DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
COCOA REGULATORY FIELD OFFICE
400 HIGHPOINT DRIVE, SUITE 600
COCOA, FLORIDA 32926

REPLY TO
ATTENTION OF

August 25, 2020

Regulatory Division
North Permits Branch
Cocoa Permits Section

PUBLIC NOTICE

Permit Application Number SAJ-1992-01224 (JMB)

TO WHOM IT MAY CONCERN: The Jacksonville District of the U.S. Army Corps of Engineers (Corps) has received an application for a Department of the Army permit pursuant to Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. §403) and Section 404 of the Clean Waters Act (33 U.S.C. §1344) as described below:

APPLICANT: Sebastian Inlet Tax District
Attn: James Gray
114 Sixth Avenue
Indiatlantic, Florida 32903

WATERWAY AND LOCATION: The Sebastian Inlet Sand Bypassing and Channel Maintenance Project is located along the shoreline of the Atlantic Ocean from Sebastian Inlet from Department of Environmental Protection (FDEP) monuments R-3 to R-17, in Sections 20 and 29, Township 30 South, Range 39 East, Sebastian Inlet, Indian River County, Florida.

Directions to the site are as follows: The project extends from just south of the intersection of State Road A1A and Sebastian Inlet south approximately 2 miles.

APPROXIMATE COORDINATES:
Latitude 27.8529 °
Longitude -80.4550°

PROJECT PURPOSE:
Basic: Sand bypassing and maintenance dredge

Overall: To mitigate the historical adverse effects of Sebastian Inlet on the downdrift oceanfront properties and to provide storm protection to the barrier island shoreline of the Sebastian Inlet State Park between FDEP monuments R-3 to R-17.

EXISTING CONDITIONS: The sand trap (borrow area) and navigation channel substrate is sand. The depth of the sand trap, when full, is approximately 10 feet NAVD88. The design dredge depths of the sand trap vary up to -17 feet NAVD88 and an allowable 1-foot over-dredge. The inlet channel maintenance dredging depth is 10.5 feet NAVD88. The submerged substrate is sand and ephemeral hardbottom.

The Sebastian Inlet Tax District (District) conducts annual seagrass surveys and permit-required seagrass monitoring surveys as required by the current FDEP and previous USACE permits. The permit sketches show the 2019 seagrass mapping.

The District conducts permit-required nearshore hardbottom monitoring surveys as required by the current FDEP and previous USACE permits. Attached are the 2019 Immediate Post- Construction Report providing the nearshore hardbottom survey

PROJECT HISTORY: The proposed Action was previously permitted under USACE authorization SAJ-1992-01224, and is unchanged from the previously authorized action. No structures are proposed.

PROPOSED WORK: The applicant seeks authorization for dredging the sand trap and channel, with beach placement of sand downdrift (south) of Sebastian Inlet within the template from Florida Department of Environmental Protection (FDEP) reference monument R-3 to R-17, Indian River County. The dredged sand will be placed either directly on the beach or within the District's dredged material management area (DMMA) for subsequent beach placement. The proposed beach template has the same extents as the previously permitted project, but also incorporates a turtle-friendly berm. The proposed activity will allow the District to meet the bypassing objective recommended by its Inlet Management Plan (IMP) and maintain a navigation channel between the ICW and inlet. The applicant has requested a 10-year permit authorization.

It is anticipated that there will be multiple dredging and beach placement events during the duration of the permit. The District has an annualized bypassing goal of 70,000 cubic yards per year. The sand trap is designed for 6-year dredging interval; however, dredging can occur more frequently based on storm impacts and channel shoaling. Sand placement is primarily based on the conditions of the beach, which often require beach placement events more frequently than the 6-year interval.

AVOIDANCE AND MINIMIZATION INFORMATION: The applicant has provided the following information in support of efforts to avoid and/or minimize impacts to the aquatic environment:

"The Activity avoids impacts that would result in mitigation and minimizes impacts to listed species. The Activity and Action Area are unchanged from the USACE authorization that expired May 4, 2020 (USACE Permit No. SAJ-1992-01224). By keeping the Action Area unchanged, there are no additional impacts to which were authorized under USACE Permit No. SAJ-1992-01224.

The applicant is in acceptance of the standard manatee, smalltooth sawfish, and sea turtle guidelines; as well as the terms and conditions (T&Cs) and reasonable and prudent measures (RPMs) listed under the Jacksonville District Programmatic Biological

Opinion and Piping Plover Programmatic Biological Opinion (P3BO). By accepting and incorporating the T&Cs and RPMs of the programmatic biological opinions, the applicant is minimizing impacts to acceptable regulatory standards."

COMPENSATORY MITIGATION: The applicant has offered the following compensatory mitigation plan to offset unavoidable functional loss to the aquatic environment:

"No mitigation is proposed."

CULTURAL RESOURCES: The permit area has been extensively modified by previous permitted work; and the Corps is not aware of any known historic properties within the permit area. By copy of this public notice, the Corps is providing information for review. Our final determination relative to historic resource impacts is subject to review by and coordination with the State Historic Preservation Officer and those federally recognized tribes with concerns in Florida and the Permit Area.

ENDANGERED SPECIES:
U.S FISH AND WILDLIFE SERVICES (USFWS): The Corps executed a Resources At Risk (RAR) report for the area within a 3 mile radius of the approximate project center. The RAR indicated that the proposed project "may affect" the loggerhead sea turtle (Caretta caretta), Kemp's ridley sea turtle (Lepidochelys kempii), leatherback sea turtle (Dermochelys coriacaea), green sea turtle (Chelonia mydas), and the hawksbill sea turtle (Eretmochelys imbricata) based on the proposed impacts to nesting beaches. The project "may affect but is not likely to adversely affect" the West Indian manatee (Trichechus manatus latirostris), as well as the piping plover (Charadrius melodus), least tern (Sterna antillarum), rufa red knot (Calidris canatus rufa), and the eastern indigo snake (Drymarchon couperi). It is the Corps' determination that the Proposed Action will have "no effect" on the Atlantic salt marsh snake (Nerodia clarkii taeniata), Florida scrub-jay (Aphelocoma coerulescens), southeastern beach mouse (Peromyscus polionotus niveiventris), Johnson's seagrass (Halophila johnsonii), and the wood stork (Mycteria americana),. The Corps will request concurrence from the USFWS with these determinations pursuant to Section 7 of the Endangered Species Act.

SEA TURTLES: The USFWS' revised Statewide Programmatic Biological Opinion (SBPO) for Shore Protection Activities along the Coast of Florida, dated February 27, 2015, discusses in detail general information for sea turtles including status and distribution, behavior, life history, population dynamics, etc. (USFWS 2015a). Common threats to sea turtles in Florida are also discussed in the SPBO. Terrestrial critical habitat has been designated by the USFWS for the loggerhead, green, leatherback, and hawksbill sea turtle; however, critical habitat overlaps with the Project Action Area for only the Northwest Atlantic Ocean distinct population segment (NWAO DPS) of the loggerhead sea turtle. The final rule, published on July 10, 2014 by the USFWS, included 45 units encompassing approximately 637 km (396 mi) of mapped shoreline along the coast of Florida (50 CFR 17). The sand placement template portion of the

Action Area is located entirely within the LOGG-T-FL-08 unit: Sebastian Inlet – Indian River Shores, Indian River County, which encompasses 4.1 km (2.5 mi) of beach and includes the Sebastian Inlet State Park and Archie Carr National Wildlife Refuge.

Sea turtles regularly nest on the beaches south of Sebastian Inlet in Indian River County, where the nesting season extends from March 1 through October 31. The Action Area provides important nesting habitat for sea turtles and the proposed Action has the potential to adversely affect nesting females, nests, and hatchlings within the Action Area. Therefore, the Corps has made the determination that this project "May affect" nesting sea turtles as listed above, per the SPBO. The SPBO indicates that the proposed actions (including the placement of compatible sediment, repair or replacement of groins and jetties, and navigation channel maintenance on the beaches of the Atlantic and Gulf coasts of Florida) have the potential to adversely affect nesting females of these species, their nests, and hatchlings on all nesting beaches where shore protection activities occur.

WEST INDIAN MANATEE: The Corps has evaluated the proposed activities and their potential to affect the West Indian Manatee (Trichechus manatus latirostris). Manatees traverse the inlet when accessing the hardbottom resources south of the inlet for feeding or thermal refuge during winter. Sebastian Inlet State Park personnel report mating herds observed in the shallow bay adjacent to the A1A bridge on the north side of the inlet and manatees feed on the seagrass beds in the western portion of the inlet. Pursuant to review of the "State of Florida Effect Determination Key for the Manatee in Florida" (April 2013), a review of the Manatee key resulted in the following sequential determination: A>B>C>D>E>F>G>N>O>P> may affect, not likely to adversely affect. The applicant agrees to follow the 'Standard Manatee Conditions for In-Water Work (2011)' and provide a dedicated manatee observer during in-water work. It is unclear at this time whether the District will abide by seasonal restrictions with no dredging between November 15 and March 31. Provided compliance with these conditions, it is the Corps' determination that the proposed project "may affect, but is not likely to adversely affect" the West Indian manatee or its critical habitat.

PIPING PLOVER, LEAST TERN & RUFA RED KNOT: The Corps has determined the proposed project is not within critical habitat for the piping plover, least tern, or rufa red knot; however, potential foraging and roosting habitat exists within the Action Area. Since 2013, Ecological Associates, Inc. has conducted formal piping plover surveys in support of the Sebastian Inlet Sand Bypassing Project, with a total of 14 birds observed in the beach fill template south of the inlet (R-3 to R-17). A review of the ebird.org database revealed an additional 5 piping plovers observed over the last 10 years. The District will adhere to the Conservation Measures outlined in the P3BO to minimize impacts to wintering piping plover, least tern, rufa red knot, and their foraging habitat including implementation of surveys for non-breeding shorebirds. Therefore, the Corps has determined the proposed project "may affect, but is not likely to adversely affect" the wintering piping plover, least tern, and rufa red knot through disturbance and

disruption of essential activities such as foraging and roosting caused by the operation of heavy machinery and construction equipment but is not anticipated to jeopardize the continued existence of these species.

EASTERN INDIGO SNAKE: The USFWS has not identified any critical habitat or consultation areas for the eastern indigo snake, however, the presence of gopher tortoise burrows within the Action Area is a key indicator of indigo snake habitat. A gopher tortoise survey of the Sebastian Inlet District Dredge Material Management Area (DMMA), conducted on March 25, 2020, found 59 burrows potentially occupied by gopher tortoises on the outer berm edge. It is possible that indigo snakes inhabit the areas surrounding the DMMA but is not likely to occur inside the berm where sand will be placed. Since the site was built in 2010, there have been no sightings of indigo snakes in the DMMA. Pursuant to review of the "Eastern Indigo Snake Programmatic Effect Determination Key" (July 2017), a review of the key resulted in the following sequential determination: A>B>C>D>E, "may affect, not likely to adversely affect" the eastern indigo snake. Provided compliance with the conditions within the key, the Corps has determined the proposed project "may affect, but is not likely to adversely affect" the West Indian manatee or its critical habitat.

ATLANTIC SALT MARSH SNAKE: The Corps has evaluated the proposed project with regards to its potential effects on Atlantic salt marsh snake (Nerodia clarkii taeniata). The Atlantic salt marsh snake inhabits coastal salt marshes and mangrove swamps. Specifically, it occurs along shallow tidal creeks and pools, in a saline environment ranging from brackish to full strength. It is often associated with fiddler crab burrows. These conditions do not present themselves in the Action Area. In consideration of the location of the project site and the information noted above, the Corps determined the project would have "no effect" on this species.

FLORIDA SCRUB-JAY: The Corps has determined the proposed project will have "no effect" on the Florida Scrub-jay (Aphelocoma coerulescens). The Florida scrub-jay inhabits sand pine and xeric oak scrub, and scrubby flatwoods, which occur in some of the highest and driest areas of Florida – ancient sandy ridges that run down the middle of the state, old sand dunes along the coasts, and sandy deposits along rivers in the interior of the state. These conditions do not present themselves within the action area.

SOUTHEASTERN BEACH MOUSE: The Corps has determined the proposed project will have "no effect" on the southeastern beach mouse (Peromyscus polionotus niveiventris). The population within Sebastian Inlet State Park was extirpated by domestic cats in 1972. Currently, a trapping program has been implemented and there are plans to translocate individuals to the park in the future (USFWS 2019e). Construction activities are not likely to result in any negative effects on the Southeastern beach mouse. Although the species once inhabited the dune system along the sand placement template in Sebastian Inlet State park, it has since been extirpated. There is no current data supporting a determination that any population remains, although a

trapping program has been implemented and there are plans to translocate individuals to the park in the future (USFWS 2019e). In general, sand placement on the beach and associated construction activities occur seaward of the toe of the existing primary dune line and thus, would not impact potential beach mouse habitat.

JOHNSON'S SEAGRASS: Seagrass monitoring is conducted prior to and following each maintenance dredging event of the sand trap and/or navigation channel to fulfill Specific Condition 4c of the FDEP permit No. 0270746-006, which authorizes the deepening of the existing sand trap and the periodic maintenance dredging of the sand trap and Sebastian Inlet using a cutterhead dredge.

The Sebastian Inlet Seagrass Monitoring Program's "2019 Annual Seagrass Monitoring Report" prepared by Atkins concluded the finalized seagrass coverage feature class (post-groundtruthing) yielded ~108.71 acres of seagrass, equivalent to 74.97% of the mitigation zone established in previous Sebastian Inlet Channel Dredge permit, SAJ-2002-7868 (IP). Shoal grass and Johnson's seagrass continue to be the predominant seagrass species; however, manatee grass appears to be returning to the shoal. A separate figure shows the distribution of Johnson's seagrass within the mitigation zone in 2019 and the designated critical habitat areas. Johnson's seagrass (or a species combination including Johnson's seagrass) was present at ~65% of all sites that contained seagrass in 2019, which is more than the 2018 survey (~43% of all sites). Johnson's seagrass has been significant in the recovery of seagrasses on the flood tidal shoal and the stability of the shoal as seagrasses recolonize. From 2018 to 2019, there was an increase in seagrass shoal-wide of ~7.86 acres. Based on the finding of the 2019 Annual Seagrass Monitoring Report, the Corps has determined that the proposed project will have "no effect" on Johnson's seagrass.

WOOD STORK: In Florida, all wood stork rookeries are mapped and monitored by the Florida Fish and Wildlife Conservation Commission (FWC). The proposed Project is within a core foraging area for the wood stork with the nearest colony (No. BC52) located 2.7 miles northwest of the Action Area. During breeding season (October to May), a 1,500-m (0.9-mi) primary "no disturbance zone" surrounding the colony is required until all young have fledged the nest. Additionally, a 2,500-m (1.6-mi) secondary zone is required for foraging and roosting, in which minimal disturbance is allowed. While the Action Area lies within the core foraging area for the BC52 colony, it is outside of both the primary and secondary zones. The Corps has determined pursuant to the "Wood Stork Effect Determination Key" (September 2008), the proposed project will have "no effect" on the species. A review of the key resulted in the following sequential determination: A>B, "no effect".

ENDANGERED SPECIES:
NATIONAL MARINE FISHERIES SERVICE (NMFS): The Corps has determined the proposed project may affect, but is not likely to adversely affect swimming sea turtles; the loggerhead sea turtle (Caretta caretta), Kemp's ridley sea turtle (Lepidochelys

kempii), leatherback sea turtle (Dermochelys coriacea), green sea turtle (Chelonia mydas), hawksbill sea turtle (Eretmochelys imbricata); and also the North Atlantic Right Whale (Eubalaena glacialis).

SWIMMING SEA TURTLES: Swimming sea turtles are likely to utilize the inlet, seagrass beds, and hardbottom reefs within the Action Area. Based on a review of the Section 7 Consultation Biological Opinion (JAXBO), the Project Effects Determinations for Activities Occurring in Florida table indicates that the proposed project "may affect, but is not likely to adversely affect" swimming sea turtles during dredging and shoreline stabilization activities.

NORTH ATLANTIC RIGHT WHALE: Proposed activities "may affect, but are not likely to adversely affect" the North Atlantic right whale. Although sightings are reported offshore of Sebastian Inlet, and a mother-calf pair were observed within the Sebastian Inlet in 2016, they are unlikely to occur in the inlet or nearshore habitats within the Action Area, which is not designated as critical habitat for the species. To avoid potential encounters with whales, the District has agreed to implement the NOAA's Vessel Strike Avoidance Measures. Therefore, the Corps has determined that his project "may affect, but is not likely to adversely affect" the right whale.

ESSENTIAL FISH HABITAT (EFH): This public notice initiates consultation with the National Marine Fisheries Service on EFH as required by the Magnuson-Stevens Fishery Conservation and Management Act 1996. While EFH is identified within the action areas of this project, the proposed activities are a continuance of ongoing maintenance efforts and no expansion beyond the previously permitted efforts is proposed. Similar activities have been a regular occurrence for this inlet and surrounding areas since the inlet was constructed in 1918. The RAR indicated coastal areas below the mean high water line could be utilized by coral including nearshore and inshore hard bottom and worm reefs, shrimp, migratory pelagics, snapper, and grouper throughout various life stages. Indications are that fill placed above the mean high water line would not have a substantial adverse impact on EFH, Habitats of Particular Concern (HAPC), or federally managed fisheries in the South Atlantic. The final determination relative to project impacts and the need for mitigation measures is subject to review by and coordination with the National Marine Fisheries Service.

NEARSHORE AND INSHORE HARD BOTTOM AND WORM REEFS: Post-Construction Nearshore Hardbottom Monitoring Survey was completed in June 2019 (as required by (Florida Department of Environmental Protection [FDEP] Permit No. 0270746-011-JN and United States Army Corp of Engineers [USACE] Permit No. SAJ-1992-01224 [SP-IS])). The study indicated "the nearshore hardbottom biological community was algal dominated; however, non-living sediments composed much of the quadrat percent cover as sediment over hardbottom. Non-living substrates also made up a large amount of the seafloor as >30 cm deep shore parallel sand troughs were evident along most monitoring transects. Red macroalgae and turfs were the most

prevalent algae taxa, with wormrock contributing substantially to the fauna. Wormrock abundance followed similar geographic distribution as in 2018 but was significantly lower in percent cover in 2019. Wormrock, however, is known to exhibit annual fluctuations in recruitment and growth, so this is likely a natural process.

The nearshore hardbottom edge mapping showed that much of the landward edge was intertidally exposed low relief limestone covered by filamentous turf algae. Slightly less intertidally exposed area was mapped in 2019, and the general trend was slightly further from shore than in 2018. This intertidally exposed hardbottom has historically shown cycles of exposure and burial, dependent on storm activity and other natural processes. Flora and fauna along the subtidal sections of the nearshore hardbottom edge were similar to those recorded along the monitoring transects and in previous years, dominated by turf algae and wormrock. Areas with canopy-forming macroalgae were also observed throughout the Project area, and drift macroalgae occasionally piled up inside the landward edge of hardbottom, obscuring the benthos.

The 2019 Immediate Post-construction monitoring results were compared to the 2018 dataset through non-parametric means to assess any potential impacts from the 2019 fill project. The analyses indicated the two years were significantly different based on percent cover data; however, no direct link to sediment impacts in the percent cover dataset were evident and decreases in macroalgal and wormrock percent cover were the main factors driving the significant results. In consideration of the monitoring results, the Corps determination is that the proposed project "may effect, but is not likely to adversely affect" nearshore and inshore hard bottom and worm reefs.

SHRIMP: Pursuant to the Corps' RAR assessment, the Action Area may support EFH for shrimp (Farfantepenaeus spp., Penaeus sp., and/or Litopenaeus spp.). Areas that meet the criteria for essential fish habitat-habitat areas of particular concern (EFH-HAPCs) for penaeid shrimp include all coastal inlets, all state designated nursery habitats of particular importance to shrimp, and state-identified overwintering areas. In consideration of the location of the project site and the work proposed, the Corps determination is that the proposed project "may effect, but is not likely to adversely affect" these species.

SNAPPER/GROUPER: Pursuant to the Corps' RAR assessment, the Action Area may support snapper (Lutjanus spp.) and grouper (Mycteroperca spp. and/or Epinephelus spp.). Areas that meet the criteria for EFH-HAPCs for species in the snapper-grouper management unit include medium to high profile offshore hard bottoms where spawning normally occurs; localities of known or likely periodic spawning aggregations; nearshore hard bottom areas; mangrove habitat; seagrass habitat; oyster/shell habitat; all coastal inlets; all state-designated nursery habitats of particular importance to snapper grouper; and Council-designated Artificial Reef Special Management Zones. In consideration of the location of the project site and the work proposed, the Corps determination is that the proposed project "may effect, but is not likely to adversely affect" these species.

NOTE: This public notice is being issued based on information furnished by the applicant. This information has not been verified or evaluated to ensure compliance with laws and regulation governing the regulatory program. The Corps has verified the extent of Federal jurisdiction.

AUTHORIZATION FROM OTHER AGENCIES: Water Quality Certification may be required from the Florida Department of Environmental Protection and/or one of the state Water Management Districts.

COMMENTS regarding the potential authorization of the work proposed should be submitted in writing to the attention of the District Engineer through the Cocoa Permits Section, 400 High Point Drive, Cocoa, Florida 32926 within 21 days from the date of this notice.

The decision whether to issue or deny this permit application will be based on the information received from this public notice and the evaluation of the probable impact to the associated wetlands and waters. This is based on an analysis of the applicant's avoidance and minimization efforts for the project, as well as the compensatory mitigation proposed.

QUESTIONS concerning this application should be directed to the project manager, John Baehre, in writing at the Cocoa Permits Section, 400 High Point Drive, Cocoa, Florida 32926, by electronic mail at John.M.Baehre@usace.army.mil or by telephone at (321)504-3771 extension 13.

IMPACT ON NATURAL RESOURCES: Preliminary review of this application indicates that an Environmental Impact Statement will not be required. Coordination with U.S. Fish and Wildlife Service, Environmental Protection Agency (EPA), the National Marine Fisheries Services, and other Federal, State, and local agencies, environmental groups, and concerned citizens generally yields pertinent environmental information that is instrumental in determining the impact the proposed action will have on the natural resources of the area. By means of this notice, we are soliciting comments on the potential effects of the project on threatened or endangered species or their habitat.

EVALUATION: The decision whether to issue a permit will be based on an evaluation of the probable impact including cumulative impacts of the proposed activity on the public interest. That decision will reflect the national concern for both protection and utilization of important resources. The benefits, which reasonably may be expected to accrue from the proposal, must be balanced against its reasonably foreseeable detriments. All factors which may be relevant to the proposal will be considered including cumulative impacts thereof; among these are conservation, economics, esthetics, general environmental concerns, wetlands, historical properties, fish and wildlife values, flood hazards, floodplain values, land use, navigation, shoreline erosion and accretion,

recreation, water supply and conservation, water quality, energy needs, safety, food, and fiber production, mineral needs, considerations of property ownership, and in general, the needs and welfare of the people. Evaluation of the impact of the activity on the public interest will also include application of the guidelines promulgated by the Administrator, EPA, under authority of Section 404(b) of the Clean Water Act of the criteria established under authority of Section 102(a) of the Marine Protection Research and Sanctuaries Act of 1972. A permit will be granted unless its issuance is found to be contrary to the public interest.

