWMD's hydroperiod classes for Everglades Protection Area.

Hydroperiod Class	Number of days inundated
1	0-60
2	60-120
3	120-180
4	180-240
5	240-300
6	300-330
7	330-365

The Service estimated the fish biomass available to the wood stork for each of the SFWMD's hydroperiod classes listed in Table WSM4 as follows. First, we took estimates of fish density (number of fish/ m^2) for the various hydroperiod classes presented in Trexler et al. (2002) (Table WSM5). Trexler et al. (2002) derived these density estimates from throw trap sampling of wetland sites in the Everglades, and the estimates were presented as the square root of the number of fish/m^2 for each of six hydroperiod classes. It is important to note that Trexler et al. (2002) used six hydroperiod classes to characterize the length of inundation during the year compared to the seven hydroperiod classed employed by the SFWMD and used by the Service in our Methodology (Table WSM4). The fish density estimates presented Trexler et al. 2002, increase with hydroperiod class, and this trend has been noted by other investigators (Turner et al. 1999, Turner and Trexler 1997, Carlson and Duever 1979).

Table WSM5. Fish densities per hydroperiod from Trexler et al. (2002).

Hydroperiod class	Days inundated	Fish Density(fish/m^2)*
Class 1	0-120	2.0
Class 2	120-180	3.0
Class 3	180-240	4.0
Class 4	240-300	4.5
Class 5	300-330	4.8
Class 6	330-365	5.0

*As presented, these densities are square root transformed, as described in Trexler et al 2002.

For our assessment, we transformed the fish density data provided by Trexler et al. 2002 to obtain fish density values for each of seven hydroperiods defined by the SFWMD. We obtained a fish density value of 2 fish/m^2 for the SFWMD's Class 1 hydroperiod (0 to 60 days inundated; Table WSM6) by extrapolating Trexler et al.'s Class 1 hydroperiod fish density value of 2.0 fish/m^2 for 0 to 120 days inundated to 1.0 fish/m.^{2} and doubling this value. To calculate fish density values for the remaining SFWMD hydroperiods (Classes 2 through 7), the fish density values for hydroperiod classes 1 through 6 presented by Trexler et al. 2002 (Table WSM5) were squared. Fish density values for each of the seven SFWMD hydroperiod classes are as presented in Table WSM6.

Table WSM6. Extrapolated values of fish density per each SFWMD hydroperiod.

Hydroperiod class	Days inundated	Fish density
Class 1	0-60	2 fish/m^2
Class 2	60-120	4 fish/m^2
Class 3	120-180	9 fish/m^2
Class 4	180-240	16 fish/m^2
Class 5	240-300	20 fish/m^2
Class 6	300-330	23 fish/m^2
Class 7	330-365	25 fish/m^2

The Service is aware the throw-trap method used by Trexler et al. (2002) generally only captures fish 8 centimeters (cm) (3.15 inches [in]) or less in total length. However, the Service believes the data provide a good approximation of the fish sizes preferred by wood storks. We note Ogden et al (1976) found wood storks generally consume fish ranging in total length from 1.5 cm (0.59 in) to 9 cm (3.54 in), and Kushlan et al. (1975) reported wood storks feed primarily on fish from 6 cm (2.36 in) to 8 cm (3.15 in) total length. The Service is aware wood storks will occasionally forage on fish larger than 8cm total length, and we acknowledge this size class of fish is not completely captured by our methodology. However, we note only a small proportion of the wood stork's diet consists of fish greater than 8 cm total length. As such, we do not believe our assessment of wood stork foraging biomass is significantly flawed.

The transformed estimates of fish density listed in Table WSM6 are now used to estimate fish biomass for each of the seven hydroperiods. For our assessment, we considered class 7 hydroperiod wetlands with a density of 25 fish/m^2 to have a mean annual biomass of 6.5 grams /m^2 (wet mass). This estimate of mean annual biomass was based on studies conducted by Turner et al. (1999), Trexler et al. (2002), and Carlson and Duever (1979) in Everglades National Park and WCA-3A. In these studies, the mean biomass (standing stock) of fish from Class 5 and 6 hydroperiod wetlands ranged from 5.5 to 6.5 grams/m^2 (wet mass). These data were originally calculated as g/m^2 dry mass and converted to g/m^2 wet mass following the procedures referenced in Kushlan et al (1986) and also referenced in Turner et al (1999). The fish density data provided in Turner et al. (1999) included both data from samples representing fish 8 cm or smaller and fish larger than 8 cm (3.15 in) and included summaries of data presented in Turner and Trexler (1997), Carlson and Duever (1979), and Loftus and Eklund (1994). These data sets also applied a 0.6 g/m^2 (dry mass) correction estimate for fish greater than 8 cm (3.15 in) based on Turner et al's (1999) block-net rotenone samples.

We estimated the biomass for the SFWMD hydroperiod classes 1 through 6 based on the fish density of 25 fish/m^2 and the biomass of 6.5 grams/m^2 wet mass derived for the Class 7 hydroperiod described above. First, we calculated a mean biomass per fish value of 0.26 grams/m^2 wet mass by dividing 6.5 grams/m^2 wet mass by 25 fish/m^2. We then multiplied the mean biomass per fish value of 0.26 grams/m^2 wet mass by the fish density values for hydroperiod classes 1 through 6. For example, the biomass of fish provided by the Class 3 hydroperiod is 2.3 grams/m^2 (9 x 0.26 = 2.3). The calculated values of fish biomass are presented in Table WSM7.

Table WSM7. Estimated mean annual fish biomass for SFWMD's hydroperiods.

Hydroperiod class	Days inundated	Mean annual fish biomass
Class 1	0-60	0.5 gram/m^2
Class 2	60-120	1.0 gram/m^2
Class 3	120-180	2.3 grams/m^2
Class 4	180-240	4.2 grams/m^2
Class 5	240-300	5.2 grams/m^2
Class 6	300-330	6.0 grams/m^2
Class 7	330-365	6.5 grams/m^2

Parameter 3 – Prey Size Suitability

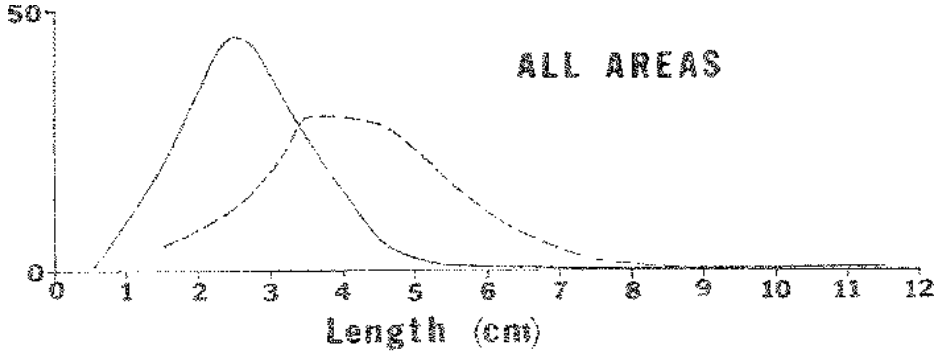
Wood storks are highly selective in their feeding habits. Ogden et al. (1976) reported that five species of fish comprised over 85 percent of the number and 84 percent of the biomass of over 3,000 prey items collected from adult and nestling wood storks (Table WSM8). These species were also observed to be consumed by wood storks in greater proportion than smaller and more abundant fish species [*e.g.*, mosquito fish (*Gambusia affinis*), least killifish (*Heterandria formosa*), and bluefin killifish (*Lucania goodei*)]. This may be the

result of the small body size of these species not eliciting a bill-snapping reflex by wood storks (Coulter et al. 1999).

Table WSM8. Primary fish species consumed by wood storks from Ogden et al. (1976).