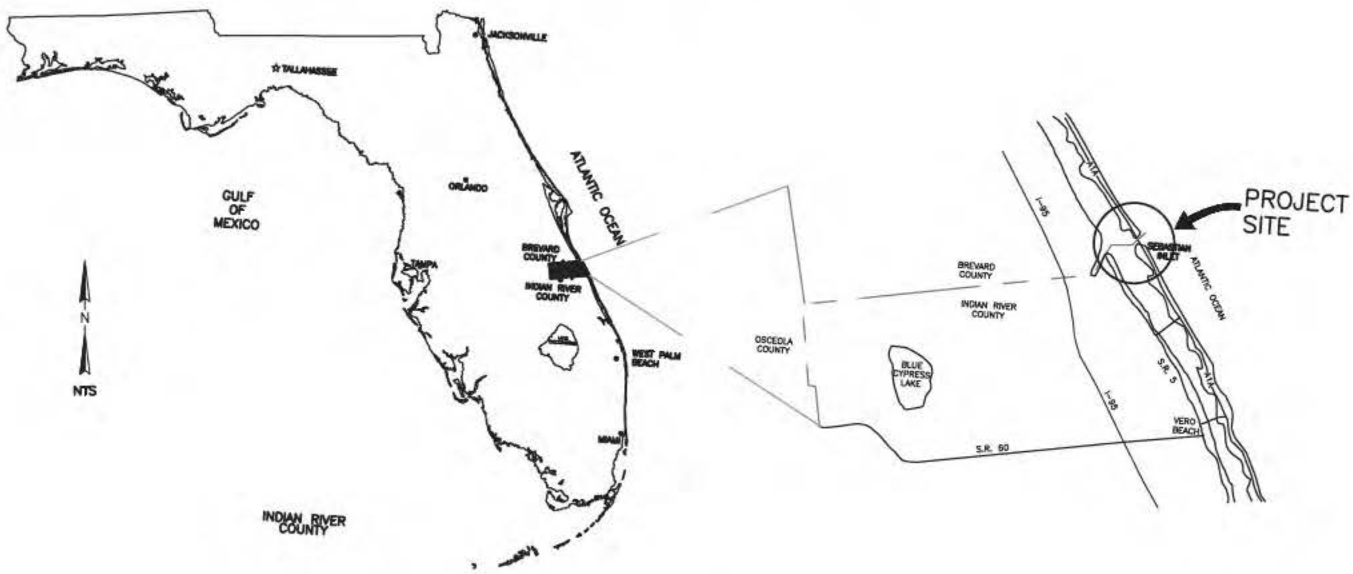
The US Army Corps of Engineers (Corps) is soliciting comments from the public; Federal, State, and local agencies and officials; Indian Tribes; and other Interested parties in order to consider and evaluate the impacts of this proposed activity. Any comments received will be considered by the Corps to determine whether to issue, modify, condition, or deny a permit for this proposal. To make this decision, comments are used to assess impacts on endangered species, historic properties, water quality, general environmental effects, and the other public interest factors listed above. Comments are used in the preparation of an Environmental Assessment and/or an Environmental Impact Statement pursuant to the National Environmental Policy Act comments are also used to determine the need for a public hearing and to determine the overall public interest of the proposed activity.

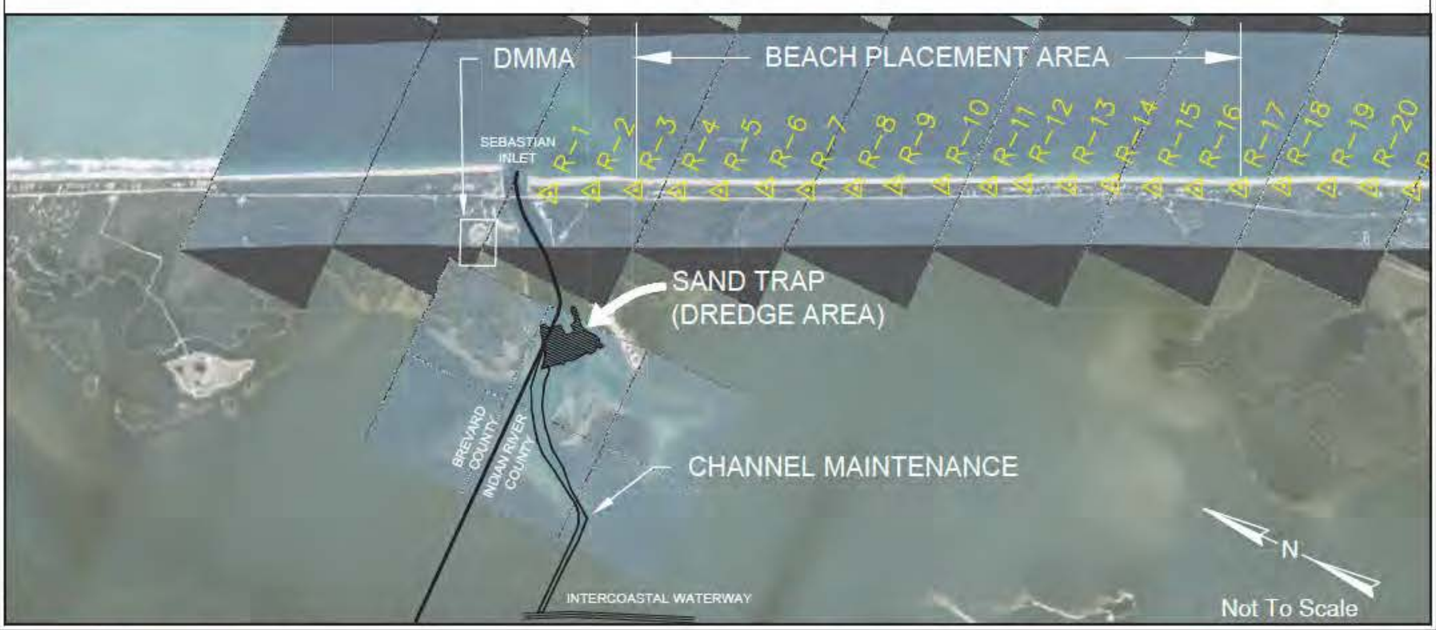
COASTAL ZONE MANAGEMENT CONSISTENCY: In Florida, the State approval constitutes compliance with the approved Coastal Zone Management Plan. In Puerto Rico, a Coastal Zone Management Consistency Concurrence is required from the Puerto Rico Planning Board, in the Virgin Islands, the Department of Planning and Natural Resources permit constitutes compliance with the Coastal Zone Management Plan.

REQUEST FOR PUBLIC HEARING: Any person may request a public hearing. The request must be submitted in writing to the District Engineer within the designated comment period of the notice and must state the specific reasons for requesting the public hearing.

Sebastian Inlet Sand Trap Bypassing and Channel Maintenance

USACE PERMIT SKETCHES





ATM 2047 Vista Parkway, Suite 101 West Palm Beach, FL 33411 (561) 659-0041 Certificate of Authorization #4669	Cover/Location Map	SHEET 1 JOB NUMBER: 20-3481	
	Sebastian Inlet Sand Trap Dredging and Channel Maintenance	ISSUE DATE: 06-26-2020 FOR PERMITTING PURPOSES ONLY NOT FOR CONSTRUCTION	Peter N. Seidle Professional Engineer Florida License Number: 59493

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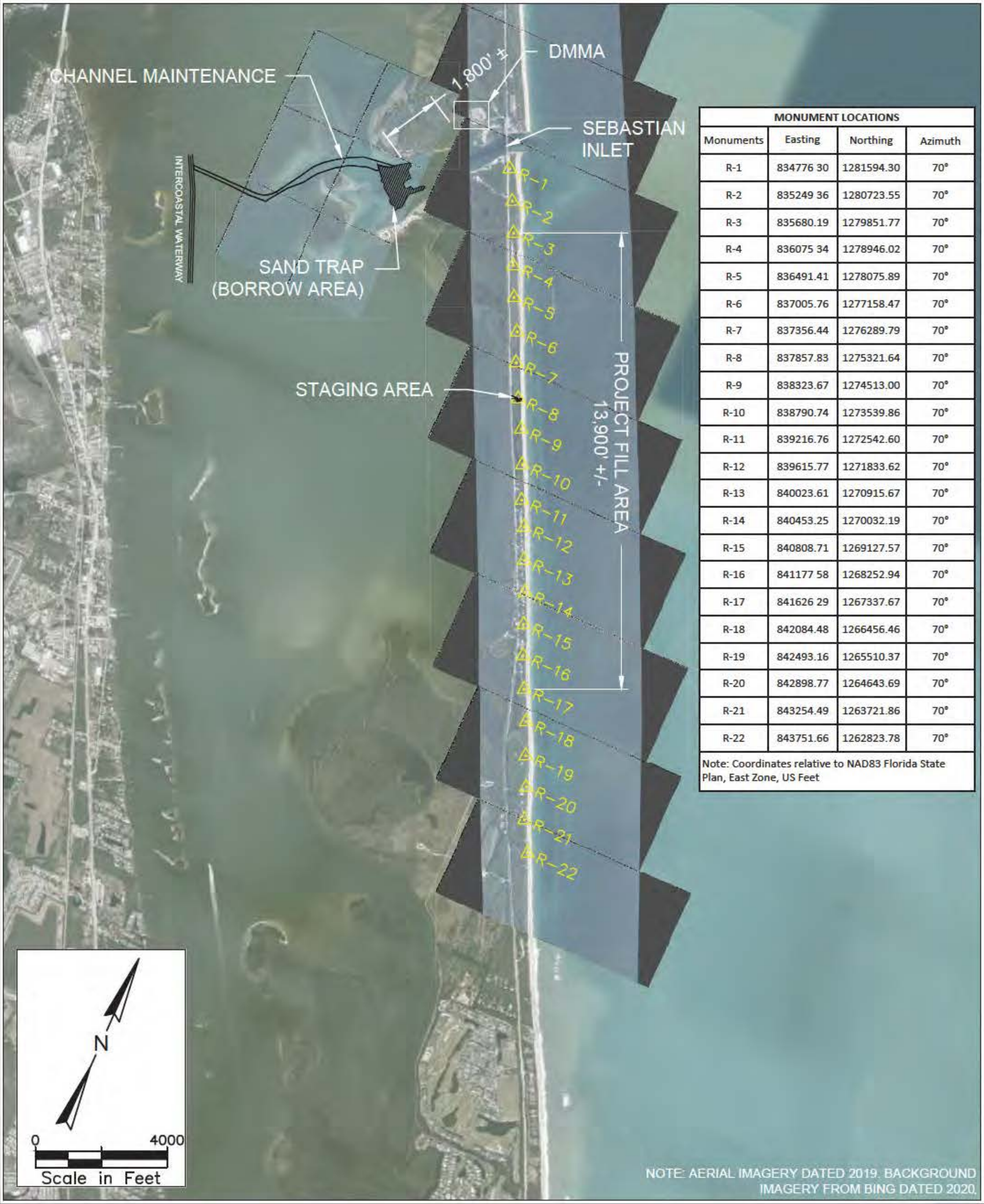


MONUMENT LOCATIONS			
Monuments	Easting	Northing	Azimuth
R-1	834776 30	1281594.30	70°
R-2	835249 36	1280723.55	70°
R-3	835680.19	1279851.77	70°
R-4	836075 34	1278946.02	70°
R-5	836491.41	1278075.89	70°
R-6	837005.76	1277158.47	70°
R-7	837356.44	1276289.79	70°
R-8	837857.83	1275321.64	70°
R-9	838323.67	1274513.00	70°
R-10	838790.74	1273539.86	70°
R-11	839216.76	1272542.60	70°
R-12	839615.77	1271833.62	70°
R-13	840023.61	1270915.67	70°
R-14	840453.25	1270032.19	70°
R-15	840808.71	1269127.57	70°
R-16	841177 58	1268252.94	70°
R-17	841626 29	1267337.67	70°
R-18	842084.48	1266456.46	70°
R-19	842493.16	1265510.37	70°
R-20	842898.77	1264643.69	70°
R-21	843254.49	1263721.86	70°
R-22	843751.66	1262823.78	70°

Note: Coordinates relative to NAD83 Florida State Plan, East Zone, US Feet

ATM
2047 Vista Parkway, Suite 101
West Palm Beach, FL 33411
(561) 659-0041
Certificate of Authorization #4669

Project Area

Sebastian Inlet
Sand Trap Dredging and Channel Maintenance

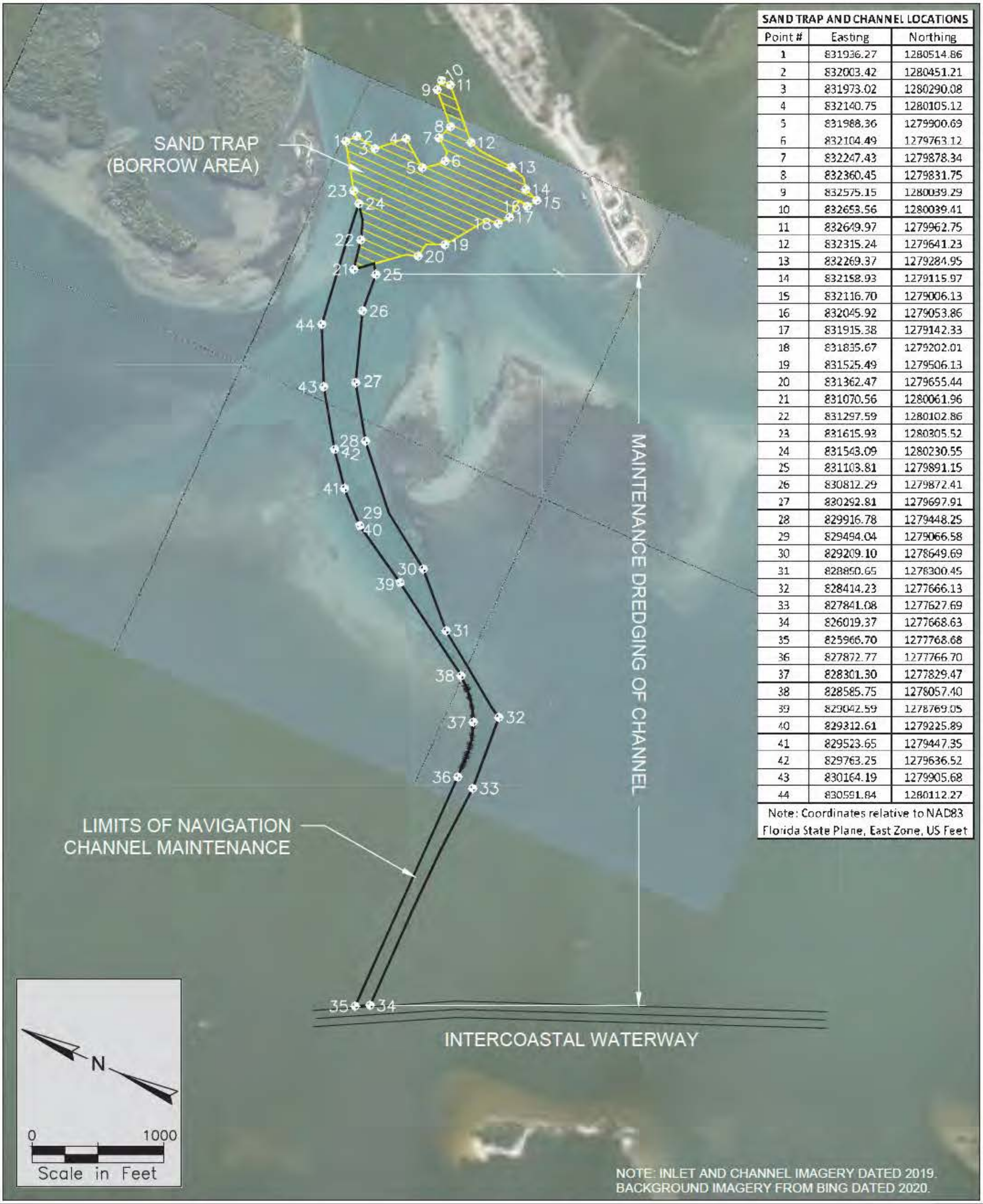
SHEET 2

JOB NUMBER: 20-3481

ISSUE DATE: 06-26-2020

FOR PERMITTING PURPOSES ONLY
NOT FOR CONSTRUCTION

Peter N. Seidle
Professional Engineer
Florida License Number: 59493



SAND TRAP AND CHANNEL LOCATIONS

Point #	Easting	Northing
1	831936.27	1280514.86
2	832003.42	1280451.21
3	831973.02	1280290.08
4	832140.75	1280105.12
5	831988.36	1279900.69
6	832104.49	1279763.12
7	832247.43	1279878.34
8	832360.45	1279831.75
9	832575.15	1280039.29
10	832653.56	1280039.41
11	832649.97	1279962.75
12	832315.24	1279641.23
13	832269.37	1279284.95
14	832158.93	1279115.97
15	832116.70	1279006.13
16	832045.92	1279053.86
17	831915.38	1279142.33
18	831835.67	1279202.01
19	831525.49	1279506.13
20	831362.47	1279655.44
21	831070.56	1280061.96
22	831297.59	1280102.86
23	831615.93	1280305.52
24	831543.09	1280230.55
25	831103.81	1279891.15
26	830812.29	1279872.41
27	830292.81	1279697.91
28	829916.78	1279448.25
29	829494.04	1279066.58
30	829209.10	1278649.69
31	828850.65	1278300.45
32	828414.23	1277666.13
33	827841.08	1277627.69
34	826019.37	1277668.63
35	825966.70	1277768.68
36	827872.77	1277766.70
37	828301.30	1277829.47
38	828585.75	1278057.40
39	829042.59	1278769.05
40	829312.61	1279225.89
41	829523.65	1279447.35
42	829763.25	1279636.52
43	830164.19	1279905.68
44	830591.84	1280112.27

Note: Coordinates relative to NAD83 Florida State Plane, East Zone, US Feet

ZACKERY.VALERIO LOCATION: G:\WESTPALMBEACH SHARES\DRAWINGS\PROJECTS\20-3481 SID PLANS\X\FED. PERMIT\3 CHANNEL MAP.DWG

ATM
2047 Vista Parkway, Suite 101
West Palm Beach, FL 33411
(561) 659-0041
Certificate of Authorization #4669

Sand Trap/Channel Location

Sebastian Inlet
Sand Trap Dredging and Channel Maintenance

SHEET 3

JOB NUMBER: 20-3481

ISSUE DATE: 06-26-2020

FOR PERMITTING PURPOSES ONLY
NOT FOR CONSTRUCTION

Peter N. Seidle
Professional Engineer
Florida License Number: 59493

ATKINS

Sebastian Inlet Seagrass Monitoring Program

2019 Annual Seagrass Monitoring Report

November 2019

Prepared for: Sebastian Inlet District
114 Sixth Avenue
Indialantic, FL 32903

Table of contents

Tables

Figures

1. Introduction

In August 2007 the Sebastian Inlet District (SID) completed the construction of a navigation channel connecting Sebastian Inlet from Channel Markers No.18 and 19 westward to the Intracoastal Waterway (ICW). The purpose of this 3,120-ft long, 10.7-acre (5:1 side slope; -9 ft NGVD) channel extension was to provide the growing maritime community with a safe, clearly designated passage to/from the Atlantic Ocean as a matter of public safety and for the future protection of associated aquatic resources. To offset impacts to 3.08 acres of seagrass habitat and 7.62 acres of non-vegetated soft bottom, and pursuant with the U.S. Army Corps of Engineers (USACE) and the Florida Department of Environmental Protection (FDEP) permits SAJ-2002-7868 (IP-TSD) and 05-264486-001, issued March of 2007, the permittee, the SID, provided the following over the course of a five-year (2008-2012) seagrass mitigation and monitoring program:

1) The recovery of 459 seagrass planting units (179 *Halodule wrightii*; 279 *Syringodium filiforme*; 1 *Halophila johnsonii*) from the proposed channel alignment and subsequent planting of 41 propeller scars (hereafter, “prop scars”), filling an estimated 366.95 m of linear damage.

2) The balance of financial support needed to install the Indian River County Main Relief Canal Pollution Control Structure, estimated at $750,000.00. The structure came online in July 2008.

3) The establishment and/or monitoring of the St. Johns River Water Management District (SJRWMD) fixed seagrass transect No. 51, plus 9 additional transects in the vicinity of the Main Relief Canal Outfall (Vero Beach, Florida). The monitoring protocol and periodicity followed those previously established and utilized by the SJRWMD. Three baseline monitoring events and eight post-activation monitoring events occurred from May 2007- August 2012.

4) The placement of “*Caution, Shallow Water, Seagrass Area*” signs clearly delineating 145 acres of the flood tidal shoal as seagrass habitat, protecting an initially estimated 110.26 acres (2007) of mixed meadow seagrasses. Current (2019) estimates place this area of live seagrass habitat at 108.71 acres.

5) The quantification of seagrass coverage within the six designated protected areas (“A” thru “F”) using low-level, high resolution, digital orthophotography.

6) A complete inventory and tracking of annual changes to anthropogenic damage within the protected areas.

7) The successful deployment of 2,031 Sediment Tubes® into 32 previously identified propeller-related scars, including 22 significant “blow-out” features. Work was conducted in partnership with Seagrass Recovery, Inc.

The five-year monitoring program associated with the Sebastian Inlet navigation channel was completed in 2012. However, the SID completed the Sebastian Inlet channel realignment project (FDEP Permit No. 05-264486-005-EM) from May 2012 to July 2012, which corrected the severe angle of the channel west of the shoal by widening the turn. The widening resulted in additional seagrass impacts which were included in the available mitigation from the original channel construction project. The widening project resulted in the continuation of an abbreviated version of the seagrass monitoring program. As part of this abbreviated monitoring program, the SID continued to quantify seagrass coverage (#5 above) and inventory and tracked anthropogenic damage (#6 above) within the protected areas on the flood tidal shoal over a period of three years (terminating in 2015). The SID contracted Atkins to continue the abbreviated seagrass monitoring program in 2016, 2017, 2018, and 2019 with a focus on the quantification of seagrass coverage within the protected areas of the flood tidal shoal.

The SID is authorized to periodically maintenance dredge the channel and sand trap (FDEP Permit No. 02-70746-006-JC). Specific Condition 4c of that permit requires seagrass surveys along specific transects prior to and following each maintenance dredging event of the sand trap and/or the navigational channel. Atkins was contracted to perform the pre-dredging seagrass survey in the summer of 2018 in anticipation of the dredging of the sand trap and channel in early 2019 and the post-dredging seagrass survey in the summer of 2019. The pre- and post-dredging seagrass surveys were performed in accordance with the Seagrass Monitoring Plan approved December 16, 2014 (ATM 2014, Appendix A). Dredging was conducted between January 21 and June 7, 2019.

2. Aerial Image Analysis

2.1. Objectives

To assess changes in the submerged aquatic resources within the protected areas or mitigation zone, a Geographic Information System (GIS)-based approach using low-level, digital aerial photography was implemented in June 2007 and has continued annually thereafter. The 2019 aerial image analysis had five primary objectives:

1) To quantify the aerial extent of existing seagrasses within the mitigation zone (*see Section 2.3.1*),
2) To assess changes to the spatial distribution and aerial extent of seagrass (*see Section 2.3.2*),
3) To identify visible anthropogenic impacts (i.e., prop scarring) within the mitigation zone (*see Section 3.2*), and
4) To field verify (hereafter referred to as “groundtruthing”) the validity of observations made remotely (i.e., by analyzing the aerials) (*see Section 3.2*).

2.2. Methods

GPI Geospatial, Inc. (previously Aerial Cartographics of America, Inc.) was selected to supply low-altitude, high-resolution, color imagery for the 500-acre region of the shoal. Aerial imagery was captured on June 13, 2019 during an incoming tide. The resultant digital imagery was georectified and had an effective ground pixel resolution of 0.25 feet (Figure 2-1).

To estimate seagrass coverage within the mitigation zone, the 2019 aerial photographs were assessed for the presence or absence of perceived seagrasses (i.e., features that appeared to be seagrasses) using the Environmental Systems Research Institute (ESRI) ArcGIS software, ArcMap 10.5.1 and recorded manually as a polygonal feature class. All GIS analyses were conducted using source data projected in the State Plane system for East Florida:

Projected Coordinate System: NAD_1983_HARN_StatePlane_Florida_East_FIPS_0901_Feet
Projection: Transverse_Mercator
False_Easting: 656166.66666667
False_Northing: 0.00000000
Central_Meridian: -81.00000000
Scale_Factor: 0.99994118
Latitude_Of_Origin: 24.33333333
Linear Unit: Foot_US

Geographic Coordinate System: GCS_North_American_1983_HARN
Datum: D_North_American_1983_HARN
Prime Meridian: Greenwich
Angular Unit: Degree

Generally, the distinction between seagrass and the surrounding habitat was made while viewing the photography at an absolute resolution of 1:400 to 1:500. In most cases, water depth and clarity provided a seemingly clear view of the benthos (bottom flora), with little ambiguity regarding bed boundaries. However, during systematic sweeps of the image, several locations were unidentifiable or visually skewed by wave activity, turbidity, color, density (salinity) discontinuity layers, and/or artifacts of image manipulation made during production. These locations, and all positions of uncertainty, were carefully recorded on a separate point feature class (N=147) or polyline feature class (N=3) and visited during the field verification or “groundtruthing” exercise (*see Section 3 Groundtruthing below*).

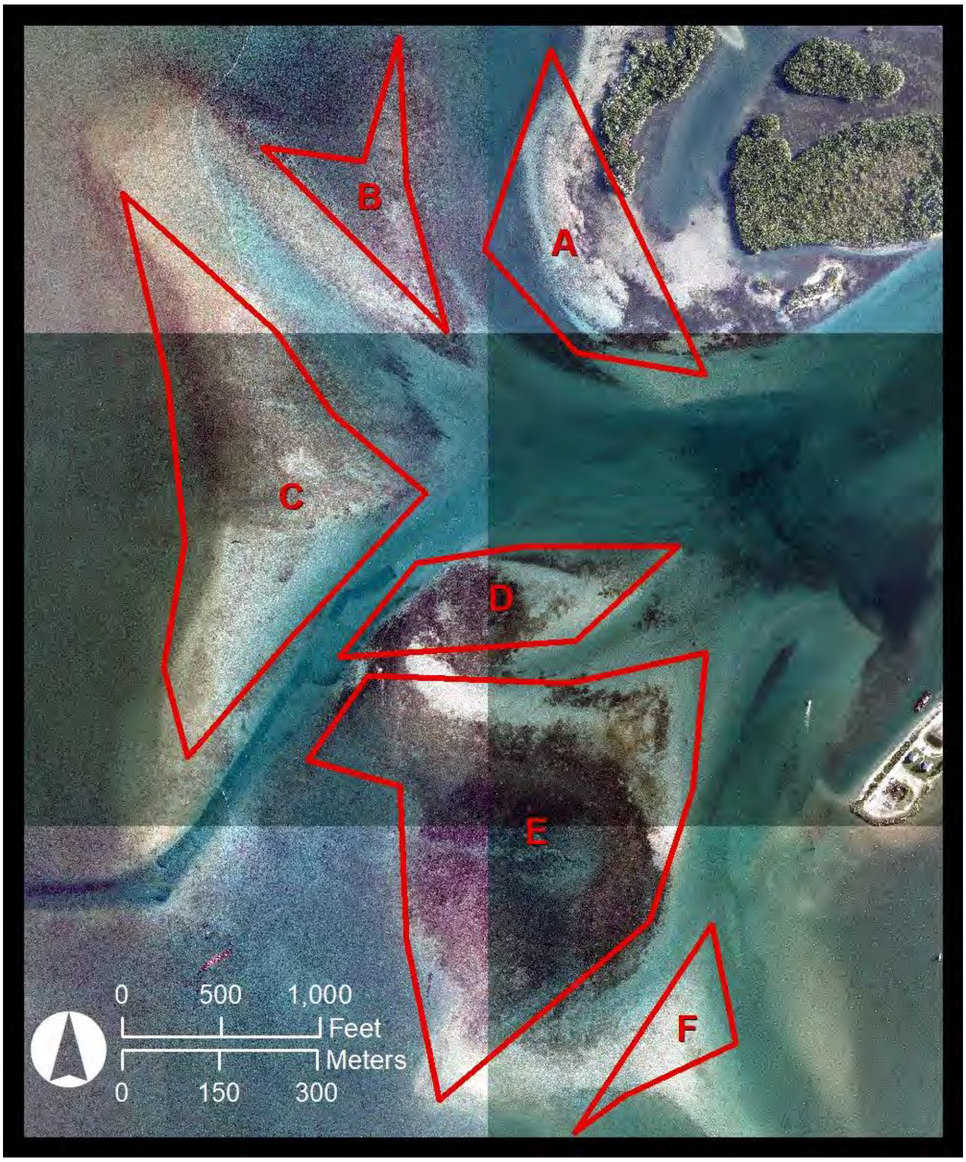


Figure 2-1 **Aerial imagery of Sebastian Inlet flood tidal shoal (Florida). The image was taken on June 13, 2019 by GPI Geospatial, Inc. for the Sebastian Inlet District.**

2.3. Results

2.3.1. 2019 Seagrass Coverage

The finalized seagrass coverage feature class (post-groundtruthing) yielded ~108.71 acres of seagrass in 2019, equivalent to 74.97% of the mitigation zone (Figure 2-2). Zone-specific seagrass acreage estimates ranged from 3.95 acres (Zone F) to 48.07 acres (Zone E) with percent cover values (i.e., the percentage of the zone area covered by seagrass) from 33.48% (Zone A) to 98.65% (Zone B). A complete listing of 2019 zone values can be found in the inset table of Figure 2-2.

Zone	SAV Acreage	Zone Acreage	%SAV
Total	108.71	145.01	74.97%
A	6.26	18.7	33.48%
B	8.02	8.13	98.65%
C	33.85	41	82.56%
D	8.56	13.66	62.66%
E	48.07	57.73	83.27%
F	3.95	5.79	68.22%

Figure 2-2 ESRI feature class depicting the estimated extent of seagrass within the mitigation zone in 2019. The associated table summarizes area and percent coverage of seagrass by zone. Aerial image taken June 13, 2019.

2.3.2. Change Analysis

To estimate changes in the distribution of seagrass within the flood tidal shoal, finalized seagrass coverage feature classes were compared between 2018 and 2019 for regions of "Gain" and "Loss." ESRI ArcGIS 10.5.1 was used to cut the areas of non-overlap from alternating comparisons of the two datasets, leaving a remaining portion as a static region of "No Change." A visual depiction of these changes can be seen in Figure 2-3.

Figure 2-3 Spatial distribution of inter-year change in seagrass coverage within the mitigation boundaries. Gains are depicted as - green, losses - red, and areas consistent between years - gray. Analysis included 2018 and 2019 data.

From 2018 to 2019, there was an increase in seagrass shoal-wide of ~7.86 acres. Net values for each zone ranged from -0.16 acres (Zone E) to 5.43 acres (Zone C) (Figure 2-4). With the exception of a slight loss in seagrass coverage in Zone E, all other zones exhibited increases in seagrass coverage ranging from 0.21 acres (Zone A) to 5.43 acres (Zone C). Zones E and F respectively had the highest and lowest total acreage of seagrass in both 2018 and 2019; however, this is unsurprising as these are respectively the largest and smallest shoals. In terms of percent coverage of the zone occupied by seagrass, Zone E had the highest coverage in 2018 but was surpassed by Zone B in 2019, while Zone A had the lowest coverage in both years. Zone A has experienced erosion of sediment along the southwest facing edge since 2012 preventing seagrass reestablishment in the deeper, eroded areas.

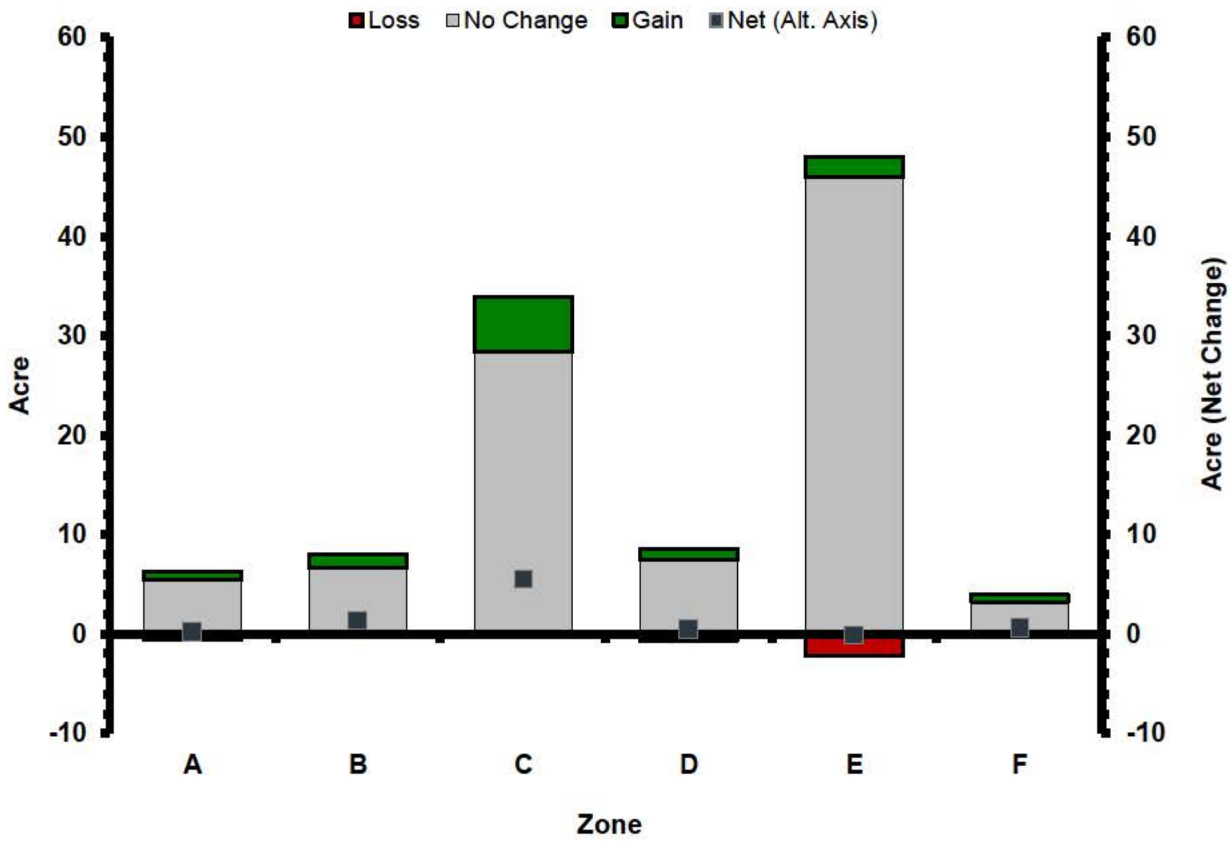


Figure 2-4 **Zone-specific changes in seagrass cover (acres) between 2018 and 2019. Net change in total acreage depicted on alternate axis.**

3. Groundtruthing/Field Verification

3.1. Objectives

Any attempt to characterize benthic composition from high-resolution aerial imagery presents a suite of technical challenges, including changing optical properties of water with depth and water density, variations in water constituents across the spatial extent of an image (e.g., tannins), reflections caused by an imperfect water surface, and shadows from taller features. These issues were exacerbated at the Inlet by the confluence of two distinctly different water bodies (i.e., sometimes lower salinity, tannin-rich lagoonal water and more saline, comparatively clearer, but at times sand/silt containing, nearshore Atlantic Ocean water), creating a heterogeneous mixture of optical properties over a range of depths. The darker tannin-rich water is evident in Figure 2-1 west of Zone C and northwest of Zone B.

Methodological errors are confounded by lag time between the aerial flight and actual physical groundtruthing (time needed to produce and review the aerials before fieldwork can be performed). During the 2019 monitoring event, official groundtruthing efforts commenced July 29, 2019, which was 46 days post-flight (aerial imagery collected June 13, 2019). The sampling of the shoal was successfully accomplished using the results of the aerial image analyses and guided by a Trimble R1 handheld DGPS unit, interfacing with a Samsung Galaxy S3 handheld tablet running ESRI Collector (hereafter referred to as ESRI Collector).

The objectives of the 2019 groundtruthing event were to:

1) Confirm potential anthropogenic damage (e.g. prop scarring) to the shoal,

2) Field-verify points or lines (i.e., groundtruthing transects) of uncertainty encountered during the aerial image analyses,

3) Refine the original seagrass coverage GIS dataset using *in situ* mapping and field annotation, and

4) Obtain adjacent seagrass species data for each position visited.

3.2. Methods and Results

To estimate the quantity of anthropogenic impact within the mitigation zone in 2019, biologists systematically examined the 2019 aerial photography at an absolute resolution of 1:400 to 1:500 for the presence of linear and otherwise un-natural features on the shoal (i.e., prop scars). The potential prop scars digitized from the aerial imagery were uploaded to ESRI Collector which was used for data collection and navigation purposes during the groundtruthing effort (Figure 3-1).

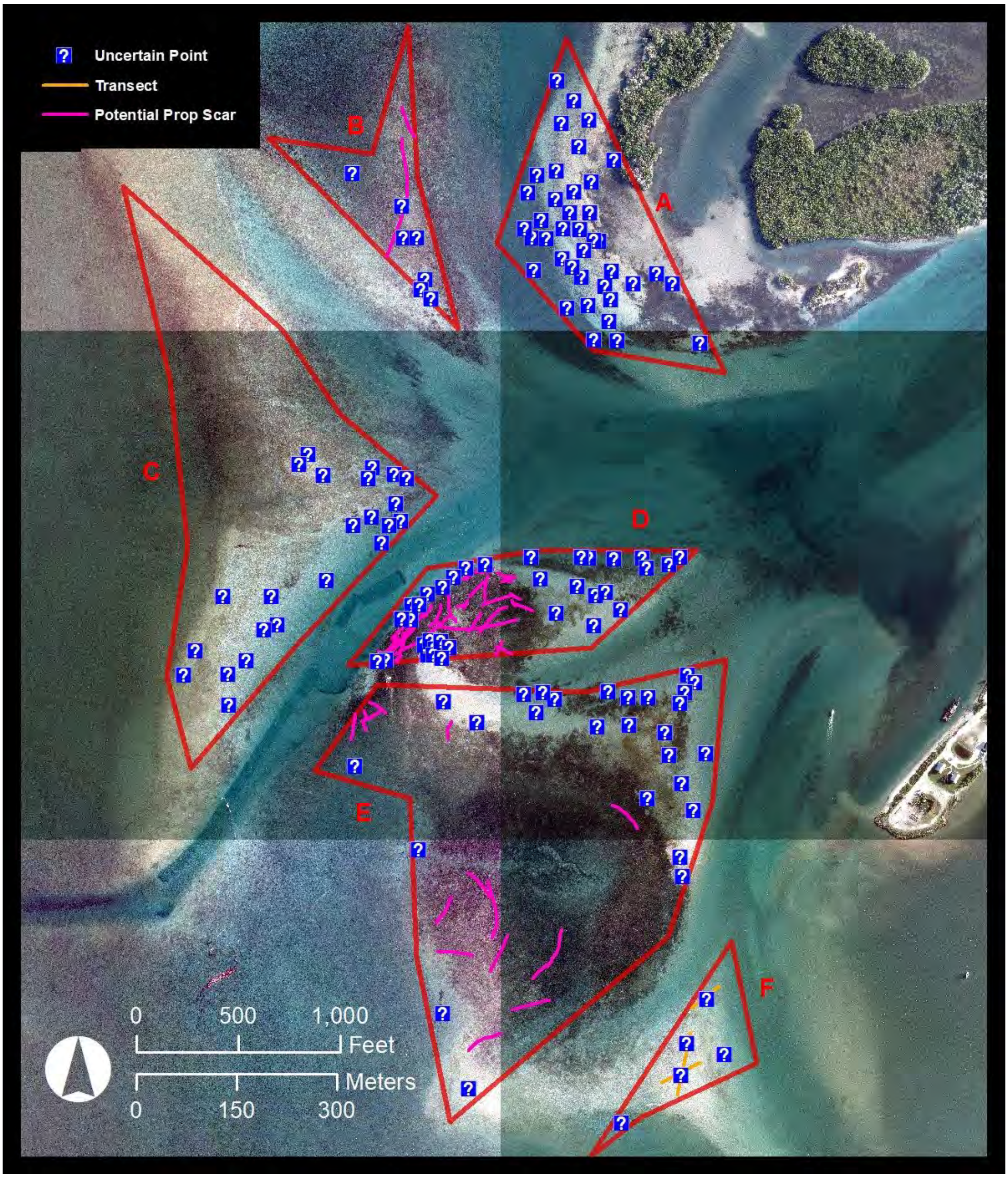


Figure 3-1 Location of potential prop scars, points of uncertainty, and groundtruthing transects visited during the 2019 groundtruthing event. Aerial image taken June 13, 2019.

During the July 29-30, 2019 groundtruthing effort, biologists used ESRI Collector to visit the potential prop scar locations identified in the June 13, 2019 aerial image, assessing them for validity. Thirty-four prop scars were field verified from the aerial imagery (Figure 3-2 and 3-4). The majority prop scars occur in Zone D and generally represent attempts by boaters to deviate from the channel in transit to or from the inlet or enter the popular anchoring area between Zones D and E.

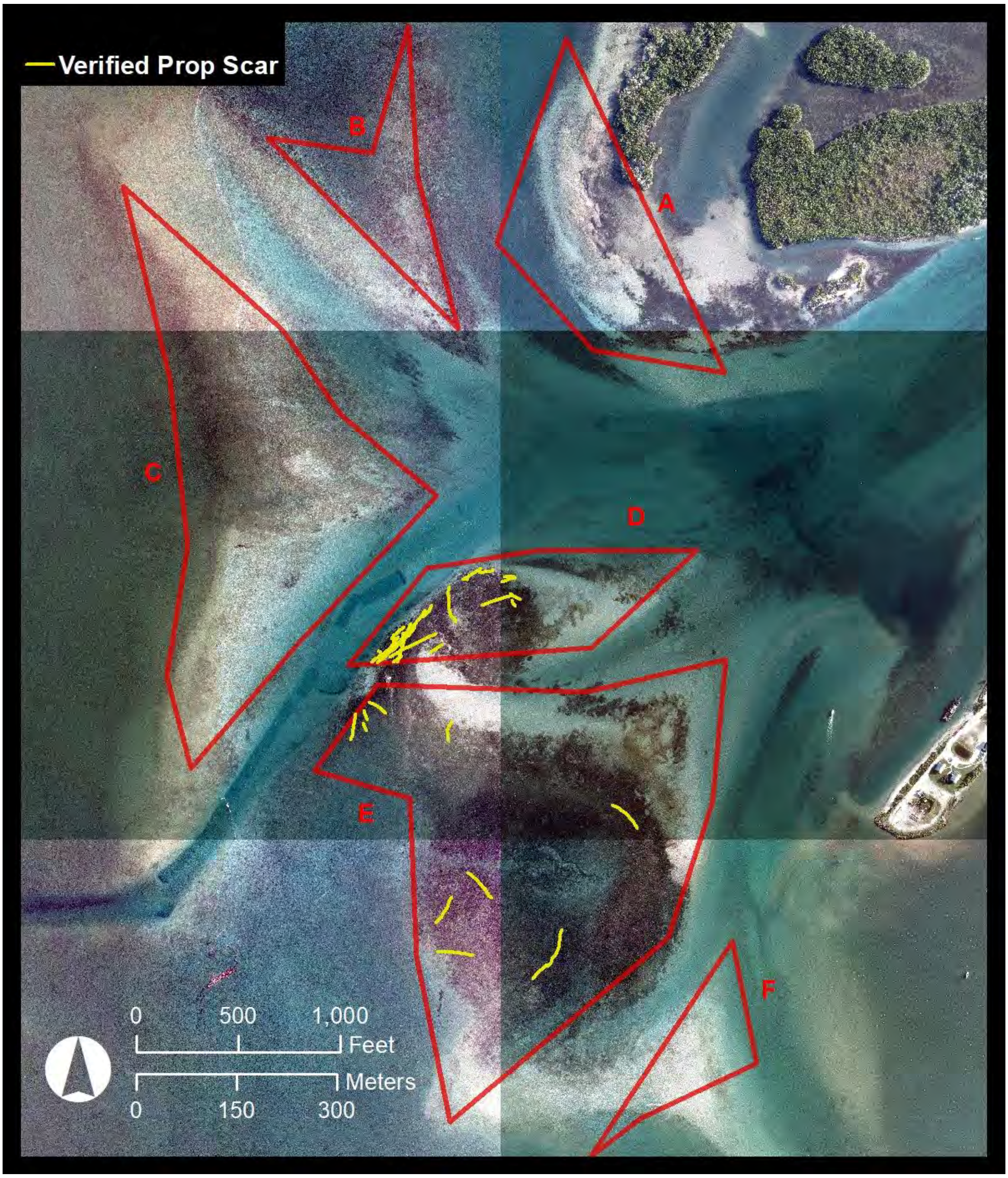


Figure 3-2 Locations of prop scars verified during the 2019 groundtruthing event.

Points of uncertainty (N=147) were also identified during the 2019 aerial image analysis and generally consisted of darkened (or lightened) areas inconsistent with the color signal of adjacent seagrasses, or other spectral anomalies potentially related to changes in seagrass density within contiguous beds, discontinuous epiphytic or drift algal loads, or differences in underlying substrata (Figure 3-1). Similar to the potential prop scar locations, these points of uncertainty were uploaded to ESRI Collector, which was used for data collection and navigation purposes. Physical confirmation of seagrass presence or absence at each of these sites consisted of a haphazard swim, resulting in a broad assessment of bottom type, as well as seagrass species identification (where applicable). The point feature class was then appended on site and used for later refinement of the bed boundaries within the seagrass coverage GIS dataset.

Groundtruthing transects were also identified during the aerial image analysis (Figure 3-1). A total of 3 transects occurred in Zone F where apparent barren areas were present. These groundtruthing transects were uploaded to ESRI Collector. Biologists visited each transect and performed a broad assessment of the bottom type including seagrass species identification (where applicable). The polyline feature class was then appended on site. In certain instances, point data were also collected along the transects to signal a change in benthic composition (e.g., seagrass presence/absence or seagrass species observed).

Additional field annotation regarding seagrass presence/absence was recorded in transit between uncertain points/groundtruthing transects. Using ESRI Collector, biologists were able to confirm in real-time the accuracy of the seagrass coverage data and/or collect new seagrass data that were not observed during the aerial image analysis. In these instances, using ESRI Collector, biologists collected data around the boundaries of seagrass patches. Point, line, and polygon data were used for refinement of the seagrass bed boundaries within the seagrass coverage GIS dataset. The finalized 2019 seagrass GIS dataset can be seen in Figure 2-2 and was used in all acreage calculations reported within this document.

All positions identified during the image analysis, as well as additional seagrass data collected during the groundtruthing event, were sampled for benthic composition (N=201 positions). Approximately 68% of these positions (N=137) contained seagrass species (Figure 3-3). The remaining ~32% consisted of shell material (Figure 3-4) with algae, sand, worm tubes, macroalgae (*Caulerpa* sp., see photo in Figure 3-4), and in one case a large blowout. Figure 3-3 depicts the locations of seagrass species/species combinations observed on the shoal in 2019. Species-specific data revealed that ~47% of the sites that contained seagrass were monospecific patches of seagrass, including *Halodule wrightii* (22%), *Halophila johnsonii* (18%), and *Syringodium filiforme* (7%). The remaining ~53% consisted of species combinations, including *H. wrightii/H. johnsonii* (the predominant species combination at 44%), *S. filiforme/H. wrightii* (7%), *S. filiforme/H. wrightii/H. johnsonii* (3%), and *H. wrightii/S. filiforme/H. johnsonii/H. decipiens/H. engelmannii* (1%) (see Figure 3-5 photographs of seagrass species observed).

Differences were observed when comparing predominant seagrass species/species combinations on the flood tidal shoal over time. In the past (2008-2011), the flood tidal shoal was predominately *Syringodium filiforme, Halodule wrightii,* and combinations of the two species (Figure 3-6). *Halophila johnsonii* was only observed at a small percentage of locations. In 2012 and 2013 (beginning of seagrass recovery after region-wide seagrass loss), the dominant seagrass species on the flood tidal shoal were *H. johnsonii, H. wrightii,* and combinations of the two species (Figure 3-6). In 2014-2019, *H. wrightii* and *H. johnsonii* continue to be the predominant seagrass species; however, *S. filiforme* appears to be returning to the shoal (Figure 3-6).

According to the Endangered Species Act (ESA), *Halophila johnsonii* is listed as a threatened species (listed on September 14, 1998) throughout the range of the species from central Biscayne Bay to Sebastian Inlet. The ESA requires the federal government to designate “critical habitat” for any listed species. The designation provides explicit notice to federal agencies and the public that these areas are vital to the conservation of the species. Critical habitat for *H. johnsonii* was established on April 5, 2000 and includes ten locations between Sebastian Inlet and Biscayne Bay. Because areas located north and south of the Sebastian Inlet channel are considered *H. johnsonii* critical habitat, a separate figure was created, clearly showing the distribution of *H. johnsonii* within the mitigation zone in 2019 and the designated critical habitat areas (Figure 3-7). *H. johnsonii* (or a species combination including *H. johnsonii*) was present at ~65% of all sites that contained seagrass in 2019, which is more than the 2018 survey (~43% of all sites). *H. johnsonii* has been significant in the recovery of seagrasses on the flood tidal shoal and the stability of the shoal as seagrasses recolonize.