Common name	Scientific name	Percent individuals	Percent biomass
Sunfishes	*Centrarchidae* spp.	14	44
Yellow bullhead	*Italurus natalis*	2	12
Marsh killifish	*Fundulus confluentus*	18	11
Flagfish	*Jordenella floridae*	32	7
Sailfin molly	*Poecilia latipinna*	20	11

The following figure from Ogden et al. (1976) compares the frequency (expressed as percent, 0 to 50) of the fish size available to wood storks (solid line) and the frequency of fish size consumed by wood storks (dashed line). The area under the dashed line represents the size of fish most likely consumed by wood storks (1.5 to 9.0 cm in total length).



The Service has adopted this range of fish sizes as those most likely to be consumed by the wood stork and we will use this size range in our assessment of wood stork forage (see discussion below). As discussed above, the throw-trap method used by Trexler et al. (2002) generally only captures fish 8 cm or less in total length, and wood storks occasionally consume fish larger than 8cm in total length. However, the Service believes the data from Trexler et al. (2002) provide a good approximation of the fish sizes preferred by wood storks.

The next element of our wood stork Methodology is the wood stork suitable prey base (biomass per hydroperiod). The wood stork suitability prey base is comprised of two components: (1) the amount of biomass per hydroperiod class within the range of fish sizes likely to be consumed by wood storks and (2) the likelihood that this prey base is actually consumed by the wood stork.

To estimate the fraction of the available fish biomass within the size range of fish likely to be consumed by wood storks (1.5 to 9.0 cm), the Service used the following approach. We noted that Kushlan et al. (1986) listed the mean biomass of the warmouth (*Lepomis*

gulosus) as 36.76 g (rounded to 36.8 g in Appendix WSM-A [see page 12]). In Trexler et al. (2002), the warmouth accounts for about 0.048 percent (18/37,715=0.000477) of the total number of fish collected during the study (Appendix WSM-A). We then multiplied the mean biomass of 36.76 g of the warmouth reported by Kushlan et al. (1986) by the percent occurrence value of 0.048 percent provided by Trexler et al. 2002 to calculate an adjusted mean biomass of 1.75 g (36.76 g x 0.048 = 1.75 g). The mean biomass of the warmouth (1.75 g) accounts for 6.57 percent (1.75/26.715 = 0.0657) of the estimated average biomass (26.715 g) of Trexler et al.'s (2002) samples. Using the Service's estimate of mean annual biomass for class 7 hydroperiod wetlands of 6.5 g/m^2, the warmouth biomass for class 7 hydroperiod wetlands would be 0.427 g/m^2 (6.5 g/m^2 x 0.0657 = 0.427 g/m^2).

However, the Service noted the size frequency distribution (assumed normal) of warmouth from Kushlan et al. (1986) indicate that 48 percent of warmouth sampled were greater than 9 cm total length and 0.6 percent were less than 1.5 cm total length. As such, 48.6 percent of warmouth were outside of the size range (1.5 cm to 9 cm total length) of fish most likely consumed by the wood stork. The mean annual biomass for warmouth for class 7 hydroperiod wetlands in the size range likely consumed by the wood stork is calculated as 0.208 g/m^2 [0.427 x (0.48 + 0.006)] = 0.2075 g/m^2 (rounded to 0.208). Using this approach for all fish species collected by Trexler et al. 2002 (Appendix WSM-A) for class 7 hydroperiod wetlands, the Service estimates that only 3.685 g/m^2 of the 6.5 g/m^2 mean annual fish biomass consists of fish within the size range likely consumed by wood storks (about 57 percent [3.685/6.5 x 100=56.7] of the total mean annual fish biomass available).

The Service also used data in Ogden et al 1976 (Appendix WSM-A) to estimate the available mean annual fish biomass for fish within the size range likely consumed by wood storks for class 7 hydroperiod wetlands. We calculated that 2.97 g/m^2 of the 6.5 g/m^2 mean annual fish biomass for a class 7 hydroperiod wetland (about 45.7 percent) consists of fish within the size range likely to be consumed by wood storks.

Finally, we adjusted the values of estimated mean annual fish biomass for each of the SFWMD's hydroperiods (Table WSM7) to reflect the size of fish most likely consumed by woods storks.