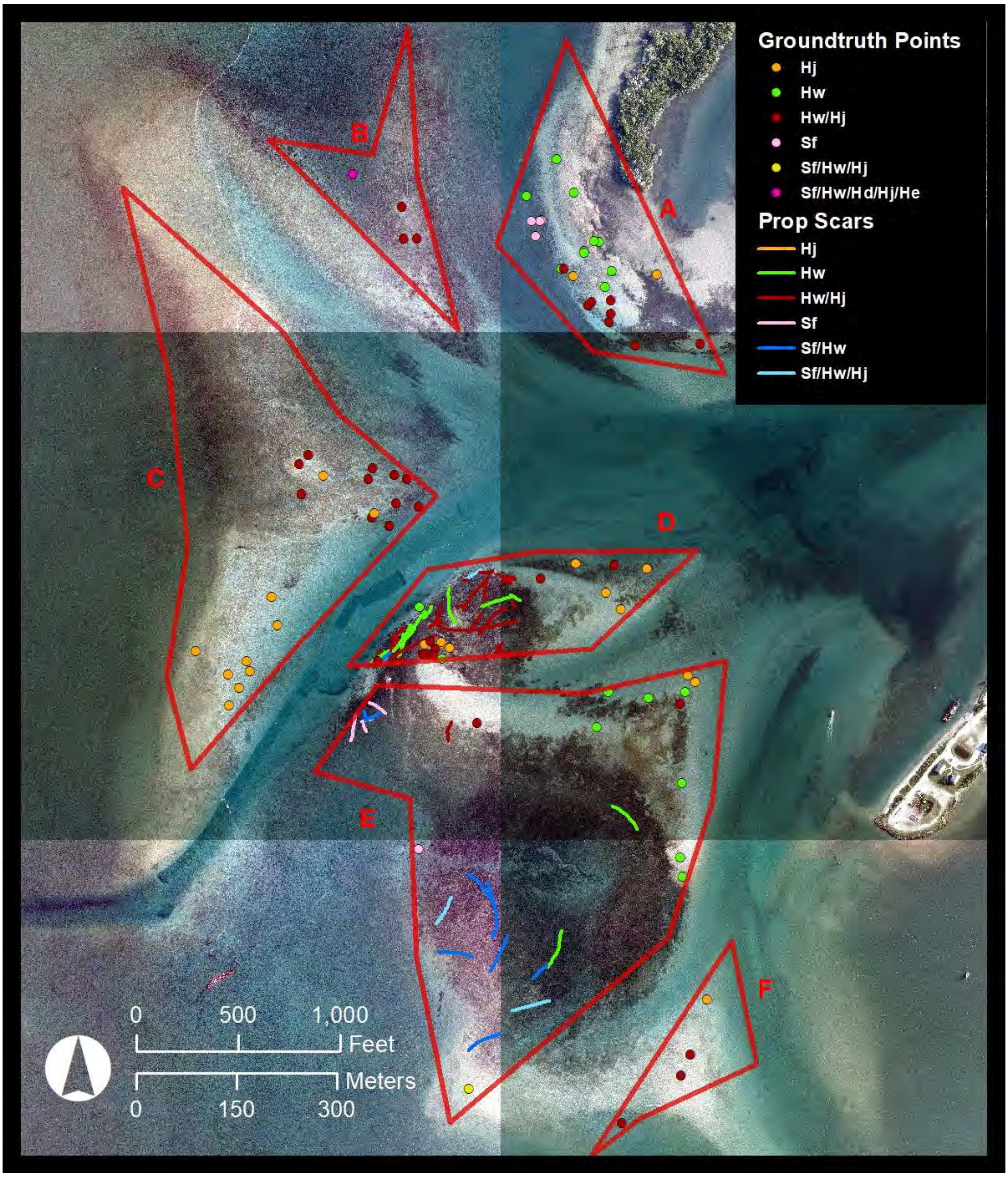


Figure 3-3 **Locations of seagrass species and species combinations observed during the 2019 groundtruthing event. Abbreviations Hj = *Halophila johnsonii*, Hw = *Halodule wrightii*, Hd = *Halophila decipiens*, and Sf = *Syringodium filiforme*.**

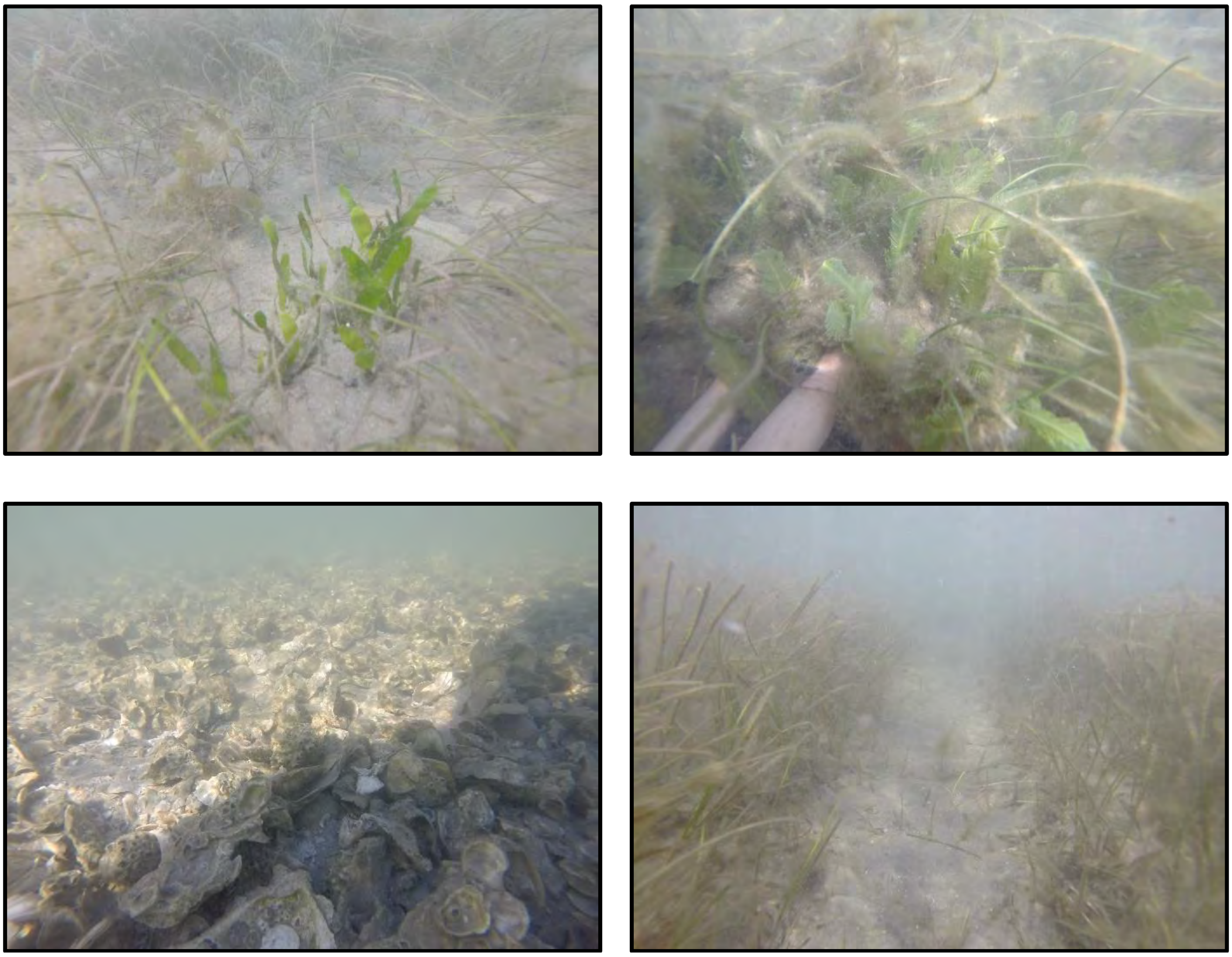
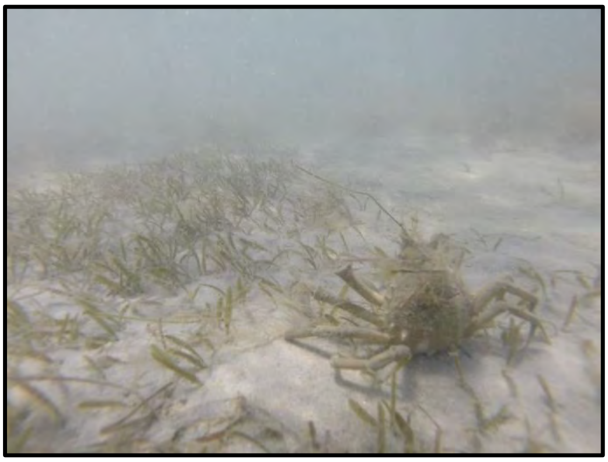
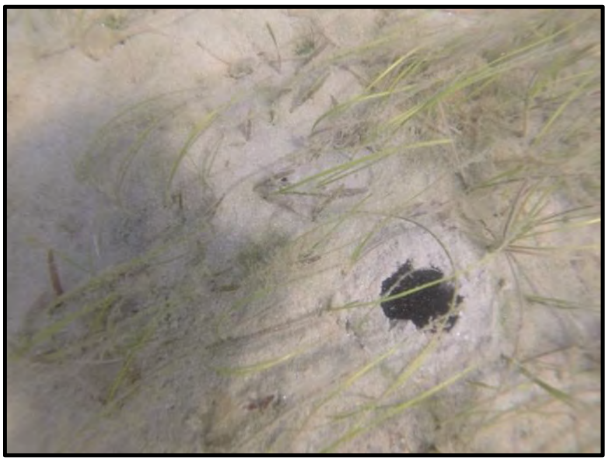
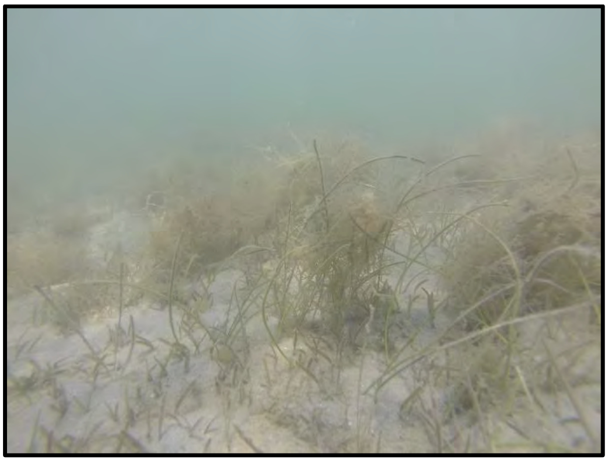


Figure 3-4 **Other features observed in groundtruthing – *Caulerpa prolifera* surrounded by *Halodule wrightii* (upper left); *Caulerpa sertularioides* surrounded by *Syringodium filiforme* (upper right); bottom covered with oyster shell (lower left); and a prop scar through *Halodule wrightii* (lower right).**







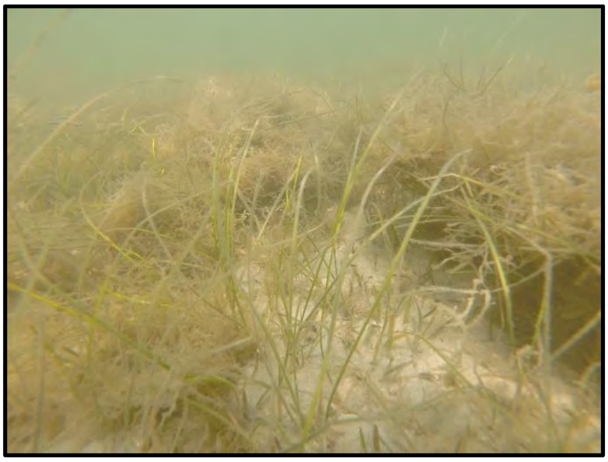


Figure 3-5 **The seagrass species found on the shoal – *Halophila johnsonii* and the longnose spider crab (*Libinia dubia*) (upper left); *Halodule wrightii* and *Halophila johnsonii* with a stomatopod burrow (upper right); *Syringodium filiforme* and *Halophila johnsonii* with drift algae – an important component to seagrass beds in the Indian River Lagoon (lower left); and *Halodule wrightii* and drift algae many of the seagrass beds are now identifiable from the drift algae captured within the seagrasses (lower right).**

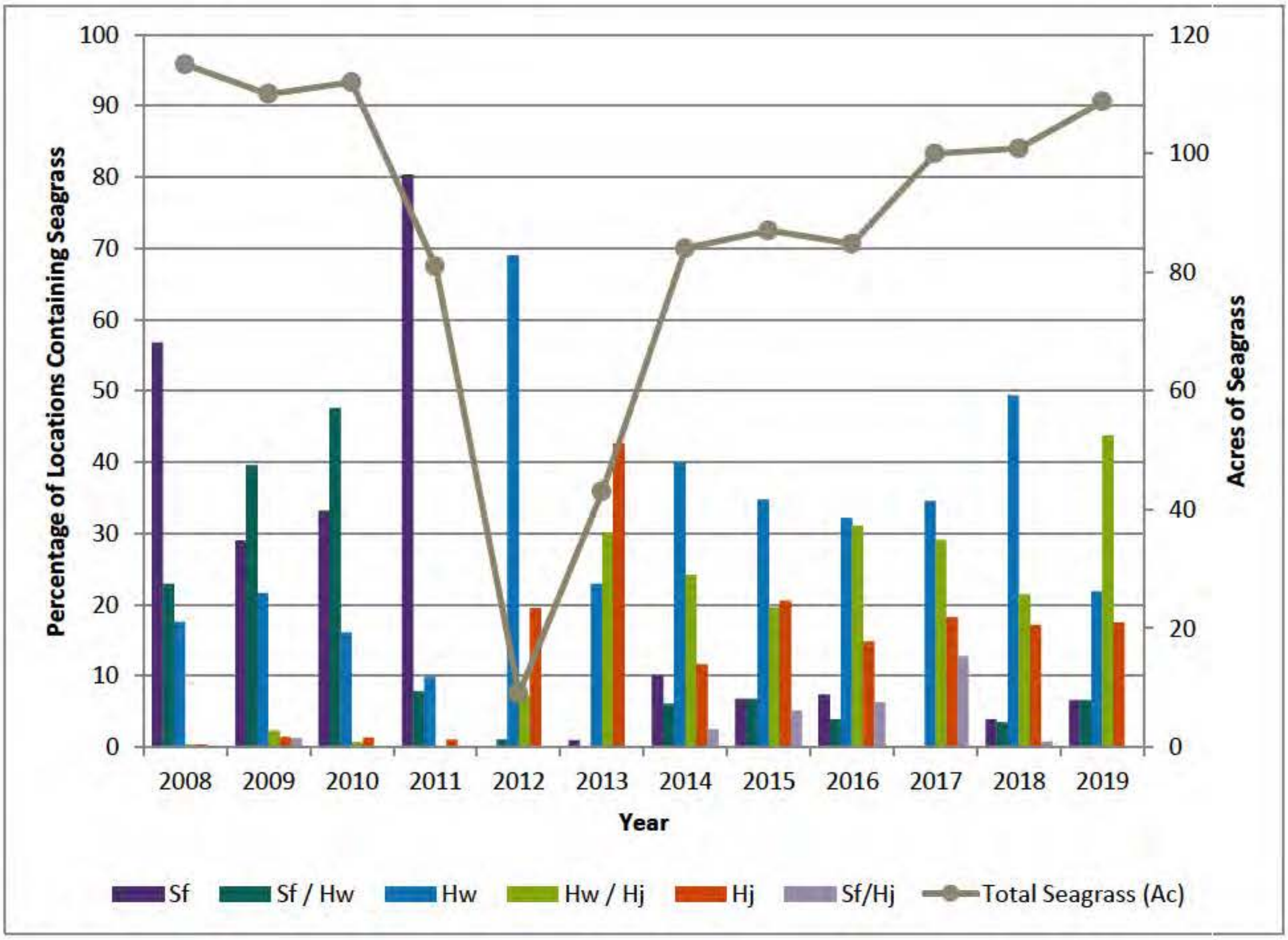


Figure 3-6 **Predominant seagrass species/species combinations observed from 2008 to 2019 showing the effects of and recovery after the region-wide seagrass loss. Abbreviations: Sf = *Syringodium filiforme*, Sf/Hw = *S. filiforme/Halodule wrightii*, Hw = *H. wrightii*, Hw/Hj = *H. wrightii/Halophila johnsonii,* Hj = *H. johnsonii,* and Sf/Hj = *S. filiforme/H. johnsonii*. Total seagrass acreage within the mitigation zone displayed on the secondary y-axis.**

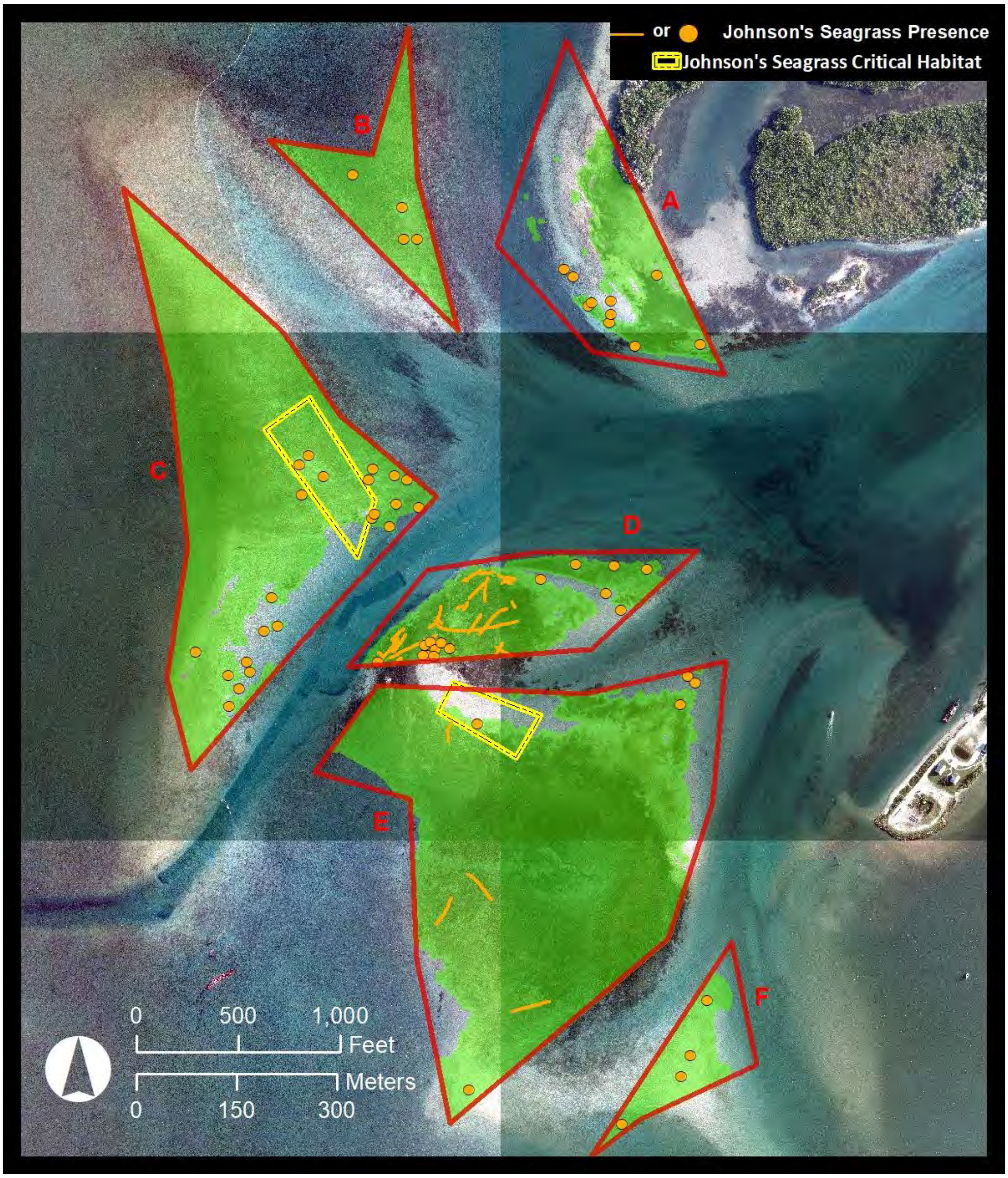


Figure 3-7 **Locations with *Halophila johnsonii* observed during the 2019 groundtruthing event.**

4. Post-Dredging Seagrass Survey

4.1. Objectives

The overall objectives of the Seagrass Monitoring Plan (ATM 2014, Appendix A) are:

1) To ensure that there is no submerged aquatic vegetation (SAV) in the submerged pipeline route prior to construction.
2) Assess potential project-induced unmitigated impacts to SAV adjacent to the sand trap and the navigation channel easement.

4.2. Methods and Results

The methods are outlined in detail in the approved Seagrass Monitoring Plan (ATM 2014, Appendix A). The SID dredged both the sand trap and the navigational channel from January 21-June 7, 2019. For the 2018 pre-dredging survey, 46 30-meter long transects were established at predetermined locations, perpendicular to the sides of the sand trap and navigational channel through the flood tidal shoals (Figures 4-1 and 4-2). Transects 1-5 surround the sand trap and Transects 6-46 occur along the north (even number) and south (odd number) sides of the channel from the sand trap through the flood shoal area.

For the 2019 post-dredging survey, efforts were focused on revisiting transects which either a) had seagrass in the 2018 pre-dredging survey, or b) had potential seagrass signatures in the 2019 aerial analysis. Buoys were placed at the predetermined beginning and end points of each transect. The transects were surveyed for presence of seagrass.

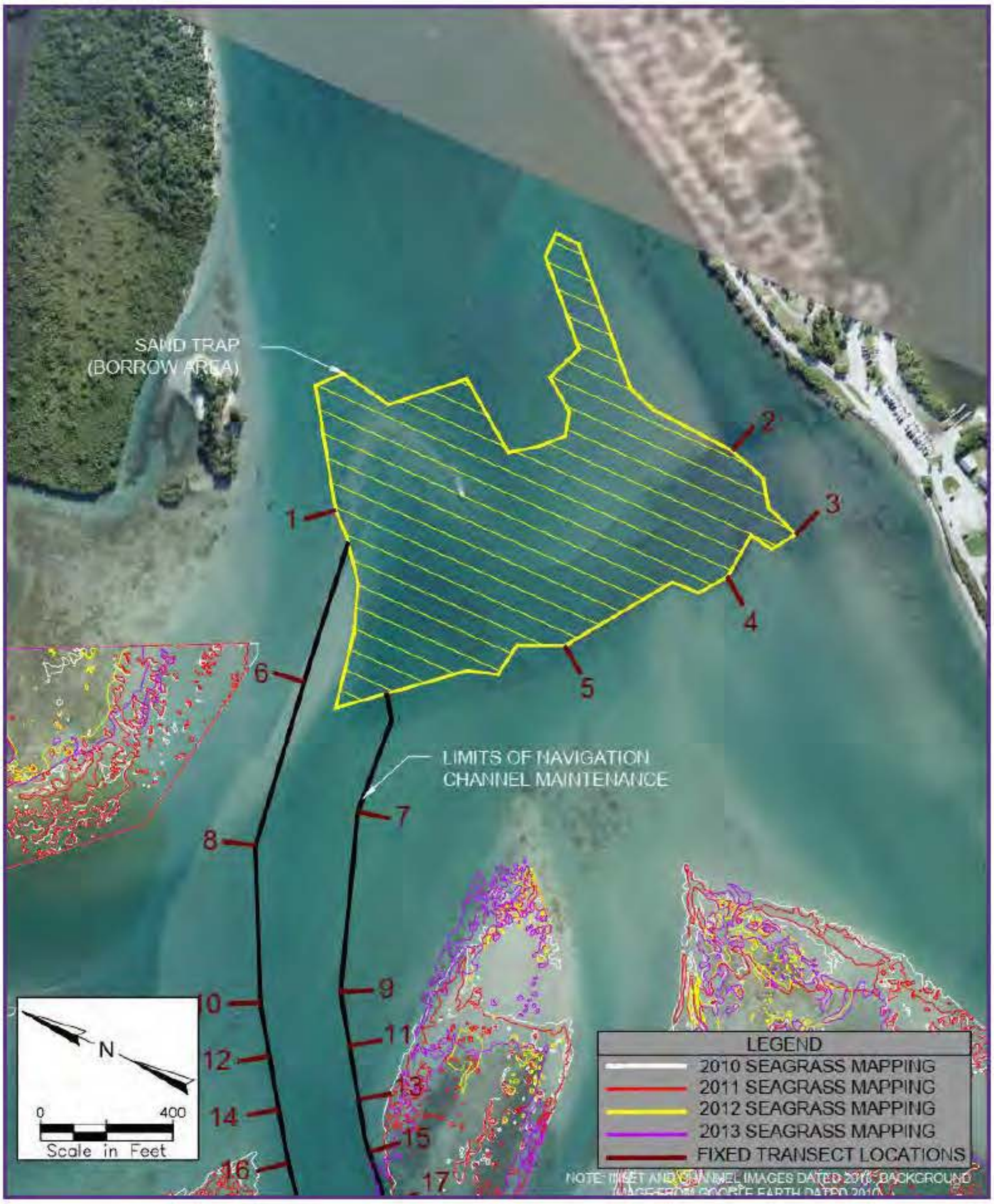


Figure 4-1. Transects surrounding sand trap and eastern end of the channel (from ATM 2014).