This was accomplished by adding the biomass value of 3.685 g/m^2 (derived from data in Kushlan et al. 1986 and Trexler et al. 2002; Appendix WSM-A) to the biomass value of 2.97 g/m^2 (derived from data in Ogden et al 1976 2002; Appendix WSM-A) and dividing the sum of 6.665 g/m^2 by to obtain a mean value of 3.33 g/m^2 for class 7 hydroperiod wetlands. The Service notes that the mean biomass value of 3.33 g/m^2 s for class 7 hydroperiod wetlands comprises 51 percent of the mean annual biomass estimate of 6.5 g/m^2 for class 7 hydroperiod wetlands listed in Table WSM7 (3.33 g/m^2/6.5 g/m^2 = 0.51 or 51 percent). Therefore, we multiplied each value of mean annual fish biomass listed in Table WSM7 to calculate values of mean annual fish biomass per hydroperiod adjusted for the size range of fish (1 to 9 cm total length) most likely to be consumed by wood storks (*i.e.,* the wood stork suitable prey base) (Table WSM9).

Table WSM9. Estimates of suitable fish biomass per hydroperiod.

Hydroperiod class	Days inundated	Fish biomass
Class 1	0-60	0.26 gram/m^2
Class 2	60-120	0.52 gram/m^2
Class 3	120-180	1.196 grams/m^2
Class 4	180-240	2.184 grams/m^2
Class 5	240-300	2.704 grams/m^2
Class 6	300-330	3.12 grams/m^2
Class 7	330-365	3.38 grams/m^2

Crayfish Biomass

Although the diet of the wood stork is made up primarily of fish, wood storks are known to forage on crayfish (*Procambarus* spp.) (J. Lauritsen, Audubon Corkscrew Swamp Sanctuary, personal communication 2007, 2009; Depkin et al. 1992; Bryan and Gariboldi 1998; Kahl 1964). Depkin et al. (1992) report that crayfish make up 1 percent of the biomass and 1.9 percent of the prey items observed for wood storks from east-central Georgia and also noted the presence of crayfish in the diets of wood storks (fish represented 92 percent of all individual prey items and 93 percent of the total biomass). Lauritsen (Audubon Corkscrew Swamp Sanctuary, personal communication 2007, 2009) suggests crayfish may be an important source of food for wood storks. The importance of crayfish in the wood stork's diet in unclear. Nonetheless, the Service has decided to assess crayfish biomass as part of our estimate of biomass production per hydroperiod.

The presence of melalueca in wetlands does not seem to affect the use of these habitats by crayfish. O'Hare and Dalrymple (1997) found that crayfish are randomly distributed among cover types and melaleuca coverage did not largely affect dispersion patterns. Lauritsen (Corkscrew Swamp Sanctuary 2007, 2009) noted crayfish occur in wetlands with dense melaleuca and migrate to more open areas as water levels fall during the dry season. Hendrix and Loftus (2000) noted that *P. alleni* typically burrow during the dry season, a behavior which provides persistence during droughts, and *P. fallax* was typically found in long hydroperiod wetlands.

Acosta and Perry (2002) assessed the biomass of the *P. alleni* from seasonal wetlands of various hydroperiods within the Florida Everglades. However, Acosta and Perry (2002) defined wetland hydroperiods in terms of months of inundation. Therefore, the Service converted the hydroperiod class used in Acosta and Perry (2002) from months of inundation to days of inundation for use in our Methodology. Acosta and Perry (2002) only provided crayfish density and biomass estimates for wetlands of hydroperiod class 2, 4, and 5, and the converted values are 0.10 gram/m^2, 0.15 gram/m^2, and 0.23 gram/m^2, respectively (Table WSM10). Acosta and Perry (2002) noted that long hydroperiod wetlands typically had densities of crayfish two times greater than medium hydroperiod wetlands and five

times greater than short hydroperiod wetlands. Therefore, we estimated the crayfish biomass for hydroperiod Class 3 wetlands by adding the crayfish biomass estimate for hydroperiod class 2 wetlands (0.10 gram/m^2) to the crayfish biomass estimate for hydroperiod class 4 wetlands (0.15 gram/m^2) and divided the sum (0.25 gram/m^2) by 2 to obtain a value of 0.125 gram/m^2 (rounded to 0.13 gram/m^2 in Table WSM10). The Service estimated the mean annual crayfish biomass for Class 1 hydroperiod wetlands based on Acosta and Perry's (2002) comment that long hydroperiod wetlands typically had densities five times greater than short hydroperiod wetlands.