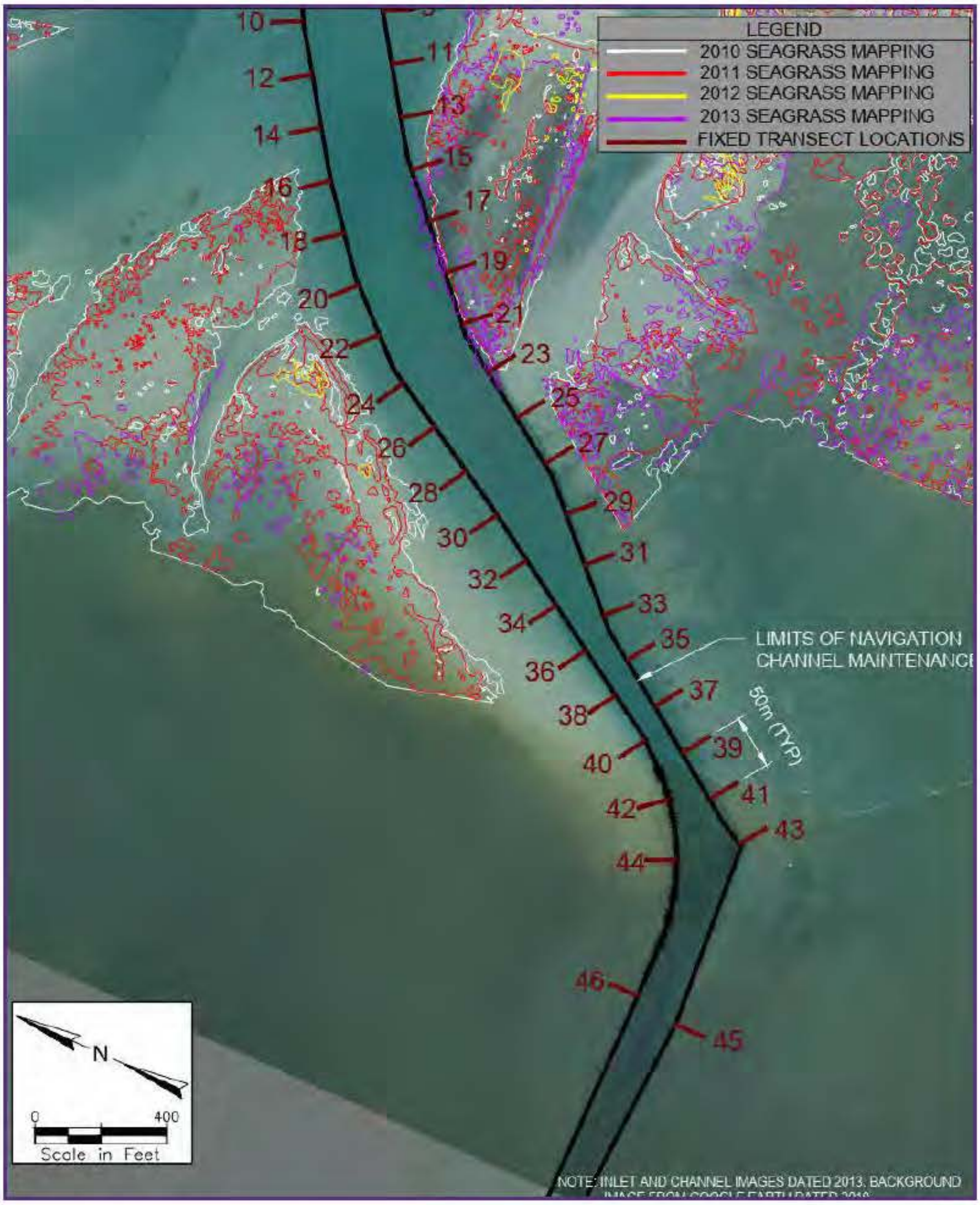


Figure 4-2. Transects on the north and south sides of the western end of the channel (from ATM 2014).

Along each of the transects containing seagrass, five 1 m^2 quadrats were sampled. The quadrat sampling occurred at 0, 5, 10, 20 and 30 meters from the beginning of the transect (sand trap or channel edge) perpendicular into the shoal 30 m (see Figures 4-1 and 4-2). The quadrat was divided into a 100-cell grid composed of 10 cm x 10 cm cells. Ground cover was reported as the number of cells in the quadrat occupied by seagrass. Additionally, information on the diversity (seagrass species), abundance and density of seagrass within each quadrat was visually surveyed using standard Braun-Blanquet (BB) methods. The canopy height (max blade length) and total number of seagrass shoots rooted within one 10 cm x 10 cm cell of the quadrat were also recorded.

No seagrass was found at Transects 1, 2, 4, and 5 around the sand trap both in the pre- and post- dredge surveys. No seagrasses were found at Transects 6-14, 16, 18, 20, 22, 24, 26, 27, 28, and 31 in the pre-dredge survey; however, during the post-dredge event seagrasses were found at Transects 16, 20, 27, 28 and 31.

Seagrasses were found at Transect 3 at the southwest corner of the sand trap and at 22 transects along the channel in both the pre- and post-dredge surveys (Transects 15, 17, 19, 21, 23, 25, 30, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, and 46). Transects 15-28 are located along the northern edges of Zones D and E of the flood shoals. Transects 30-42 occur on the north and south sides of the channel at the southern edge of Zone C (north side of the channel) and north of Zone E (south side of the channel). Transects 42-45 are along the channel in areas north and south of the channel dog-leg.

Seven seagrass species were observed along the transects during the pre- and post-dredge surveys including *Halodule wrightii* (shoal grass), *Halophila engelmannii* (star grass), *Halophila johnsonii* (Johnson's seagrass), *Halophila decipiens* (paddle grass), *Syringodium filiforme* (manatee grass), and *Thalassia testudinum* (turtle grass) (Table 4-1). *H. johnsonii* was the seagrass species most frequently observed followed by *H. wrightii, H. decipiens,* and *S. filiforme*. *H. engelmannii* was only observed within a single transect in the pre-dredge survey (Transect 3, adjacent to the sand trap) and post-dredge survey (Transect 41 along the channel). Similarly, *T. testudinum* was only observed within a single transect in the pre-dredge survey only (Transect 45, the westernmost transect on the south side of the channel). In both surveys, when present, the total seagrass density within a given quadrat did not exceed a BB score of 3 (25-50% cover).

There were differences between the pre- and post-dredge surveys in addition to the additional transects containing seagrass. In the pre-dredge survey seagrass was present at the 0-m quadrat location (i.e., location closest to the channel) on Transects 34-37, 39-42, and 45. Seagrass did start at 3-5 m at several transects in the post-dredge survey including Transects 21, 28, 34, 35, 37, 39, and 41. *S. filiforme* was the dominant seagrass on the shoals prior to the die-off; the return of *S. filiforme* to areas where it was not found could be a sign of recovery. *S. filiforme* was found at Transects 33, 34, 37, 39 and 44 in the post-dredge survey, where it had not been present in the pre-dredge survey.

All of the transect and seagrass data for both the pre- and post- dredge surveys are contained with Appendix B including water depths, maximum canopy height, and shoot counts.

Table 4-1 Seagrass species and location on transects containing seagrass around the sand trap and along the channel through the flood tidal shoals.

Transect No.	Pre-Dredge Survey	Post-Dredge Survey
3	*H. wrightii, H. engelmannii* at 30 m	*H. wrightii* at 30 m
15	*H. wrightii* at 20 m; *H. wrightii* and *H. johnsonii* at 30 m	*H. wrightii* and *H. johnsonii* start at 17 m; *H. johnsonii* at 20 m and both at 30m
16	no seagrass	*H. johnsonii* starting at 24.4 m; at 30 m
17	*H. wrightii* at 5, 10, 20, and 30 m	*H. wrightii* start at 13 m; at 20 and 30 m
19	*H. wrightii* at 10, 20, and 30 m	*H. wrightii* start at 7 m; 20 and 30 m
20	no seagrass	*H. johnsonii* start at 21.8 m
21	*H. wrightii* at 5, 10, 20, and 30 m	*H. wrightii* start at 3 m, at 10, 20, 30 m
23	*H. wrightii* at 10, 20, 30 m	*H. wrightii* at 10, 20, 30 m
25	*H. johnsonii* at 10, 20, 30 m; *H. wrightii* at 20 m	*H. wrightii* start at 12 m; at 20 and 30 m
27	no seagrass	*H. johnsonii* start at 9.5 m and at 20, 30 m; *H. wrightii* at 10, 20, and 30 m
28	no seagrass	*H. wrightii* and *H. johnsonii* start at 5.4 m; *H. johnsonii* at 30 m
30	*H. wrightii* at 30 m	*H. wrightii* start at 19 m; *H. johnsonii* at 20, 30 m
31	no seagrass	*H. wrightii* start at 6 m; *H. decipiens* at 20 and 30 m
32	*H. johnsonii* at 10 and 20 m	*H. johnsonii* at 10 and 30 m; *H. wrightii* at 20 and 30 m
33	*H. johnsonii* at 10 m; *H. decipiens* at 10 and 20 m	*S. filiforme* start at 16 m; *H. decipiens* at 30 m
34	*H. decipiens* at 0 m, *H. johnsonii* at 10, 20, 30 m with *H. wrightii* at 30 m	*H. johnsonii* at 5 m and 20 m; *S. filiforme* at 5 m and 10 m
35	*H. decipiens* at 0, 5, 10, 20 m	*H. johnsonii* start at 3 m; *H. decipiens* at 30 m
36	*H. wrightii* at 0 m; *H. johnsonii* at 20, 30 m	*H. johnsonii* at 5, 10, 20, 30 m

Table 4-1 Seagrass species and location on transects containing seagrass around the sand trap and along the channel through the flood tidal shoals.

Transect No.	Pre-Dredge Survey	Post-Dredge Survey
37	*H. decipiens* at 0, 5, 10 m	*H. johnsonii* start at 3 m; *H. johnsonii, H. decipiens*, and *S. filiforme* at 30 m
38	*H. johnsonii* at 5, 20, 30 m; *H. wrightii* at 30 m	*H. johnsonii* at 20, 30 m; *H. wrightii* at 30 m
39	*H. decipiens* at 0 and 5 m; *H. johnsonii* at 10 and 30 m	*H. johnsonii* start at 6 m; *S. filiforme* at 30 m
40	*H. johnsonii* at 0, 5, 10, 20, 30 m; *H. wrightii* at 10 m	*H. johnsonii* start at 18 m and at 20, 30 m
41	*H. decipiens* at 5 m; *H. johnsonii* at 20 and 30 m, *S. filiforme* at 20 m	*H. decipiens* start at 4.3 m and at 5, 10 m; *H. johnsonii* at 20, 30 m; *H. engelmannii* at 10 m, *S. filiforme* at 30 m
42	*H. wrightii* at 0 m; *H. johnsonii* at 10 m	*H. johnsonii* start at 29 m and at 30 m
43	*H. johnsonii* at 10 m; *H. wrightii* at 20 m; *S. filiforme* at 30 m	*S, filiforme* start at 9.4 m and at 10, 30 m; *H. wrightii* at 20 m
44	*H. wrightii* at 5 and 20 m; *H. johnsonii* at 5, 10, 20 m	*S. filiforme* start at 14 m and at 20 m; *H. decipiens* at 30 m
45	*T. testudinum* at 0 m; *H.* wrightii and *H. decipiens* at 5 and 30 m	*H. decipiens* start at 26 m and at 30 m
46	*H. decipiens* at 20 and 30 m	*H. decipiens* start at 17 m and at 30 m

5. Conclusions

The SID contracted Atkins to continue the abbreviated seagrass monitoring on the Sebastian Inlet flood tidal shoal in 2019 with the focus on the identification of species and quantification of seagrass coverage within the designated protected areas on the shoals. This was accomplished using a GIS-based approach using low-altitude, high-resolution digital aerial photography followed by a groundtruthing/field verification exercise to validate the observations made remotely. In addition, Atkins was contracted to perform the pre-dredging seagrass survey in the summer of 2018 in anticipation of the dredging of the sand trap and channel in early 2019 and the post-dredging seagrass survey in the summer of 2019. The following is a summary of the 2019 results within the protected areas on the flood tidal shoal including a change analysis from 2018-2019.

- 2019 Results
  - The finalized seagrass coverage feature class (post-groundtruthing) yielded ~108.71 acres of seagrass in 2019, equivalent to 74.97% of the mitigation zone. Zone A had the least coverage of seagrass while Zone B had the greatest.
  - Species-specific data revealed that ~47% of the sites that contained seagrass were monospecific patches of seagrass, including *Halodule wrightii* (22%), *Halophila johnsonii* (18%), and *Syringodium filiforme* (7%). The remaining ~53% consisted of species combinations, including *H. wrightii, H. johnsonii, H. decipiens, H. engelmanii,* and *Syringodium filiforme*. *H. wrightii/H. johnsonii* was the predominant species combination at 44%.
  - Thirty-four prop scars were field verified from the aerial imagery. The majority prop scars occur in Zone D and generally represent attempts by boaters to deviate from the channel in transit to or from the inlet or enter the popular anchoring area between Zones D and E.

- 2018-2019 Results
  - From 2018 to 2019, there was an increase in seagrass shoal-wide of ~7.86 acres. With the exception of a slight loss in seagrass coverage in Zone E, all other zones exhibited increases in seagrass coverage ranging from 0.21 acres (Zone A) to 5.43 acres (Zone C).
  - Zones E and F respectively had the highest and lowest total acreage of seagrass in both 2018 and 2019; however, this is unsurprising as these are respectively the largest and smallest shoals. In terms of percent coverage of the zone occupied by seagrass, Zone E had the

highest coverage in 2018 but was surpassed by Zone B in 2019, while Zone A had the lowest coverage in both years.

- In the past (2008-2011), the flood tidal shoal was predominately *Syringodium filiforme, Halodule wrightii,* and combinations of the two species. In 2012 and 2013 (beginning of seagrass recovery after region-wide seagrass loss), the dominant seagrass species on the flood tidal shoal were *H. johnsonii, H. wrightii,* and combinations of the two species. In 2014-2019, *H. wrightii* and *H. johnsonii* continue to be the predominant seagrass species; however, *S. filiforme* appears to be returning to the shoal.
- *H. johnsonii* (or a species combination containing *H. johnsonii*) was present at ~65% of all sites that contained seagrass in 2019, which is an increase over the 2018 survey (~43% of all sites). *H. johnsonii* has been significant in the seagrass recovery on the flood tidal shoal and the stability of the shoal as seagrasses recolonize.

The SID is authorized by permit to periodically maintenance dredge the channel and sand trap. Atkins was contracted to perform the pre-dredge seagrass survey in 2018 in anticipation of the dredging of the sand trap and channel in early 2019 and the post-dredge survey in 2019. Both surveys were performed in accordance with the Seagrass Monitoring Plan approved December 16, 2014 (ATM 2014, Appendix A). The following is a summary of the comparison of the pre- and post-dredge seagrass survey conducted August 2018 and August 2019, respectively.

- No seagrass was found at Transects 1, 2, 4, and 5 around the sand trap both in the pre- and post- dredge surveys. No seagrasses were found at Transects 6-14, 16, 18, 20, 22, 24, 26, 27, 28, and 31 in the pre-dredge survey. During the post-dredge survey, seagrasses were found at Transects 16, 20, 27, 28, and 31.
- Seagrasses were found at Transect 3 at the southwest corner of the sand trap. Seagrasses were found at 22 transects in both the pre- and post-dredge surveys (Transects 15, 17, 19, 21, 23, 25, 30, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, and 46) along the channel and an additional five transects listed above at the post-dredge survey.
- Seven seagrass species were observed along the transects during the pre- and post-dredge surveys including *Halodule wrightii* (shoal grass), *Halophila engelmannii* (star grass), *Halophila johnsonii* (Johnson’s seagrass), *Halophila decipiens* (paddle grass), *Syringodium filiforme* (manatee grass), and *Thalassia testudinum* (turtle grass) (Table 4-1). *H. johnsonii* was the seagrass species most frequently observed followed by *H. wrightii, H. decipiens,* and *S. filiforme.*
- In both surveys, when present, the total seagrass density within a given quadrat did not exceed a Braun-Blanquet score of 3 (25-50% cover).
- In the pre-dredge survey seagrass was present at the 0-m quadrat location (i.e., location closest to the channel) on Transects 34-37, 39-42, and 45. Seagrass did start at 3-5 m at several transects in the post-dredge survey including Transects 21, 28, 34, 35, 37, 39, and 41.
- *S. filiforme* was the dominant seagrass on the shoals prior to the die-off; the return of *S. filiforme* to areas where it was not found could be a sign of recovery. *S. filiforme* was found at Transects 33, 34, 37, 39, and 44 in the post-dredge survey, where it had not been present in the pre-dredge survey.

Appendices

Appendix A. Seagrass Monitoring Plan Sebastian Inlet Maintenance Dredging (ATM 2014)

Seagrass Monitoring Plan

SEBASTIAN INLET MAINTENANCE DREDGING

Sebastian Inlet District

Prepared by Applied Technology and Management

FDEP Permit No.: 0270746-006-JC

November 2014

A. Introduction

This seagrass monitoring plan is provided in partial fulfillment of Specific Condition 4c of the FDEP permit No. 0270746-006-JC, which authorizes the deepening of the existing sand trap and the periodic maintenance dredging of the sand trap and Sebastian Inlet using a cutterhead dredge. This plan provides the protocol for completion of permit-required seagrass surveys. Seagrass surveys are required prior to and following each maintenance dredging event of the sand trap and/or navigation channel (Figure 1).

Historically, seagrasses have not been observed within the sand trap (Ecological Associates, Inc. (EAI) 2005; Atkins 2007, 2013); although seagrasses have been identified in shallow areas north and south of the sand trap. Mitigation for impacts to seagrasses for the 2007 dredging of the navigation channel (FDEP Permit Nos. 0270746-001-EM and 05-264486-001) and the 2012 channel realignment project (FDEP Permit No. 05-264486-005-EM) was required by the previously mentioned permit and reached succession. Because of the 2010 phytoplankton superbloom in the northern Indian River Lagoon, the bed-forming seagrasses, particularly manatee grass (*Syringodium filiforme*), had been eliminated from the shoals and the deeper areas around the shoals (e.g., the area around the dredged channel “dog-leg”) (Figure 1). However, the growing season surveys of submerged aquatic vegetation (SAV) in June 2013 found seagrass (predominately *Halophila johnsonii*) growing on the tops of the flood tidal shoals. Moreover, during a recent site inspection (August 2014); several species of seagrasses (predominantly *Halophila johnsonii* and *Halodule wrightii*) were observed around the sand trap and along the channel. Although seagrass cover was generally sparse, seagrasses were present throughout the project area and appeared to be recovering from the 2010 through 2012 seagrass die-back.

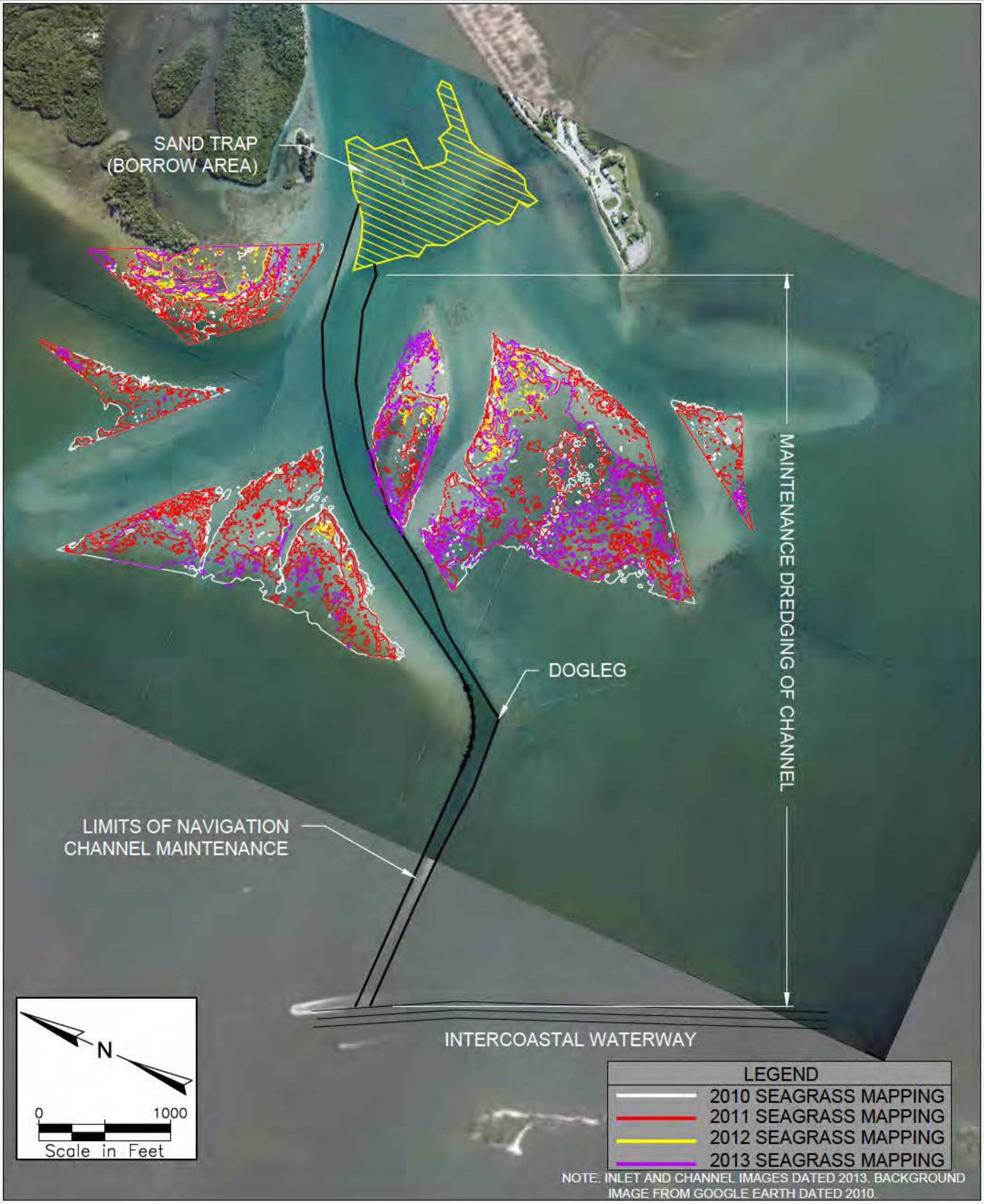


Figure 1
Location Map

APPLIED TECHNOLOGY & MANAGEMENT

B. Objective

The objectives of this seagrass monitoring plan are the following:

1) To ensure that there is no submerged aquatic vegetation (SAV) in the submerged pipeline route prior to construction.
2) Assess potential project-induced unmitigated impacts to SAV adjacent to the sand trap and the navigation channel easement.

C. Monitoring Area and Methods

SAV surveys will be conducted in the summer (during the peak growing season) immediately before and immediately after each construction event to determine whether any project-induced unmitigated impacts to SAV occurred. All SAV surveys will be conducted by qualified marine biologist(s) with experience performing such surveys; resumes for the monitoring team will be submitted to the FDEP for approval 45 days prior to each construction event.

As part of this plan, monitoring transects are established perpendicular to both areas to be dredged: the sand trap and navigation channel (Figure 2). Appendix A provides the locations and azimuths for the transects as shown on Figure 2. All transects will extend 30 meters from the authorized dredge area (i.e., sand trap and/or channel easement). The established transects will be surveyed to document the distribution of SAV. Transects containing SAV will be surveyed to document the abundance, density, and diversity of SAV.

The linear length of the navigation channel is approximately 1,680 meters (5,500 feet). Only portions of the navigation channel are anticipated to require dredging, based on hydrographic surveys; thus, only the transects in the vicinity of the dredging event will be required for the pre- and post-construction surveys. However, if at any time the entire permitted area (sand trap and the full length of the navigational channel) is to be dredged along its entire length, then the permittee shall either 1) monitor all transects in the project area or 2) contact the Department at least 90 days prior to starting the pre-construction survey and provide justification for reducing the number of transects and / or streamlining monitoring methods; prior to the pre-construction survey, the Department will use all available data on SAV resources in the project area to determine which areas are most likely to be impacted by the dredging activities and will notify the permittee which of the transects shall be monitored in order to provide reasonable assurance that potential impacts from that dredging event could be detected if they were to occur. In this scenario, the Department may recommend that all transects be surveyed.

If only a portion of the project area (i.e., sand trap and/or sections of the navigational channel) is to be dredged, then the number of transects that will be monitored will be based on the specific area(s) to be dredged. If only the sand trap is to be dredged, then only those transects adjacent to the trap (Figure 2) will be monitored. The survey area will be defined by the dredge area(s) shown on the Construction Plans for each dredging event and will extend 50 meters in both directions - seaward and towards the ICW beyond the dredge area(s) identified on the Construction Plans

The transects, as defined in Appendix A, are 30 meters long and extend generally perpendicular to the sand trap and navigation channel. The transects will be located in situ using differential global positioning system (DGPS). During field surveys, the actual starting and ending position (GPS coordinates ±1m accuracy) shall be within ±1m of the coordinates provided in Appendix A; and if there is any deviation greater than 1 meter, the coordinates shall be recorded.

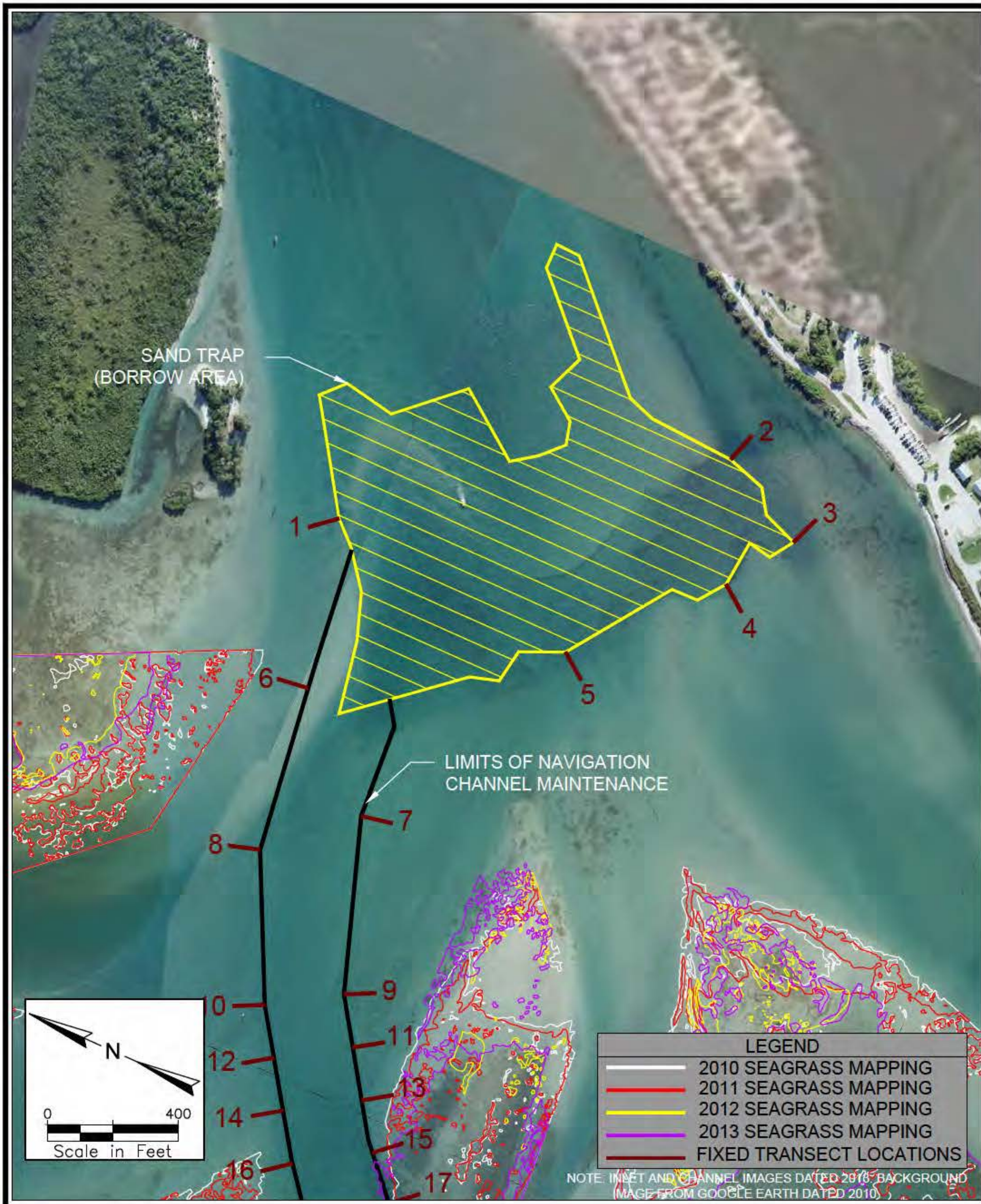


Figure 2a
Sand Trap and Channel Transects

APPLIED TECHNOLOGY & MANAGEMENT

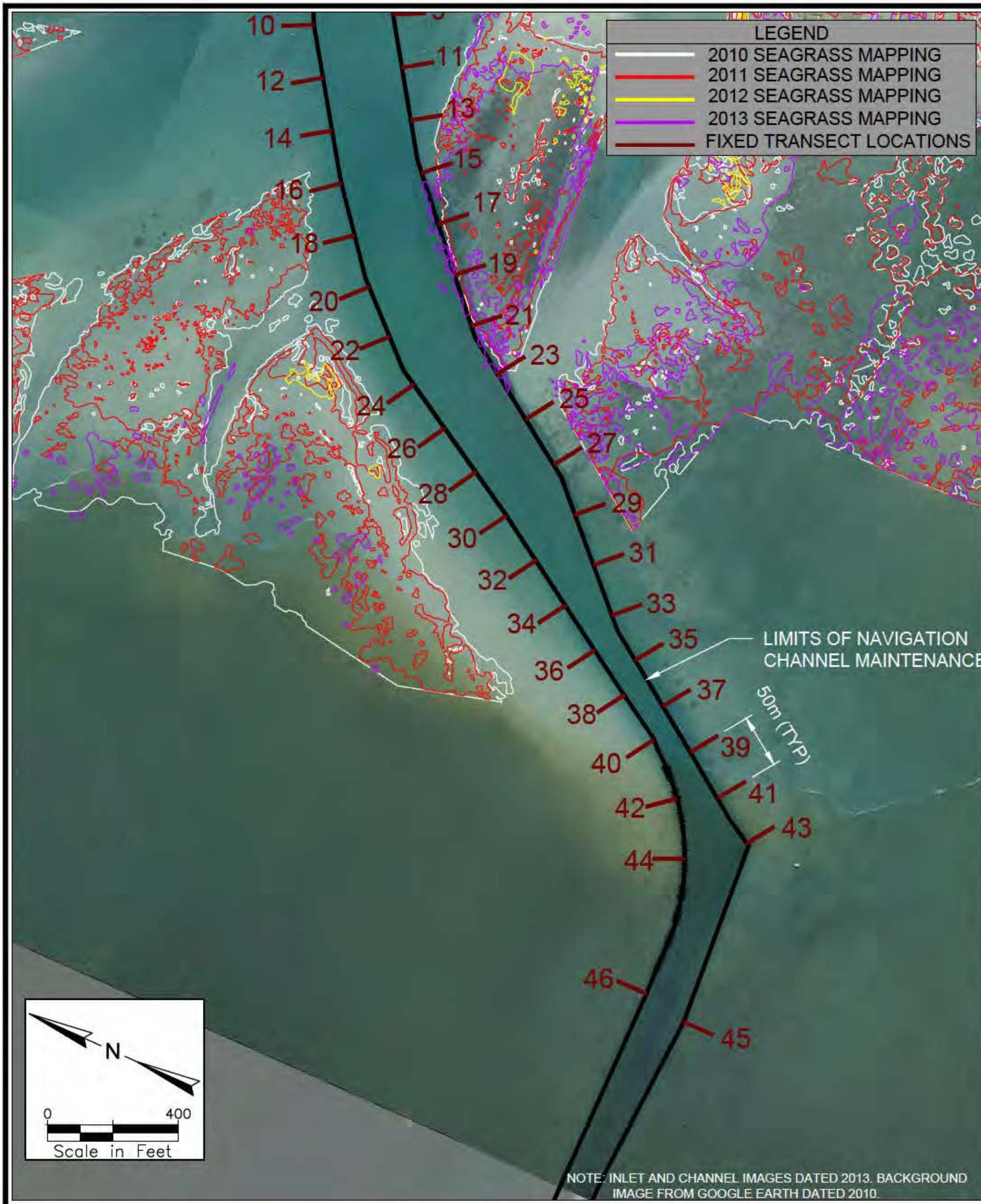


Figure 2b
Sand Trap and Channel Transects

APPLIED TECHNOLOGY & MANAGEMENT

For each transect, a buoy or a suitable temporary marker will be placed (at pre-determined coordinates, see above) using DGPS at the beginning and end of each transect. A weighted line or weighted measuring tape will be stretched between the markers, and the water depth (cm) will be recorded at the starting and ending position of each transect. As the transect line is set-up the surveyor will determine if SAV is present within 1m (on either side) of the transect line. If no SAV is present along that transect (within 1m on either side of the transect line), then the absence of SAV will be noted, and the surveyor will begin working on the next transect. If seagrass is observed within 1m of either side of the initial transect line, the transect will be re-positioned to go through the seagrass and the new starting and ending points will be noted.

Along each of the transects containing SAV, five 1 m^2 quadrats will be sampled. The quadrat sampling will be at 0, 5, 10, 20 and 30 meters from the beginning of the transect (i.e., the edge of the channel easement). The surveyor will quantify SAV ground cover by counting the number of cells that contain SAV within each quadrat. For this purpose, the quadrat should be divided into a 100-cell grid composed of 10 cm x 10 cm cells. Ground cover should be reported as the percentage of total cells in the quadrat that contain SAV. Additionally, information on the diversity, abundance and density of SAV within each quadrat will be visually surveyed using standard Braun-Blanquet (BB) methods; the category of cover (using BB scores ranging from 0 to 5) will be recorded for each species present within the 1 m^2 quadrat. The BB score for total SAV cover, including all taxa, shall also be recorded; note, the total BB score is not the sum of BB scores for individual taxa. Additionally, a 100 cm^2 (10 cm x 10 cm) quadrat will be centered inside each 1 m^2 quadrat; the canopy height (max blade length) and total number of seagrass shoots rooted within this 100 cm^2 quadrat will be recorded.

For all transects where SAV was observed during the pre-construction survey, a post-construction survey will be conducted during the growing season following construction. The same methods will be used for the post-construction survey as were used in the pre-construction survey to assess whether there were any adverse impacts to the SAV.

During the post-construction survey, the scientific diver will be cognitive of any notable or obvious changes to the conditions within the first 5 meters of the surveyed transects. The first 5 meters of each surveyed transect will be visually inspected for any physical or post-dredging (sloughing) impacts. If any sloughing is seen, the extent of the sloughing along the transect must be noted. FDEP will be notified of any direct or sloughing impacts within 2 days of the survey. The post-construction report will provide a detailed assessment of any impacts observed during the field investigation and reported to FDEP.

The permit-required pre- and post-construction hydrographic surveys of the sand trap and navigation channel will also be utilized to evaluate potential unmitigated project-induced impacts to SAV. The hydrographic post-construction survey will be compared to the pre-construction hydrographic survey to assess whether sloughing along the side slopes has occurred and whether there are potential impacts to the SAV due to sloughing of the substrate. Any sloughing impacts observed during the in-situ post-construction seagrass survey will be verified by the hydrographic survey.

In addition to transect surveys described above, all proposed submerged pipeline routes will be surveyed prior to pipeline placement. Any SAV within pipeline routes will be mapped by a diver-towed DGPS. If SAV is present, the pipeline placement will be re-routed to adjacent areas free of SAV.

D. Reporting

SAV survey data shall be delivered to the Department's Compliance Officer electronically within 45 days of the completion of each survey. All field notes and survey datasheets (scanned to PDF) and all survey data (in Excel workbook format) shall be submitted to the Department within 45 days of completion of each survey. Prior to the data submittal, the principal scientist shall quality check the data to ensure that survey information is complete and accurate.

A report summarizing survey data and describing survey results will be provided to the regulatory agencies as required by the FDEP and USACE within 90 days of the post-construction survey. The Department's Compliance Officer will receive electronically a monitoring report, which shall include:

- A map of the dredge area(s) and surveyed transects; this map should provide exact location of transects using GPS coordinates. This map shall be provided as GIS format files and a PDF document.
- Pre- and post-construction transect and quadrat data, including summary statistics (average and standard deviation) for SAV ground cover, abundance, density, shoot counts and canopy height. Summary statistics should be reported for total SAV and individual taxa.
- A comparison of the pre- and post-construction data, including presentation of key findings in graphical and tabular formats. The results of statistical analyses for monitoring data shall also be provided with a description of all statistical methods.
- A comparison of the pre- and post-construction hydrographic data and discussion of sloughing of the substrate near dredged areas.
- A map showing the position of pipeline routes in relation to SAV resources in the project area.

E. Mitigation

If impacts to the SAV adjacent to the sand trap and navigation channel are observed during any post-construction survey, the permittee (Sebastian Inlet District) will notify the Department immediately and will consult with the Department regarding additional monitoring and/or mitigation. Impacts to SAV within the navigation channel have been previously mitigated and no further action is necessary for SAV dredged within the navigation channel. Any additional unmitigated impacts that are detected by monitoring will be evaluated by Department staff using the Uniform Mitigation Assessment Method (UMAM, 62-345 F.A.C).

Appendix A. Transect Coordinates

Transect	Beginning (Edge of Channel)		Ending		Azimuth
	Northing	Easting	Northing	Easting	
1	1280305.52	831615.93	1280380.94	831552.72	320°
2	1279284.73	832270.05	1279255.14	832363.89	108°
3	1279006.13	832116.70	1278970.81	832208.54	111°
4	1279142.33	831915.38	1279063.56	831856.41	217°
5	1279506.13	831525.49	1279427.36	831466.52	217°
6	1280179.97	831103.38	1280277.58	831090.98	353°
7	1279872.41	830812.29	1279775.86	830831.27	169°
8	1280112.27	830591.84	1280206.54	830563.63	343°
9	1279697.91	830292.81	1279609.53	830336.06	154°
10	1279905.68	830164.19	1279994.28	830121.38	334°
11	1279606.51	830155.15	1279524.54	830209.58	146°
12	1279814.27	830028.02	1279895.97	829973.18	326°
13	1279515.80	830018.52	1279433.82	830072.95	146°
14	1279722.86	829891.86	1279804.56	829837.02	326°
15	1279419.88	829885.36	1279346.84	829951.30	138°
16	1279631.45	829755.70	1279708.68	829694.72	322°
17	1279309.98	829763.63	1279236.94	829829.57	138°
18	1279529.83	829626.98	1279607.06	829566.01	322°
19	1279199.65	829642.46	1279126.84	829708.02	138°
20	1279424.11	829501.50	1279491.99	829430.26	314°
21	1279090.17	829520.18	1279017.13	829586.12	138°
22	1279305.38	829388.36	1279373.26	829317.12	314°
23	1278956.59	829418.73	1278902.35	829500.84	123°
24	1279178.00	829284.30	1279228.07	829199.59	301°
25	1278821.09	829327.78	1278766.19	829409.44	124°
26	1279036.82	829200.85	1279086.88	829116.14	301°
27	1278684.99	829236.28	1278630.09	829317.95	124°
28	1278895.63	829117.41	1278945.70	829032.70	301°
29	1278564.46	829121.62	1278493.98	829190.28	136°
30	1278754.45	829033.96	1278807.58	828951.14	303°
31	1278450.01	829004.15	1278379.54	829072.82	136°
32	1278616.41	828945.41	1278669.55	828862.59	303°
33	1278335.57	828886.69	1278265.09	828955.36	136°
34	1278478.38	828856.85	1278531.51	828774.03	303°
35	1278214.86	828790.89	1278158.53	828871.58	125°
36	1278340.34	828768.30	1278393.47	828685.48	303°
37	1278080.39	828697.02	1278024.06	828777.70	125°

Transect	Beginning (Edge of Channel)		Ending		Azimuth
	Northing	Easting	Northing	Easting	
38	1278202.30	828679.75	1278255.43	828596.92	303°
39	1277945.92	828603.14	1277889.59	828683.82	125°
40	1278064.27	828591.19	1278117.40	828508.37	303°
41	1277811.44	828509.26	1277755.12	828589.94	125°
42	1277926.10	828457.39	1278001.95	828394.72	320°
43	1277674.98	828418.22	1277618.65	828498.90	125°
44	1277828.27	828298.34	1277917.75	828258.10	336°
45	1277627.69	827841.08	1277529.29	827841.08	180°
46	1277766.70	827872.77	1277865.10	827872.77	0°

Appendix B. Sebastian Inlet Pre/Post-Dredging Seagrass Transect Data (August 2018/2019)

Sebastian Inlet Pre-/Post-Construction Dredging Transects Comparison

Date: Pre-08/22 - 08/24/2018/Post-07/31 - 08/01/2019 **Surveyor:** SMT/ DRD

Transect No. (1-46)	Water Depth (cm)[A]		Quadrat (m)	1m² Quadrat						100cm2 Quadrat		Notes on first observation of seagrasses along transect
	Start	Stop		# of cells with seagrass	BB Total	BB_SP 1	BB_SP 2	BB_SP 3	BB_SP 4	Max canopy (cm)	# of shoots	
1 Pre	220[B]	210[B]	No seagrass observed									
1 Post	220[B]	210[B]	No seagrass observed									
2 Pre	370[B]	210[B]	No seagrass observed									
2 Post	370[B]	210[B]	No seagrass observed									
3 Pre	> 110	110	0	0	0					0	0	
			5	0	0					0	0	
			10	0	0					0	0	
			20	0	0					0	0	
			30	12	2	Hw 1			He 1	10	7	no data
3 Post	250	120	0	0								
			5	0								
			10	0								
			20	0								
			30	22	1	Hw1				12	3	Hw at 30 m
4 Pre	290[B]	190[B]	No seagrass observed									
4 Post	290[B]	190[B]	No seagrass observed									
5 Pre	380[B]	300[B]	No seagrass observed									
5 Post	380[B]	300[B]	No seagrass observed									
6 Pre	150[B]	140[B]	No seagrass observed									
6 Post	150[B]	140[B]	No seagrass observed									
7 Pre	300[B]	300[B]	No seagrass observed									
7 Post	300[B]	300[B]	No seagrass observed									
8 Pre	300[B]	260[B]	No seagrass observed									
8 Post	300[B]	260[B]	No seagrass observed									

[A] Water depth measured/estimated by biologist at time of seagrass survey unless otherwise noted by [B]

[B] If seagrass not present, water depth obtained from hydrographic survey which was conducted

Sebastian Inlet Pre-/Post-Construction Dredging Transects Comparison

Date: Pre-08/22 - 08/24/2018/Post-07/31 - 08/01/2019 **Surveyor:** SMT/ DRD

Transect No. (1-46)	Water Depth (cm)[A] Start	Water Depth (cm)[A] Stop	Quadrat (m)	1m^2 Quadrat: # of cells with seagrass	BB Total	BB_SP 1	BB_SP 2	BB_SP 3	BB_SP 4	100cm2 Quadrat: Max canopy (cm)	# of shoots	Notes on first observation of seagrasses along transect
9 Pre	300[B]	260[B]	No seagrass observed									
9 Post	300[B]	260[B]	No seagrass observed									
10 Pre	300[B]	260[B]	No seagrass observed									
10 Post	300[B]	260[B]	No seagrass observed									
11 Pre	270[B]	240[B]	No seagrass observed									
11 Post	270[B]	240[B]	No seagrass observed									
12 Pre	270[B]	220[B]	No seagrass observed									
12 Post	270[B]	220[B]	No seagrass observed									
13 Pre	260[B]	200[B]	No seagrass observed									
13 Post	260[B]	200[B]	No seagrass observed									
14 Pre	270[B]	200[B]	No seagrass observed									
14 Post	270[B]	200[B]	No seagrass observed									
15 Pre	~ 170	65	0	0	0					0	0	
			5	0	0					0	0	
			10	0	0					0	0	
			20	35	1	Hw 1				19	4	no data
			30	50	2	Hw 2	Hj 0.5			18	6	
15 Post	250	100	0	0								
			5	0								
			10	0								
			20	100	1		Hj1			2	4	Hj and Hw at 17 m
			30	100	1	Hw1	Hj1			18	16	
16 Pre	280[B]	200[B]	No seagrass observed									

[A] Water depth measured/estimated by biologist at time of seagrass survey unless otherwise noted by [B]

[B] If seagrass not present, water depth obtained from hydrographic survey which was conducted

Sebastian Inlet Pre-/Post-Construction Dredging Transects Comparison

Date: Pre-08/22 - 08/24/2018/Post-07/31 - 08/01/2019 **Surveyor:** SMT/ DRD

Transect No. (1-46)	Water Depth (cm)[A] Start	Water Depth (cm)[A] Stop	Quadrat (m)	1m² Quadrat: # of cells with seagrass	BB Total	BB_SP 1	BB_SP 2	BB_SP 3	BB_SP 4	100cm2 Quadrat: Max canopy (cm)	# of shoots	Notes on first observation of seagrasses along transect
16 Post	180	120	0	0								
			5	0								
			10	0								
			20	0								
			30	74	1		Hj1			2	12	Hj at 24.4 m
17 Pre	~150	65	0	0	0					0	0	
			5	10	0.5	Hw 0.5				14	6	No data
			10	63	2	Hw 2				18	6	
			20	30	2	Hw 2				16	6	
			30	51	2	Hw 2				14	6	
17 Post	350	100	0	0								
			5	0								
			10	0								
			20	18	1	Hw1				16	3	Hw at 13 m
			30	89	1	Hw1				15	4	
18 Pre	310[B]	210[B]	No seagrass observed									
18 Post	310[B]	210[B]	No seagrass observed									
19 Pre	~ 200	65	0	0	0					0	0	
			5	0	0					0	0	
			10	14	0.5	Hw 0.5				13	4	No data

[A] Water depth measured/estimated by biologist at time of seagrass survey unless otherwise noted by [B]

[B] If seagrass not present, water depth obtained from hydrographic survey which was conducted

Sebastian Inlet Pre-/Post-Construction Dredging Transects Comparison

Date: Pre-08/22 - 08/24/2018/Post-07/31 - 08/01/2019 **Surveyor:** SMT/ DRD

Transect No. (1-46)	Water Depth (cm)^A Start	Water Depth (cm)^A Stop	Quadrat (m)	1m² Quadrat: # of cells with seagrass	BB Total	BB_SP 1	BB_SP 2	BB_SP 3	BB_SP 4	100cm2 Quadrat: Max canopy (cm)	# of shoots	Notes on first observation of seagrasses along transect
19 Pre	200	65	20	83	2	Hw 2				15	5	
			30	44	2	Hw 2				18	4	
19 Post	250	100	0	0								
			5	0								
			10	0								
			20	35	2	Hw2				16	6	Hw at 7 m
			30	100	2	Hw2	Hj1			16	5	
20 Pre	310^B	210^B	No seagrass observed									
20 Post	310^B	210^B	Hj at 21.8 but no other seagrass along transect									
21 Pre	> 200	65	0	0	0					0	0	
			5	3	0.5	Hw 0.5				9	1	No data
			10	9	0.5	Hw 0.5				10	2	
			20	33	2	Hw 2	Hj 2			9	10	
			30	89	2	Hw 1	Hj 1		Sf 0.5	18	28	
21 Post	200	100	0	0								
			5	0								
			10	98	3	Hw3						Hw at 3 m
			20	100	1	Hw1	Hj1					

[A] Water depth measured/estimated by biologist at time of seagrass survey unless otherwise noted by [B]

[B] If seagrass not present, water depth obtained from hydrographic survey which was conducted

Sebastian Inlet Pre-/Post-Construction Dredging Transects Comparison

Date: Pre-08/22 - 08/24/2018/Post-07/31 - 08/01/2019 — **Surveyor: SMT/ DRD**

Transect No. (1-46)	Water Depth (cm)[A] Start	Water Depth (cm)[A] Stop	Quadrat (m)	$1m^2$ Quadrat: # of cells with seagrass	BB Total	BB_SP 1	BB_SP 2	BB_SP 3	BB_SP 4	100cm2 Quadrat: Max canopy (cm)	# of shoots	Notes on first observation of seagrasses along transect
			30	100	1	Hw1	Hj1					
22 Pre	290[B]	200[B]	No seagrass observed									
22 Post	290[B]	200[B]	No seagrass observed									
23 Pre	> 200	80	0	0	0					0	0	No data
			5	0	0					0	0	
			10	15	1	Hw 0.5	Hj 0.5			4	7	
			20	84	2	Hw 2	Hj 2			13	22	
			30	62	2	Hw 2	Hj 2			13	11	
23 Post	200	100	0	0								Hw 10 m
			5	0								
			10	16	1	Hw1	Hj0.5			13	4	
			20	84	2	Hw2	Hj0.5			17	10	
			30	100	2	Hw2	Hj1			16	12	
24 Pre	270[B]	210[B]	No seagrass observed									
24 Post	270[B]	210[B]	No seagrass observed									
25 Pre	> 200	85	0	0	0					0	0	No data
			5	0	0					0	0	
			10	15	1	Hj 1				2	4	
			20	3	0.5	Hw 0.5	Hj 0.5			4	3	

[A] Water depth measured/estimated by biologist at time of seagrass survey unless otherwise noted by [B]

[B] If seagrass not present, water depth obtained from hydrographic survey which was conducted