Therefore, the Service used Acosta and Perry's (2002) average long hydroperiod value for crayfish biomass of 0.229 grams/m^2 and divided this value by 5 to calculate a value of 0.05 gram/m^2 for Class 1 hydroperiod wetlands (0.229/5=0.045). We estimated the crayfish biomass value for the Class 7 hydroperiod wetlands based on the maximum density recorded in Acosta and Perry's (2002) study (0.248 gram/m^2, rounded to 0.25 gram/m^2 in Table WSM10). Finally, we estimated the crayfish biomass for class 6 hydroperiod wetlands by adding the crayfish biomass estimate for hydroperiod class 5 wetlands (0.23 gram/m^2) to the crayfish biomass estimate for hydroperiod class 7 (0.25 gram/m^2) and divided the (0.48 gram/m^2) by 2 to obtain a value of 0.24 gram/m^2 (Table WSM10).

To estimate the total forage biomass available to the wood stork for each wetland hydroperiod class (Table WSM9), we added the value of mean annual crayfish biomass derived from Acosta and Perry 2002 to the value of mean annual biomass estimated for fish (Table WSM10).

Table WSM10. Estimates of suitable fish biomass and crayfish biomass per hydroperiod.

Hydroperiod class	Fish biomass	Crayfish biomass	Total biomass	Percent change
Class 1	0.26 gram/m^2	0.05 gram/m^2	0.31 gram/m^2	19.2
Class 2	0.52 gram/m^2	0.10 gram/m^2	0.62 gram/m^2	19.2
Class 3	1.19 grams/m^2	0.13 gram/m^2	1.32 grams/m^2	10.5
Class 4	2.18 grams/m^2	0.15 gram/m^2	2.34 grams/m^2	7.0
Class 5	2.70 grams/m^2	0.23 gram/m^2	2.93 grams/m^2	8.4
Class 6	3.12 grams/m^2	0.24 gram/m^2	3.36 grams/m^2	7.7
Class 7	3.38 grams/m^2	0.25 gram/m^2	3.63 grams/m^2	7.4

Parameter 4 – Competition with other wading bird species for forage

The computer simulations of wood stork colony population size by Fleming et al. (1994) assumed that only 10 percent of the wood stork forage prey base is available to be consumed by wood storks. This reduction in prey availability was attributed to water level of the foraging habitat, and in part to the effects of competition with other wading bird species. Fleming et al. (1994) did not specify the magnitude of each effect, but the Service believes it is likely competition with other wading bird species limits the availability of

prey to wood storks. As such, the Service has included competition with other wading bird species for forage as a parameter in our assessment of wood stork forage biomass.

The Service has chosen to assess the effects of competition of other wading bird species on wood stork biomass availability as follows. We have adopted the assumption made by

Fleming et al. (1994) that only 10 percent of the potential forage at a wetland site is available to wood storks for foraging. This figure represents a 90 percent reduction of total forage biomass actually available to wood storks at a wetland site. The Service considers competition for forage with other wading bird species, as well as the 3 factors described above (vegetation density, wetland hydroperiod, and prey size) as all contributing equally to the reduction in forage availability.