Sebastian Inlet Pre-/Post-Construction Dredging Transects Comparison

Date: Pre-08/22 - 08/24/2018/Post-07/31 - 08/01/2019 Surveyor: SMT/ DRD

Transect No. (1-46)	Water Depth (cm)[A] Start	Water Depth (cm)[A] Stop	Quadrat (m)	1m² Quadrat: # of cells with seagrass	BB Total	BB_SP 1	BB_SP 2	BB_SP 3	BB_SP 4	100cm2 Quadrat: Max canopy (cm)	# of shoots	Notes on first observation of seagrasses along transect
			30	16	1	Hj 1				2	4	
25 Post	180	100	0	0								
			5	0								
			10	0								
			20	2	0.5	Hw0.5				15	7	Hw at 12 m
			30	42	1	Hw1				12	5	
26 Pre	240[B]	210[B]	No seagrass observed									
26 Post	240[B]	210[B]	No seagrass observed									
27 Pre	240[B]	150[B]	No seagrass observed									
27 Post	180	120	0	0								
			5	0								
			10	59	2	Hw2				12	5	Hj at 9.5 m
			20	97	2	Hw2	Hj0.5			12	5	
			30	100	2	Hw2	Hj0.5			12	8	
28 Pre	230[B]	190[B]	No seagrass observed									
28 Post	250	140	0									
			5									
			10									
			20									
			30	75	1		Hj1			2	14	Hw and Hj at 5.4 m
29 Pre	270[B]	170[B]	No seagrass observed									

[A] Water depth measured/estimated by biologist at time of seagrass survey unless otherwise noted by [B]

[B] If seagrass not present, water depth obtained from hydrographic survey which was conducted

Sebastian Inlet Pre-/Post-Construction Dredging Transects Comparison

Date: Pre-08/22 - 08/24/2018/Post-07/31 - 08/01/2019 Surveyor: SMT/ DRD

Transect No. (1-46)	Water Depth (cm)[A] Start	Water Depth (cm)[A] Stop	Quadrat (m)	1m² Quadrat: # of cells with seagrass	BB Total	BB_SP 1	BB_SP 2	BB_SP 3	BB_SP 4	100cm2 Quadrat: Max canopy (cm)	# of shoots	Notes on first observation of seagrasses along transect
29 Post	270[B]	170[B]	No seagrass observed									
30 Pre	> 110	130	0	0	0					0	0	
			5	0	0					0	0	
			10	0	0					0	0	
			20	0	0					0	0	
			30	5	0.5	Hw 0.5				9	10	No data
30 Post	250	120	0	0								
			5	0								
			10	0								
			20	75	1		Hj1			2	18	Hw at 19 m
			30	54	1		Hj1			2	12	
31 Pre	290[B]	200[B]	No seagrasses observed									
31 Post	200	180	0	0								
			5	0								
			10	0								
			20	20	6			Hd0.5		2	4	Hw at 6 m
			30	30	1			Hd0.5		2	2	
32 Pre	> 110	110	0	0	0					0	0	
			5	0	0					0	0	
			10	3	0.5		Hj 0.5			3	5	No data
			20	3	0.5		Hj 0.5			2	1	
			30	0	0					0	0	

[A] Water depth measured/estimated by biologist at time of seagrass survey unless otherwise noted by [B]

[B] If seagrass not present, water depth obtained from hydrographic survey which was conducted

Sebastian Inlet Pre-/Post-Construction Dredging Transects Comparison

Date: Pre-08/22 - 08/24/2018/Post-07/31 - 08/01/2019

Surveyor: SMT/ DRD

Transect No. (1-46)	Water Depth (cm)[A] Start	Water Depth (cm)[A] Stop	Quadrat (m)	1m² Quadrat: # of cells with seagrass	BB Total	BB_SP 1	BB_SP 2	BB_SP 3	BB_SP 4	100cm2 Quadrat: Max canopy (cm)	# of shoots	Notes on first observation of seagrasses along transect
32 Post	250	110	0	0								
			5	0								
			10	92	1		Hj1			2	18	Hj at 10 m
			20	51	1	Hw1				14	11	
			30	67	1	Hw0.5	Hj1			15	22	
33 Pre	>180	>180	0	0	0					0	0	
			5	0	0					0	0	
			10	8	1		Hj 0.5	Hd 1		2	6	No data
			20	9	1			Hd 1		3	16	
			30	0	0					0	0	
33 Post	220	150	0	0								
			5	0								
			10	0								
			20	0								
			30	8	0.5			Hd0.5		2	3	Sf at 16 m
34 Pre	~ 180	95	0	6	1			Hd 1		2	12	No data
			5	0	0					0	0	
			10	28	2		Hj 2			2	10	
			20	37	2		Hj 2			3	12	
			30	69	3	Hw 0.5	Hj 3			3	24	

[A] Water depth measured/estimated by biologist at time of seagrass survey unless otherwise noted by [B]

[B] If seagrass not present, water depth obtained from hydrographic survey which was conducted

Sebastian Inlet Pre-/Post-Construction Dredging Transects Comparison

Date: Pre-08/22 - 08/24/2018/Post-07/31 - 08/01/2019 **Surveyor:** SMT/ DRD

Transect No. (1-46)	Water Depth (cm)[A]		Quadrat (m)	1m² Quadrat						100cm2 Quadrat		Notes on first observation of seagrasses along transect
	Start	Stop		# of cells with seagrass	BB Total	BB_SP 1	BB_SP 2	BB_SP 3	BB_SP 4	Max canopy (cm)	# of shoots	
34 Post	250	110	0	0								
			5	96	1		Hj1		Sf0.5	25	20	Sf at 5 m
			10	4	0.5				Sf0.5	24	4	
			20	4	0.5		Hj0.5			2	6	
			30	0								
35 Pre	> 180	170	0	4	0.5			Hd 0.5		2	4	No data
			5	2	0.5			Hd 0.5		2	6	
			10	2	0.5			Hd 0.5		2	5	
			20	5	0.5			Hd 0.5		3	10	
			30	0	0					0	0	
35 Post	220	180	0	0								
			5	0								
			10	0								
			20	0								
			30	4	0.5			Hd0.5		2	2	Hj at 3 m
36 Pre	>200	85	0	2	0.5	Hw 0.5				3	3	
			5	0	0					0	0	
			10	0	0					0	0	
			20	4	0.5		Hj 0.5			2	2	No Data

[A] Water depth measured/estimated by biologist at time of seagrass survey unless otherwise noted by [B]

[B] If seagrass not present, water depth obtained from hydrographic survey which was conducted

Sebastian Inlet Pre-/Post-Construction Dredging Transects Comparison

Date: Pre-08/22 - 08/24/2018/Post-07/31 - 08/01/2019 Surveyor: SMT/ DRD

Transect No. (1-46)	Water Depth (cm)[A]		Quadrat (m)	1m² Quadrat						100cm2 Quadrat		Notes on first observation of seagrasses along transect
	Start	Stop		# of cells with seagrass	BB Total	BB_SP 1	BB_SP 2	BB_SP 3	BB_SP 4	Max canopy (cm)	# of shoots	
			30	2	0.5		Hj 0.5			2	1	
36 Post	250	110	0	0								
			5	19	1		Hj1			2	10	Hj at 5 m
			10	98	1		Hj1			2	18	
			20	98	1		Hj1			2	25	
			30	99	1		Hj1			2	27	
37 Pre	> 180	170	0	34	2			Hd 2		2	4	No data
			5	13	1			Hd 1		2	5	
			10	2	0.5			Hd 0.5		2	5	
			20	0	0					0	0	
			30	0	0					0	0	
37 Post	220	120	0	0								
			5	0								
			10	0								
			20	0								
			30	92	2		Hj0.5	Hd0.5	Sf2	22	12	Hj at 3 m
38 Pre	> 180	90	0	0	0					0	0	
			5	3	0.5		Hj 0.5			2	3	No data
			10	0	0					0	0	

[A] Water depth measured/estimated by biologist at time of seagrass survey unless otherwise noted by [B]

[B] If seagrass not present, water depth obtained from hydrographic survey which was conducted

Sebastian Inlet Pre-/Post-Construction Dredging Transects Comparison

Date: Pre-08/22 - 08/24/2018/Post-07/31 - 08/01/2019 **Surveyor:** SMT/ DRD

Transect No. (1-46)	Water Depth (cm)[A]		Quadrat (m)	1m² Quadrat						100cm2 Quadrat		Notes on first observation of seagrasses along transect
	Start	Stop		# of cells with seagrass	BB Total	BB_SP 1	BB_SP 2	BB_SP 3	BB_SP 4	Max canopy (cm)	# of shoots	
38 Pre	> 100	[illegible]	20	6	0.5		Hj 0.5			1	3	
			30	11	0.5	Hw 0.5	Hj 0.5			5	2	
38 Post	500	100	0	0								
			5	0								
			10	0								
			20	82	1		Hj1			2	12	Hw at 19 m
			30	96	2	Hw2	Hj2			14	18	
39 Pre	> 250	~ 130	0	8	1			Hd 1		3	19	No data
			5	4	0.5			Hd 0.5		3	16	
			10	10	0.5		Hj 0.5			3	14	
			20	0	0					0	0	
			30	42	3		Hj 3			3	30	
39 Post	220	120	0	0								
			5	0								
			10	0								
			20	0								
			30	18	0.5				Sf0.5	18	3	Hj at 6 m
			0	1	0.5		Hj 0.5			2	2	No data

[A] Water depth measured/estimated by biologist at time of seagrass survey unless otherwise noted by [B]

[B] If seagrass not present, water depth obtained from hydrographic survey which was conducted

Sebastian Inlet Pre-/Post-Construction Dredging Transects Comparison

Date: Pre-08/22 - 08/24/2018/Post-07/31 - 08/01/2019

Surveyor: SMT/ DRD

Transect No. (1-46)	Water Depth (cm)^A		Quadrat (m)	1m² Quadrat						100cm2 Quadrat		Notes on first observation of seagrasses along transect
	Start	Stop		# of cells with seagrass	BB Total	BB_SP 1	BB_SP 2	BB_SP 3	BB_SP 4	Max canopy (cm)	# of shoots	
40 Pre	> 180	90	5	3	0.5		Hj 0.5			2	1	
			10	14	0.5	Hw 0.5	Hj 0.5			4	2	
			20	12	0.5		Hj 0.5			3	3	
			30	30	0.5		Hj 0.5			2	5	
40 Post	500	100	0	0								
			5	0								
			10	0								
			20	89	1		Hj1			2	15	Hj at 18 m
			30	72	1		Hj1			2	9	
41 Pre	> 250	~ 130	0	0	0					0	0	
			5	1	0.5			Hd 0.5		2	13	No data
			10	0	0					0	0	
			20	16	2		Hj 1		Sf 1	11	14	
			30	16	2		Hj 2			3	15	
41 Post	220	120	0	0								
			5	3				Hd0.5		2	2	Hd at 4.3 m
			10	8				Hd0.5	He0.5	3	2	
			20	2			Hj0.5			2	2	

[A] Water depth measured/estimated by biologist at time of seagrass survey unless otherwise noted by [B]

[B] If seagrass not present, water depth obtained from hydrographic survey which was conducted

Sebastian Inlet Pre-/Post-Construction Dredging Transects Comparison

Date: Pre-08/22 - 08/24/2018/Post-07/31 - 08/01/2019 Surveyor: SMT/ DRD

Transect No. (1-46)	Water Depth (cm)[A] Start	Water Depth (cm)[A] Stop	Quadrat (m)	1m² Quadrat: # of cells with seagrass	BB Total	BB_SP 1	BB_SP 2	BB_SP 3	BB_SP 4	100cm2 Quadrat: Max canopy (cm)	# of shoots	Notes on first observation of seagrasses along transect
			30	8			Hj0.5		Sf0.5	17	2	
42 Pre	~ 180	85	0	6	0.5	Hw 0.5				5	6	No data
			5	0	0					0	0	
			10	2	0.5		Hj 0.5			2	2	
			20	0	0					0	0	
			30	0	0					0	0	
42 Post	500	120	0	0								
			5	0								
			10	0								
			20	0								
			30	94	2		Hj2			2	15	Hj at 29 m
43 Pre	120	120	0	0	0					0	0	
			5	0	0					0	0	
			10	28	1		Hj 1			2	5	No data
			20	5	0.5	Hw 0.5				4	1	
			30	8	0.5				Sf 0.5	12	5	
43 Post	250	180	0	0								
			5	0								
			10	7	0.5				Sf0.5	18	2	Sf at 9.4 m
			20	26	1	Hw1				12	4	

[A] Water depth measured/estimated by biologist at time of seagrass survey unless otherwise noted by [B]

[B] If seagrass not present, water depth obtained from hydrographic survey which was conducted

Sebastian Inlet Pre-/Post-Construction Dredging Transects Comparison

Date: Pre-08/22 - 08/24/2018/Post-07/31 - 08/01/2019

Surveyor: SMT/ DRD

Transect No. (1-46)	Water Depth (cm)[A]		Quadrat (m)	1m² Quadrat						100cm2 Quadrat		Notes on first observation of seagrasses along transect
	Start	Stop		# of cells with seagrass	BB Total	BB_SP 1	BB_SP 2	BB_SP 3	BB_SP 4	Max canopy (cm)	# of shoots	
			30	7	0.5				Sf0.5	18	4	
44 Pre	~ 180	100	0	0	0					0	0	
			5	13	0.5	Hw 0.5	Hj 0.5			4	3	No data
			10	2	0.5		Hj 0.5			2	2	
			20	28	1	Hw 0.5	Hj 0.5			4	4	
			30	0	0					0	0	
44 Post	220	180	0	0								
			5	0								
			10	0								
			20	2					Sf0.5	10	2	Sf at 14 m
			30	1				Hd0.5		2	2	
45 Pre	> 180	170	0	1	0.5				Tt 0.5	25	1	No data
			5	36	1	Hw 0.5		Hd 1		4	4	
			10	0	0					0	0	
			20	0	0					0	0	
			30	8	0.5	Hw 0.5		Hd 0.5		4	4	
45 Post	250	180	0	0								
			5	0								
			10	0								
			20	0								

[A] Water depth measured/estimated by biologist at time of seagrass survey unless otherwise noted by [B]

[B] If seagrass not present, water depth obtained from hydrographic survey which was conducted

Sebastian Inlet Pre-/Post-Construction Dredging Transects Comparison

Date: Pre-08/22 - 08/24/2018/Post-07/31 - 08/01/2019 Surveyor: SMT/ DRD

Transect No. (1-46)	Water Depth (cm)[A] Start	Water Depth (cm)[A] Stop	Quadrat (m)	1m² Quadrat: # of cells with seagrass	BB Total	BB_SP 1	BB_SP 2	BB_SP 3	BB_SP 4	100cm2 Quadrat: Max canopy (cm)	# of shoots	Notes on first observation of seagrasses along transect
			30	22	1			Hd1		2	8	Hd at 26 m
46	180	170	0	0	0					0	0	
			5	0	0					0	0	
			10	0	0					0	0	
			20	2	0.5			Hd 0.5		4	2	No data
			30	20	1			Hd 1		4	4	
46	250	180	0	0								
			5	0								
			10	0								
			20	0								
			30	3	0.5			Hd0.5		2	2	Hd at 17 m

[A] Water depth measured/estimated by biologist at time of seagrass survey unless otherwise noted by [B]

[B] If seagrass not present, water depth obtained from hydrographic survey which was conducted

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Sebastian Inlet District Sand Bypassing Project:

2019 Immediate Post-Construction Monitoring Survey

FDEP Permit No. 0270746-001-EM
USACE Permit No. SAJ-1992-01224 (SP-IS)

December 2019




Prepared for:
Sebastian Inlet District
114 Sixth Avenue
Indialantic, Florida 32903
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Under Contract to:
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TRACE CERTIFIED PEC SafeGulf AUTHORIZED PROVIDER

Sebastian Inlet District
Sand Bypassing Project:
2019 Immediate Post-Construction Monitoring Survey

DOCUMENT NO. CSA-ATM-FL-19-81019-3432-06-REP-01-FINREV01

Version	Date	Description	Prepared by:	Reviewed by:	Approved by:
01	11/04/19	Draft for review	C. Baumberger	L. Kabay	C. Baumberger
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Table of Contents

Page

Table of Contents
(Continued)

Page

List of Tables

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List of Figures

List of Figures
(Continued)

Figure **Page**

List of Photos

Photo **Page**

List of Acronyms and Abbreviations

ANOSIM	analysis of similarities
ATM	Applied Technology and Management, Inc.
BMP	biological monitoring plan
CPCe	Coral Point Count with Excel Extensions
CSA	CSA Ocean Sciences Inc.
DGPS	differential global positioning system
DMMA	Dredged Material Management Area
ETOF	equilibrium toe of fill
FDEP	Florida Department of Environmental Protection
GIS	geographic information system
HD	high-definition
IRC	Indian River County
MDS	multidimensional scaling
MHW	mean high water
NL	non-living (substrate)
R-monuments	FDEP Range Monuments
SE	standard error
SID	Sebastian Inlet District
SIMPER	similarity percentage routine
SIMPROF	similarity profile analysis
SOP	standard operating procedures
TAC	technical advisory committee
USACE	United States Army Corps of Engineers

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1.0 Introduction

CSA Ocean Sciences Inc.[1] (CSA) was contracted as a sub-consultant to Applied Technology and Management, Inc. (ATM) under their contract with the Sebastian Inlet District (SID) to conduct monitoring of nearshore hardbottom habitats in coastal waters of Indian River County (IRC) Florida following sand bypassing projects south of the Sebastian Inlet. In 2019, CSA conducted immediate post construction monitoring during the summer, following the most recent SID sand bypassing project which occurred in winter of 2018-2019. A pre-construction, baseline monitoring survey was completed in 2018 to fulfill the permit requirements for the bypassing event of 2018-2019 under the Sebastian Inlet District Sand Bypassing Project (Florida Department of Environmental Protection [FDEP] Permit No. 0270746-011-JN and United States Army Corp of Engineers [USACE] Permit No. SAJ-1992-01224 [SP-IS]).

The Commission of the Sebastian Inlet District authorizes programs and projects for beach renourishment, erosion control, environmental protection, navigation, boating, recreation, and public safety. The SID Commission is also responsible for maintaining the Sebastian Inlet's navigational channel, sand trap, and structures (i.e., jetties). The SID is charged by the FDEP to bypass sand south of the Sebastian Inlet to offset inlet impacts to the natural southward flow of sediments along the coast (longshore sediment transport).

The SID nearshore hardbottom monitoring program specifications are dictated by an FDEP-approved Nearshore Hardbottom Biological Monitoring Plan (BMP), which until 2018 had not been updated since 2013. During the 2013 to 2018 timeframe, FDEP revised the Standard Operating Procedures (SOP) for nearshore hardbottom monitoring for the state (FDEP, 2016). The most recent beach nourishment project that required 3 years of post-construction monitoring was in 2015. However, the SID did not bypass sand in 2018, and FDEP had determined no impacts from the previous 5 years of sand bypassing, therefore, the 3rd year of post-construction monitoring was waived. This proved an ideal time to update the 2013 BMP to bring it in line with the current SOP. The BMP for the SID Sand Bypassing Project was revised along with the permit for 2018 and approved by FDEP on 22 August 2018. Discontinuation of monitoring related to the 2015 sand bypassing project allowed the 2018 monitoring season to serve as a new baseline survey for future sand bypassing projects using the revised monitoring protocols. The 2019 monitoring survey represents the first post-construction survey after the 2018 baseline.

This report represents the 2019 Immediate Post-Construction Hardbottom Monitoring Survey for the Sebastian Inlet District following the 2019 sand bypassing project and was performed from 10 to 25 June 2019 which included survey of the entire project area (R-4 south to R-17) using the updated 2018 BMP. Representing the first post-construction survey, results from this report will be compared with the 2018 baseline dataset to assess changes in the nearshore hardbottom habitat.

[1] CSA International, Inc. changed its company name to CSA Ocean Sciences Inc. effective 1 January 2013.

The objectives of the 2019 Immediate Post-Construction Hardbottom Monitoring Survey were as follows:

- Describe the abundance and biodiversity of the benthic flora and fauna within the influence of the project fill area;
- Assess the position and biota along the landward edge of hardbottom following the fill project;
- Assess the locations of hardbottom and sand troughs along survey transects;
- Assess the depth of sediments along the entirety of survey transects; and,
- Compare this data with the 2018 baseline survey conditions to assess changes in the nearshore habitat.

2.0 Project History

In order to fulfill the mission of the SID to maintain safe depths for navigation, periodic dredging of the inlet's interior channel and sand trap is required. A sand trap was first constructed inside the inlet in 1962 and later expanded in 1978 and 2014 with the purpose of capturing beach-quality sand typically lost to the inlet's flood shoal. Suitable material excavated from the channel and sand trap is periodically placed on beaches down current (downdrift) from the inlet to offset the interruption of longshore sediment transport caused by the inlet. A stockpile of sand is sometimes held on the north side of Sebastian Inlet State park in a Dredged Material Management Area (DMMA) for emergency post-storm repairs when available. Surplus materials from dredging operations may be stored at the DMMA.

Since the Sebastian Inlet District was formed in 1919; a total of 21 dredging events of the inlet channel or sand trap have taken place through 2018. A history of major dredging events and beach nourishments pertaining to the Sebastian Inlet and vicinity is displayed in **Table 1**.

To facilitate meeting the bypassing goals for the Sebastian Inlet, SID contracted ATM to design, permit, and oversee the construction of sand bypassing projects. Placement of the most recent beach fill that includes sand placed below Mean High Water (MHW) occurred in 2019 via hydraulic means.

Due to the presence of sensitive nearshore hardbottom habitats just offshore of the beach in Sebastian, biological monitoring programs of these resources are required by the regulatory agencies (FDEP and USACE) in relation to beach nourishment activities (see summary of survey reports for this area, **Table 2**). From 2007 to 2011, a biological monitoring program for nearshore hardbottom habitats located south of the Sebastian Inlet was performed for the IRC Sectors 1 and 2 Beach Nourishment Project (FDEP 2007), consisting of annual monitoring surveys prior to, immediately following, and for 3 years post-construction, for a total of five annual monitoring surveys (CSA International, Inc., 2012a). Following completion of this monitoring program in 2011, SID took over responsibility for the monitoring program and also performed sand bypassing projects with annual placements of beach fill on the downdrift beach south of the inlet from 2012 to 2015; each bypassing event requiring an immediate post-construction biological monitoring survey of nearshore hardbottom habitats (**Figure 1** and **Photo 1**) (CSA International, Inc., 2012b; CSA Ocean Sciences Inc., 2013, 2014, 2015).

Following the 2015 SID Sand Bypassing Project, post-construction monitoring surveys were conducted in 2015, 2016, and 2017. The 2017 survey was ongoing at the time leading up to Hurricane Irma, 10 to 11 September 2017 which created high winds and heavy seas along the coast (Coastal Data Information Program, 2017). Therefore, the 2017 survey was not completed as conditions following the storm were not conducive to biological data collection. FDEP waived further data collection for the 2017 hardbottom monitoring following the storm. Upon review of the 2015 through 2017 datasets, FDEP determined there had been no impacts to adjacent nearshore hardbottom resources from the 2015 Sand Bypassing Project.

Table 1. Dredge and beach nourishment history of the Sebastian Inlet and vicinity from 1918 to 2019. (Data provided by Sebastian Inlet District and Applied Technology and Management, Inc.).

Project/Activity	Year	Volume Dredged from Inlet/Sand Trap, Including Non-compatible Beach Material (approximate yd^3)	South Beach Placement of Beach-Compatible Material (approximate yd^3)
Inlet construction	1918	n/a	None
Inlet dredge and jetty extension	1924	n/a	None
Inlet dredge	1939	72,000	None
Inlet blasting	1947	70,000	None
Channel dredge	1948	182,567	None
Channel dredge	1950	55,000	None
Channel dredge	1952	55,000	None
Channel dredge	1955	45,600	None
Channel dredge	1958	200,000	None
Channel dredge and sand trap construction	1962	281,147	201,000
Channel dredge and sand trap expansion	1972	440,700	420,000
Sand trap excavation	1978	286,500	187,600
Sand trap excavation	1985 to 1986	133,290	110,038
Channel dredge	1987 to 1988	103,626	None
Sand transfer	1989	None	90,000
Channel dredge and sand trap excavation	1989 to 1990	248,657	248,657
Channel dredge and sand trap excavation	1992 to 1993	116,520	116,520
Upland source sand trucking	1996 to 1997	None	236,240
Channel dredge and sand trap excavation	1998 to 1999	236,883	236,883
Upland sand source trucking	1999 to 2002	None	264,755
IRC Sectors 1 and 2 Beach Restoration	2003	None	589,000*
Sand trap and IRC Sectors 1 and 2 Beach Nourishment	2007	86,000†	86,000 172,000*
Channel dredge and sand trap excavation	2012	141,300	119,900
DMMA screening and upland sand source	2013	None	18,000† 16,600#
Sand trap maintenance and expansion	2014	160,500	111,200
DMMA screening and upland sand source (event for which this document reports)	2015	None	25,000† 31,000#
Post-Matthew Emergency Repair (All material placed above MHW)	2017	None	31,000#
Channel dredge and sand trap excavation	2019	166,260	113,570

* Offshore borrow area utilized as sand source.
† Upland sand source.
# dredged material management area (DMMA) as sand source.
IRC = Indian River County; MWH = mean high water; yd^3 = cubic yards; n/a = not applicable.