Consequently, we find that each factor comprises 0.225 or 22.5 percent of the total 90 percent reduction in forage availability (4 x 22.5 = 90 percent). As discussed above, our assessment has already accounted for the effects of vegetation density, wetland hydroperiod, and prey size. To adjust the estimates of total biomass per hydroperiod presented in Table WSM10 for the effects of competition with other wading bird species, we have established a competition adjustment factor of 0.325. This factor was calculated by subtracting 0.675 (the sum of reduction in forage availability due to vegetation density, wetland hydroperiod, and prey size [0.225 + 0.225 + 0.225 = 0.675) from 1 (this number represents 100 percent of the total forage biomass present at a wetland site) (1 – 0.675 = 0.325). Table WSM11 presents estimates of total forage biomass adjusted for competition.

Table WSM 11. Estimates of total biomass of fish and crayfish per hydroperiod adjusted for the effect of competition with other wading birds.

Hydroperiod class	Total Fish and Crayfish Biomass	Competition Factor	Adjusted Total biomass (Total Fish and Crayfish Biomass x Competition Factor)
Class 1	0.31 gram/m^2	0.325	0.1008 gram/m^2
Class 2	0.62 gram/m^2	0.325	0.2015 gram/m^2
Class 3	1.32 grams/m^2	0.325	0.4290 grams/m^2
Class 4	2.34 grams/m^2	0.325	0.7605 grams/m^2
Class 5	2.93 grams/m^2	0.325	0.9523 grams/m^2
Class 6	3.36 grams/m^2	0.325	1.0920 grams/m^2
Class 7	3.63 grams/m^2	0.325	1.1798 grams/m^2

Summary of the factors affecting vulnerability of wetland habitats to wood stork foraging in the action area

Through the above discussions, we have identified that there are essentially four parameters in assessing wood stork foraging habitat:

1. The density of vegetation within habitats suitable for wood stork foraging;

2. The hydroperiod of the wetland, including two subcomponents: (a) the fish density per hydroperiod (number of fish), and (b) the fish biomass per hydroperiod (g/m^2);

3. The size of prey size; and

4. Competition with other wading bird species

All four of these parameters can be used to calculate an estimate of the forage biomass available to wood storks in a wetland. As such, the Methodology can be applied to both wetlands being lost by a development project and the wetlands proposed as mitigation to assess the effect of an action on wood stork foraging. The following example illustrates the use of the Methodology:

A development project results in the loss of 50 acres of wetland (25 acres of Class 3 hydroperiod and 25 acres of Class 4 hydroperiod), each containing 10 percent cover of melaleuca. The forage biomass of each wetland is calculated by multiplying the number of acres of wetlands impacted by 4,047 m^2 (to convert acres to m^2) by the amount of actual biomass consumed by the wood stork (Table WSM11) and the exotic foraging suitability index (Table WSM3). The Service's Methodology considers the portion of the wetland covered by exotic vegetation (*i.e.*, the 10 percent melalueca in this example) as 100 percent suitable to wood storks. To adjust for habitat availability and the wood stork competition factor, the value of forage biomass derived in Table WSM11 is multiplied by 1.0 (*i.e.*, habitat is 100 percent suitable for wood storks). The product is divided by 1,000 grams to convert the forage biomass value calculated in grams to kilograms.

The 25 acres of class 3 hydroperiod wetlands provide 43.4 kg of biomass forage [(25 acres x 4,047 m^2 /acre x 0.4290 g/m^2 (Table WSM11) x 1.0 (Table WSM3))/1,000 grams = 43.4 kg)], and the 25 acres of class 4 hydroperiod wetlands provide 76.94 kg of biomass forage [(25 acres x 4,047 m^2 /acre x 0.7605 g/m^2 (Table WSM11) x 1.0 (Table WSM3) x 1.0)/1,000 grams =76.94 kg)]. The total forage biomass (fish and crayfish) lost due to the action is 120.34 kg (43.4 kg from class 3 hydroperiod wetlands + 76.94 kg from class 4 hydroperiod wetlands), and this value represents the loss of 0.61 nest based on Kahl's (1964) estimate that 201 kg of forage was needed for a successful wood stork nest.

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Appendix WSM-A.

Data from Kushlan et al. (1986), Ogden et al. 1986, and Trexler et al. (2002) used by the Service to estimate the fraction of the available fish biomass within the size range of fish that may be consumed by wood storks.

		Kushlan et al. (1986)				Ogden et al. (1976)		Everglades - Trexler et al. (2002)				
Species	**Common name**	**Mean Mass (g)**	**Proportion of fish <15mm**	**Proportion of fish >90mm**	**Proportion within 15-90 mm wood stork preference**	**% items consumed by stork**	**% biomass consumed by stork**	**Total collected**	**% of total collected**	**Mean mass based on % collected**	**Mass within 6 g/m2**	**Mass within stork prey size**
Osteichtheyes												
Amia calva	Bowfin	1307.3	0.000	0.997	0.002	0.1	0.1		0.000	0.000	0.000	0.000
Lepisosterus platyrhincus	gar	182.5	0.012	0.948	0.039	0.2	2.8	1	0.003	0.484	0.109	0.004
Elops saurus	lady fish	346.7	0.000	1.000	0.000				0.000	0.000	0.000	0.000
Notemigonus crysoleucas	golden shiner	2.5	0.086	0.028	0.885	0.1	0.2		0.000	0.000	0.000	0.000
Notropis petersoni	coastal shiner	0.3	0.029	0.000	0.971			60	0.159	0.046	0.010	0.010
Notropis maculatus	taillight shiner					0.2	0.1	1	0.003	0.000	0.000	0.000
Erimuzon sucetta	Lake cubsucker	20.5	0.300	0.211	0.489				0.000	0.000	0.000	0.000
Ictalurus natalis	yellow bullhead catfish	29.0	0.063	0.438	0.499	1.7	11.8	29	0.077	2.228	0.500	0.250
Ameiurus nebulosus	brown bullhead catfish								0.000	0.000	0.000	0.000
Noturus gyrinus	tadpole madtom	1.4	0.052	0.000	0.948	0.2	0.1	8	0.021	0.029	0.007	0.006
Clarias batrachus	walking catfish	40.5	0.016	0.796	0.188			4	0.011	0.429	0.096	0.018
Bagre marinus	gafftopsail catfish	464.4	0.000	0.997	0.003				0.000	0.000	0.000	0.000
Opsanus beta	gulf toadfish	14.9	0.001	0.339	0.660				0.000	0.000	0.000	0.000
Strongylura notata	redfin needlefish	3.9	0.034	0.669	0.297				0.000	0.000	0.000	0.000
Adinia xenica	diamond killfish	0.7	0.002	0.000	0.998				0.000	0.000	0.000	0.000
Cyprinidon variegatus	sheepshead minnow	0.3	0.278	0.000	0.722	4.1	2.7	41	0.109	0.035	0.008	0.006
Floridichthylys carpio	goldspotted killfish	1.1	0.033	0.000	0.967				0.000	0.000	0.000	0.000
Fundulus chrysotus	golden topminnow	0.4	0.273	0.000	0.727	1.3	0.8	1844	4.889	1.750	0.393	0.286
Fundulus confluentus	marsh killifish	0.5	0.188	0.000	0.812	18.0	10.7	87	0.231	0.120	0.027	0.022
Fundulus grandis	gulf killfish	9.9	0.001	0.118	0.881				0.000	0.000	0.000	0.000
Fundulus seminolis	seminole killifish	5.8	0.000	0.110	0.890	0.7	3.1	1	0.003	0.016	0.003	0.003
Jordanella floridae	flagfish	0.3	0.260	0.000	0.740	32.0	7.0	1783	4.728	1.480	0.332	0.246
Lucania goodei	bluefin killifish	0.1	0.280	0.000	0.720	0.1	0.1	8391	22.248	2.759	0.620	0.446
Lucania parva	rainwater killifish	0.2	0.150	0.000	0.850	0.3	0.1	1	0.003	0.001	0.000	0.000
Gambusia affinus	mosquitofish	0.1	0.464	0.000	0.536	6.3	0.5	9825	26.051	2.214	0.497	0.266
Heterandria formosa	least killifish	0.0	0.917	0.000	0.083	0.5	0.1	12713	33.708	1.315	0.295	0.025
Poecilia latipinna	sailfin molly	0.2	0.292	0.000	0.708	19.8	10.6	1699	4.505	1.081	0.243	0.172
Labidesthes sicculus	brook silverside	0.5	0.002	0.000	0.998	0.1	0.1	5	0.013	0.007	0.002	0.002
Menidia beryllina	tidewater silverside	0.8	0.000	0.000	1.000	0.1	0.1		0.000	0.000	0.000	0.000
Elassoma evergladei	everglades pygmy sunfish	0.2	0.250	0.000	0.750			487	1.291	0.200	0.045	0.034
Enneacanthus gloriosus	bluespotted sunfish	0.5	0.155	0.000	0.845	0.8	0.9	238	0.631	0.321	0.072	0.061
Lepomis gulosus	warmouth	36.8	0.006	0.484	0.510	4.8	27.2	18	0.048	1.754	0.394	0.201
Lepomis macrochirus	bluegill	21.2	0.047	0.283	0.670	0.3	0.7	6	0.016	0.337	0.076	0.051
Lepomis marginatus	dollar sunfish	2.1	0.046	0.000	0.954			14	0.037	0.077	0.017	0.016
Lepomis microlophus	redear sunfish	30.8	0.052	0.362	0.586	2.3	5.4	55	0.146	4.490	1.008	0.591
Lepomis punctatus	spotted sunfish	7.0	0.182	0.030	0.787	2.8	8.7	197	0.522	3.661	0.822	0.647
Lepomis	unidentified sunfish	12.6	0.137	0.134	0.729	2.5	1.0	16	0.042	0.534	0.120	0.087
Sunfish	unidentified sunfish	9.8	0.175	0.070	0.754	2.5	1.0		0.000	0.000	0.000	0.000
Micropterus salmoides	largemouth bass	104.0	0.007	0.855	0.138	0.3	4.4	4	0.011	1.103	0.248	0.034
Etheostoma fusiforme	swamp darter	0.4	0.002	0.000	0.998			2	0.005	0.002	0.001	0.001
Astronotus ocellatus	oscar								0.000	0.000	0.000	0.000
Hemichromis bimaculatus	jewelfish	4.2	0.092	0.000	0.908				0.000	0.000	0.000	0.000
Spilotum nicaraguense	Nicaraguan cichlid								0.000	0.000	0.000	0.000
Eucinostomus gula	jenny mojarra	2.9	0.000	0.000	1.000				0.000	0.000	0.000	0.000
Haemulon plumieri	white grunt	6.2	0.000	0.011	0.988				0.000	0.000	0.000	0.000
Lagodon rhomboides	pinfish	7.1	0.001	0.039	0.960				0.000	0.000	0.000	0.000
Bairdiella chrysoura	silver perch	7.1	0.000	0.047	0.953				0.000	0.000	0.000	0.000
Cichlasoma bimaculatum	black acara	13.0	0.000	0.005	0.995			7	0.019	0.242	0.054	0.054
Cichlasoma urophthalmus	mayan cichlid							21	0.056	0.000	0.000	0.000
Mugil curema	white mullet					0.1	0.8		0.000	0.000	0.000	0.000
Rivulus marmoratus	rivulus					0.1	0.1		0.000	0.000	0.000	0.000
Esox niger	chain pickerel					0.1	0.1	5	0.013	0.000	0.000	0.000
Erimyzon sucetta	lake chubsucker							145	0.384	0.000	0.000	0.000
Belonesox belizanus	pike killifish							3	0.008	0.000	0.000	0.000
Tilapia mariae	spotted tilapia							4	0.011	0.000	0.000	0.000
Total								**37715**	**100.000**	**26.715**	**6.000**	**3.539**

*Shaded estimate of average mass from length-weight relationship given for species on www.fishbase.org with average length assumed to be 5 cm (FLMNH). The proportion of fish length less than 1.5 cm was set to be the average of all sunfish.