Table 2. Summary of nearshore hardbottom monitoring surveys associated with the Indian River County (IRC) Sectors 1 and 2 Beach Nourishment Project and the Sebastian Inlet District (SID) Sand Bypassing Projects since 2007.

Year	Project	Permittee	Monitoring Survey Type
2007	IRC Sectors 1 and 2 Nourishment Project	Indian River County	Pre-Construction Baseline
2008	IRC Sectors 1 and 2 Nourishment Project	Indian River County	Immediate Post-Construction
2009	IRC Sectors 1 and 2 Nourishment Project	Indian River County	Year 1 Post-Construction
2010	IRC Sectors 1 and 2 Nourishment Project	Indian River County	Year 2 Post-Construction
2011	IRC Sectors 1 and 2 Nourishment Project	Indian River County	Year 3 Post-Construction/Pre-Construction Baseline
2012	SID Sand Bypassing Project	Sebastian Inlet District	Immediate Post-Construction
2013	SID Sand Bypassing Project	Sebastian Inlet District	Immediate Post-Construction
2014	SID Sand Bypassing Project	Sebastian Inlet District	Immediate Post-Construction
2015	SID Sand Bypassing Project	Sebastian Inlet District	Immediate Post-Construction
2016	No Fill, SID Sand Bypassing Project	Sebastian Inlet District	Year 1 Post-Construction
2017	Emergency Dune Project, SID Sand Bypassing Project	Sebastian Inlet District	Year 2 Post-Construction
2018	No Fill, SID Sand Bypassing Project	Sebastian Inlet District	Pre-Construction Baseline
2019	SID Sand Bypassing Project	Sebastian Inlet District	Immediate Post-Construction

In 2018, FDEP revised the BMP for the SID Sand Bypassing project to bring the project in line with the current FDEP Monitoring Standards for Nearshore Hardbottom (FDEP, 2016). The monitoring transects were shortened to 100 m and their origins were adjusted to the equilibrium toe of fill (ETOF), as opposed to the landward edge of the hardbottom, as the previous projects called for. A new baseline datum was recorded for the SID project area in 2018, prior to the 2019 inlet sand trap dredging project. In 2019, SID placed 113,570 cy of sand dredged from the inlet sand trap onto the beach in the project area, from R-4 to R-17 (**Figure 1**). The fill operation required immediate post-construction monitoring, which was conducted in June 2019, and is the subject of this report.

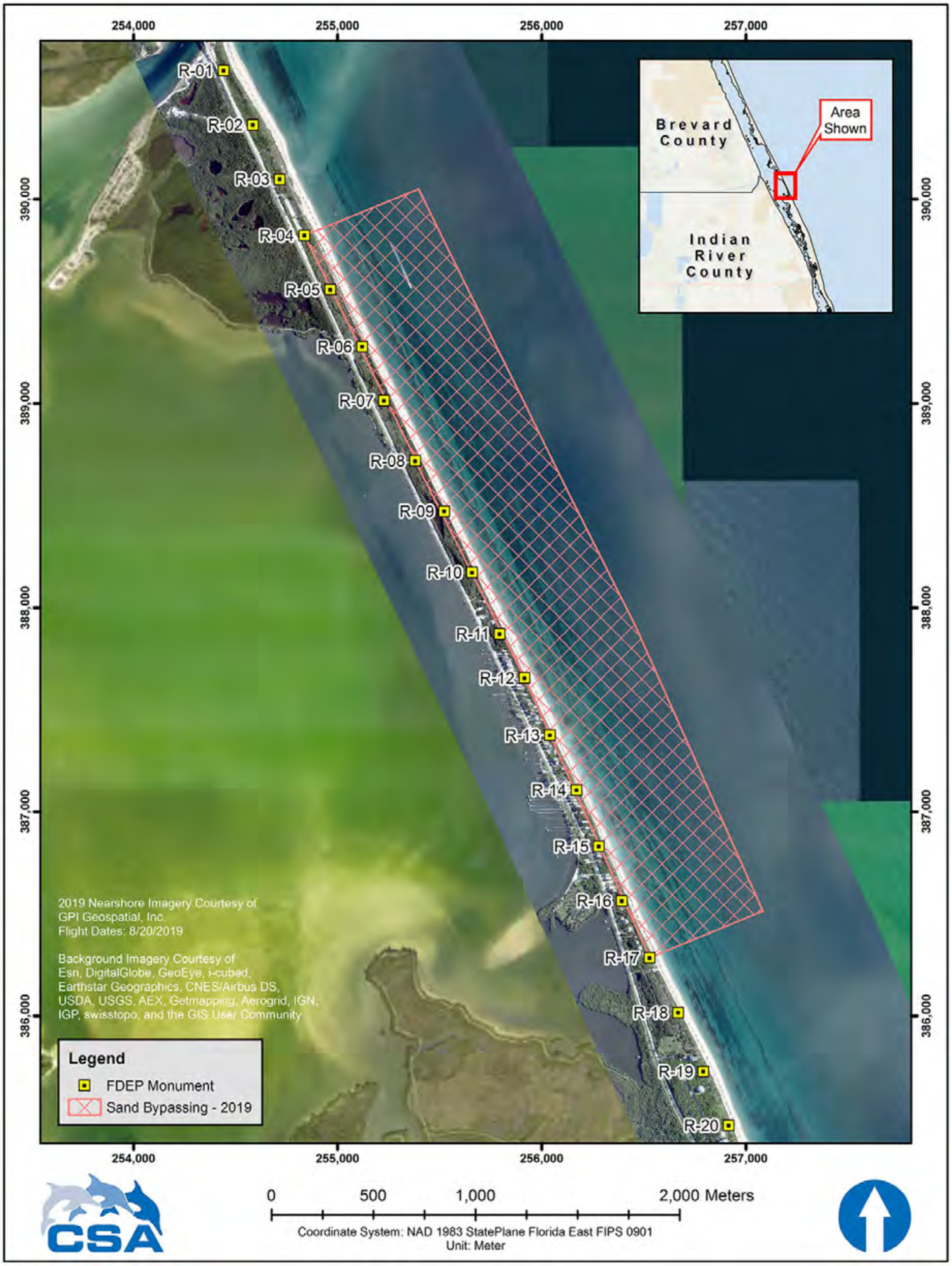

Figure 1. Location map showing project construction area for the 2019 Sebastian Inlet District Sand Bypassing Project

Photo 1. Overview of Sebastian Inlet District project area from Sebastian Inlet South Jetty, visible in photo from beach camera, 06 August 2018.

3.1 FIELD METHODS

The BMP for monitoring nearshore hardbottom habitats potentially influenced by the SID Sand Bypassing Projects (FDEP, 2012) was updated in 2018 (FDEP, 2018) to ensure that monitoring is consistent with the Department's current SOP's (FDEP, 2016) and is conducted as efficiently as is practicable. The following updates and changes made in 2018 were followed in 2019.

3.1.1 Survey Area

The revised BMP called for the survey of nine permanent cross-shore monitoring transects: Transects R-5, R-6.5, R-8, R-9.5, R-10.5, R-12, R-14.2, and R-16.9 which were originally installed in 2007 for the Indian River County Sectors 1 and 2 beach nourishment project. Transects were named by location relative to FDEP range monuments (R-monuments) at the time of transect establishment (CSA International, Inc., 2007). The 2018 BMP also required diver mapping of the nearshore (landward) edge of hardbottom from R-4 to R-17.

The permanent cross-shore monitoring transects were originally established at bearings ranging from 70° to 90° from the shoreline at prescribed geographic locations, denoted by R-monuments between R-5 and R-16.9 (**Figure 2**). The 2018 revision required the transects to begin at the ETOF, as any impacts shoreward of the ETOF have been mitigated for previously. This revision included alteration of the start position of each transect and the movement of Transect R-10.5 shoreward to the ETOF, which aligned it with the other monitoring transects (**Table 3**). All transects terminated at approximately 100 m in length.

Transects were permanently established in 2018 by installing either stainless steel rods or eyebolts as permanent markers along transects at 5-meter spacing from 0 m to approximately 30 m and then every 10 m until 100 m (**Table 4**). A long, stainless-steel rod (40 to 60 cm) was typically installed to denote the beginning and end of each transect; however, along some transects originating in shallow areas close to shore, low-relief eyebolts with a round end were used where rods could cause injury to swimmers, surfers, fishermen, etc. The rods were used in deeper areas to increase their visibility to divers for future monitoring surveys. A Trimble SPS 461 differential global positioning system (DGPS) in conjunction with Hypack hydrographic survey software on a DGPS integrated laptop computer was used for vessel navigation and locating transects. A diver towed buoy equipped with a Leica MX420 DGPS antenna connected to the vessel Hypack system via radio telemetry was used to record geographic coordinates at the start and end points as well as at each of the permanent markers along each transect at the time of transect establishment (**Appendix A**).

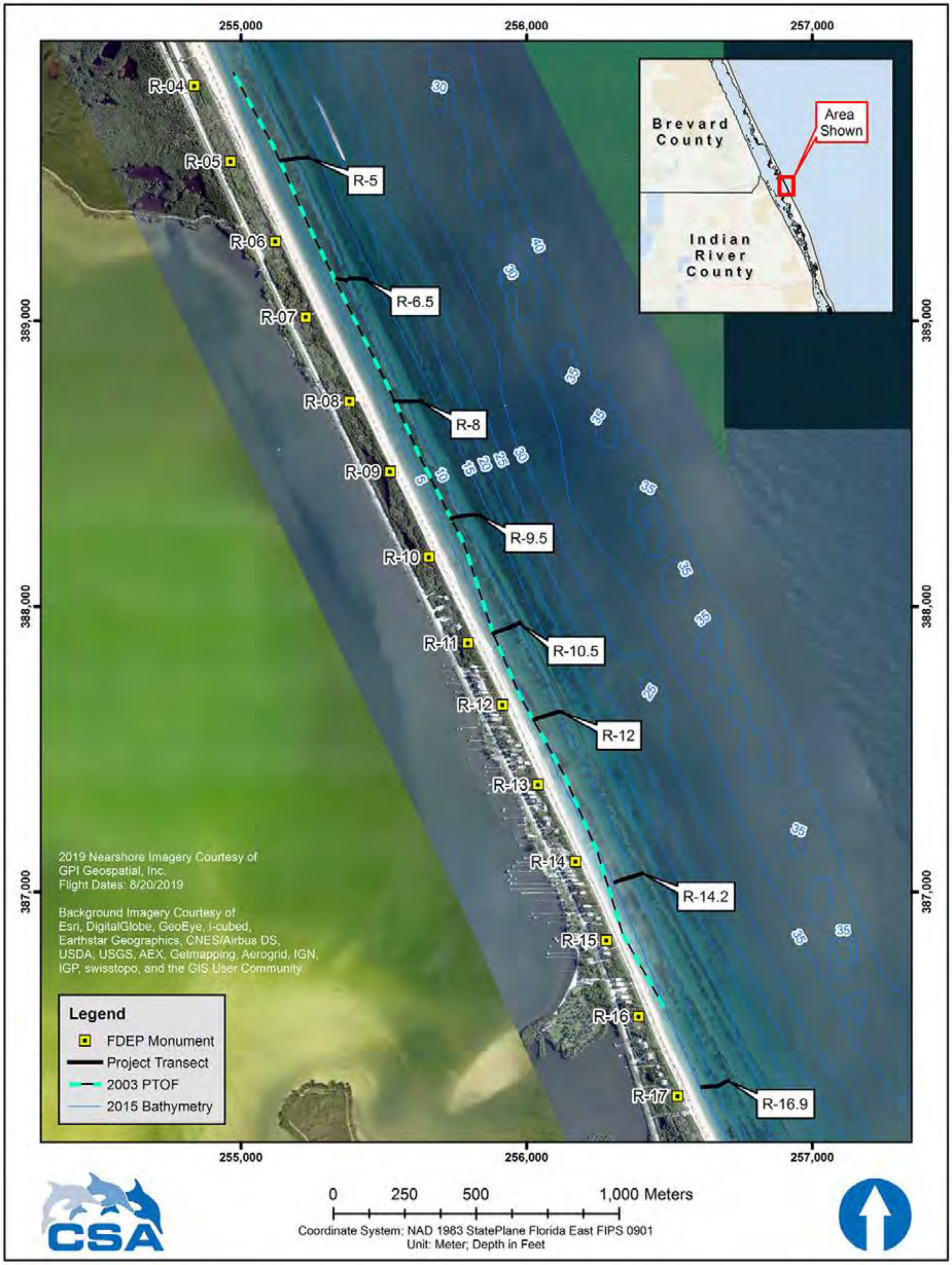

Figure 2. Overview of the eight monitoring transects surveyed for the Sebastian Inlet District Sand Bypassing Project: 2019 Immediate Post-Construction Hardbottom Monitoring Survey. PTOF = permitted toe of fill.

Table 3. Geographic coordinates (X/Y and latitude/longitude) for start and end points of the eight monitoring transects surveyed for the Sebastian Inlet District Sand Bypassing Project: 2019 Immediate Post-Construction Hardbottom Monitoring Survey.

Transect	Start Point (0 m marker)				End Point (100 m marker)			
	Easting X (ft) *	Northing Y (ft) *	Latitude (N)	Longitude (W)	Easting X (ft) *	Northing Y (ft) *	Latitude (N)	Longitude (W)
R-5	255141.56	389561.75	27.848634	-80.440153	255235.55	389572.20	27.848725	-80.439199
R-6.5	255336.64	389147.50	27.844888	-80.438192	255440.90	389145.76	27.844868	-80.437134
R-8	255538.90	388717.35	27.840998	-80.436159	255631.66	388717.22	27.840993	-80.435217
R-9.5	255736.66	388307.69	27.837293	-80.434170	255836.59	388318.50	27.837386	-80.433156
R-10.5	255883.16	387905.93	27.833661	-80.432702	255976.41	387942.93	27.833992	-80.431754
R-12	256026.75	387603.32	27.830925	-80.431259	256121.52	387629.43	27.831156	-80.430296
R-14.2	256310.98	387033.94	27.825775	-80.428400	256404.26	387064.48	27.826046	-80.427452
R-16.9	256616.14	386316.17	27.819285	-80.425337	256705.04	386337.83	27.819476	-80.424434

*Data are provided in NAD_1983_State Plane_Florida_East_FIPS_0901_Meters.

Table 4. Permanent transect marker location and type along the eight monitoring transects surveyed for the Sebastian Inlet District Sand Bypassing Project: 2019 Immediate Post-Construction Hardbottom Monitoring Survey.

Transect															
R-5		R-6.5		R-8		R-9.5		R-10.5		R-12		R-14.2		R-16.9	
Established 8/13/2018		Established 8/14/2018		Established 8/15/2018		Established 8/14/2018		Established 8/22/2018		Established 8/22/2018		Established 8/23/2018		Established 8/15/2018	
Marker Location (m)	Type of Marker	Marker Location (m)	Type of Marker	Marker Location (m)	Type of Marker	Marker Location (m)	Type of Marker	Marker Location (m)	Type of Marker	Marker Location (m)	Type of Marker	Marker Location (m)	Type of Marker	Marker Location (m)	Type of Marker
0	Long rod	0	Long rod	0	Long rod	0	Eyebolt	0	Eyebolt	0	Eyebolt	0	Eyebolt	0	Long rod
5	Short rod	5	Eyebolt	4.4	Short rod	5	Eyebolt	5	Long rod	5	Eyebolt	5	Eyebolt	5	Eyebolt
10	Short rod	10	Eyebolt	6	Eyebolt	10	Eyebolt	12	Short rod	11	Eyebolt	10	Eyebolt	16	Eyebolt
16	Eyebolt	15	Eyebolt	16.8	Eyebolt	15	Eyebolt	16	Short rod	15	Eyebolt	15	Eyebolt	31	Short rod
20	Short rod	20	Eyebolt	20	Short rod	20	Eyebolt	54	Short rod	33	Eyebolt	21	Eyebolt	35	Eyebolt
25	Eyebolt	25	Eyebolt	24	Short rod	25	Eyebolt	60	Eyebolt	65	Short rod	25	Eyebolt	53	Short rod
30	Eyebolt	30	Eyebolt	27	Short rod	27	Eyebolt	69	Eyebolt	78	Short rod	30	Short rod	58	Short rod
38	Short rod	43	Eyebolt	40	Eyebolt	32	Eyebolt	80	Eyebolt	84	Short rod	35	Short rod	88	Short rod
42	Eyebolt	50	Short rod	50	Short rod	37	Eyebolt	100	Long rod	99	Long rod	41	Eyebolt	95	Short rod
50	Eyebolt	83	Short rod	80	Short rod	45	Short rod					56	Short rod	100	Long rod
59	Eyebolt	100	Long rod	90	Eyebolt	80	Short rod					63	Short rod		
89	Short rod			100	Long rod	88	Short rod					87	Short rod		
103	Eyebolt					100	Long rod					100	Short rod		

Eyebolt = 10 cm high; long rod = 60 cm high; short rod = 40 cm high.

3.1.2 Video Data Collection

Scientists on scuba collected quantitative video data along each of the monitoring transects. A Canon XA-10 high-definition (HD) digital video camera in a Light and Motion underwater housing equipped with Sola video lights was used to record video. The camera was held perpendicular to the substrate, and two lasers mounted on the video camera housing converged at a point that guided the diver in maintaining a camera height of 25 cm above the seafloor. These videos are currently maintained for archival purposes at FDEP, ATM, and CSA. The quantitative video data could be analyzed subsequently if the results of future fill projects indicate substantial burial of hardbottom communities and if the FDEP requires analysis as a provisional task to quantify project-related impacts.

Qualitative video data also were collected along the entire length of each transect 40 to 50 cm above the seafloor (or within visibility limits) at an oblique angle (approximately 45º from horizontal) with a Go-Pro Hero 7 UHD video camera. These video data were collected to document benthic relief changes, expanse of sand gaps, presence of scleractinian corals, and other fauna of interest in the general vicinity of the transects and provide a record of conditions during the survey.

3.1.3 Quadrat Sampling

Quadrats (0.5 m^2 **Photo 2**) were sampled at 13 point-intercept locations along each transect. Water depths of quadrat sampling locations ranged from 0.25 m (on the intertidal portion of the beach on some transects) to approximately 5 m on the offshore end of transects.

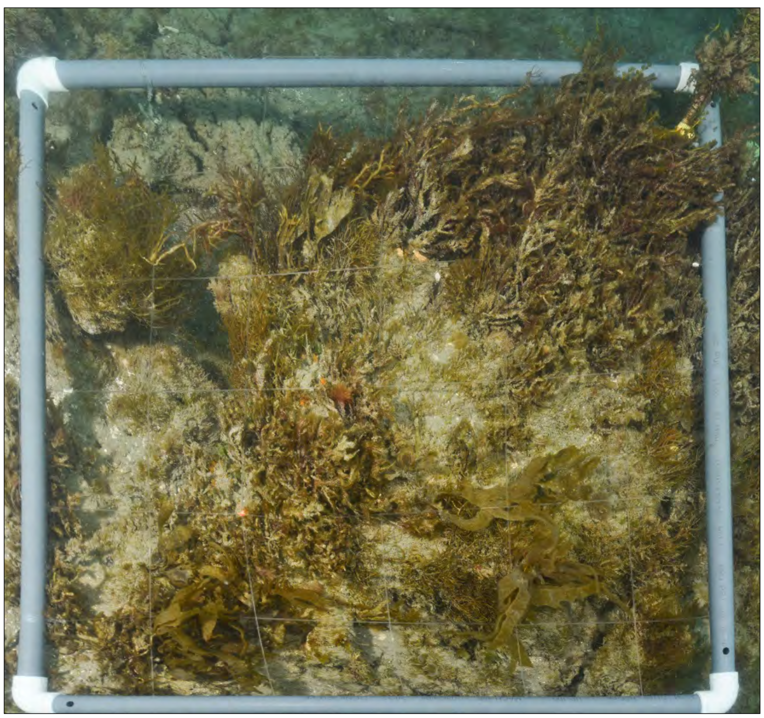

Photo 2. Monitoring quadrat at 100 m on Transect R-6.5, sampled on 12 June 2019.

Within each quadrat, visual estimates of percent cover and genus/species identification were performed *in situ* for the following flora and fauna: macroalgae, turf algae, cyanobacteria,

sponges (genus level, with a separate assessment of the boring sponge *Cliona* spp.), tunicates, zoanthids, hydroids, sabellariid wormrock, *Phragmatopoma lapidosa* (wormrock), octocorals (genus level), and scleractinian corals (species level). Summary categories were created for algae and fauna which consisted of all taxa which fell into those two categories. Individual counts were conducted for all octocorals, scleractinian corals, urchins, and holothuroids within quadrats. Scleractinian corals and octocorals were also assessed for size class distribution (diameter of scleractinian/height of octocoral); size classes 1, 2, 3, and 4 are defined as <5 cm, 5 to 15 cm, 15 to 25 cm, and >25 cm, respectively. Percent cover by substrate type (hardbottom, rubble, sand, shell hash, and sediment over hardbottom [sediment veneer up to 1 cm thick]) was recorded. A summary category called non-living (NL) substrate was created from the sum of substrate types.

The maximum physical relief of hardbottom from the apparent lowest to highest point within the quadrat was measured to the nearest millimeter. Sediment accumulation was measured to the nearest millimeter at three haphazardly selected locations within each quadrat by manually pressing a ruler into the sediment until the point of refusal or until a maximum depth of 30.0 cm was reached. Sediment depth >30.0 cm was recorded as 30.0 cm.

3.1.4 Line-Intercept and Sediment Accumulation Measurements

A line-intercept method was used to document larger areas of uninterrupted sand (physical transitions along the monitoring transect between sand and hardbottom), and to track changes in sediment and hardbottom cover. Divers estimated the linear extent of sand cover (sediment depth ≥1 cm uninterrupted by protruding benthic biota) by recording the landward and seaward position of each sand patch or trough larger than 0.5 m in length along each transect by reference to transect tape meter mark to the nearest decimeter.

To track changes in sediment depth associated with changes in sediment cover, sediment depth (±1 mm) was measured at 1 m intervals from the 0-m marker along the entire length of each 100 m transect, inclusive of sand patches. A stainless-steel ruler was manually pressed into the sediment until the point of refusal or until a maximum depth of 30.0 cm was reached. Sediment depth >30.0 cm was recorded as 30.0 cm.

3.1.5 Nearshore Edge of Hardbottom Mapping

The nearshore (western) edge of hardbottom between R-4 and R-17 required a continuous survey *in situ*; therefore, it was mapped by two divers on scuba or by wading in very shallow areas. One diver towed a buoy with Leica MX420 DGPS antenna and a Pacific Crest Corp. EDL II radio telemetry transmitter interfaced with the survey vessel computer providing a real-time, sub-meter fix on the buoy which was recorded in Hypack. The other diver swam beneath the buoy to collect geo-referenced qualitative HD video. To assist mapping efforts, side-looking sonar images were reviewed simultaneously during mapping from the vessel with a Humminbird 1198c SI Combo unit to ensure divers mapped the most landward edge of nearshore hardbottom. In cases where the nearshore edge of hardbottom was semi-exposed above water or in very shallow water close to the beach, divers walked along the edge with the telemetry buoy. Sand gaps greater than 10 m alongshore were noted if they were encountered by the divers.

3.2 DATA ANALYSIS

3.2.1 Video Data Analysis

If mandated by the FDEP, subsequent analysis of quantitative video transect data will be implemented as a provisional task to quantify project-related impacts. If undertaken, quantitative video data will be analyzed with Coral Point Count with Excel Extensions (CPCe), (Kohler and Gill, 2006) or a comparable software package based on the random point-count method to estimate percent cover from digitally frame-grabbed underwater video images.

3.2.2 Quadrat Data Analysis

Quadrat data were entered into an Excel spreadsheet, and mean percent cover of all benthic and NL substrate categories was calculated. Faunal counts also were entered into a spreadsheet, and total number of colonies or individuals per quadrat (0.5 m^2) were calculated. Transect means, overall means, and standard errors were calculated for the survey dataset. Comparison with the baseline data were made through multivariate statistics in Primer-E.

3.2.3 Sediment Accumulation Analysis

Sediment depths were measured at each meter along transects and from three haphazardly-selected locations within quadrats. Sediment depths recorded by these methods were tabulated for each survey and figures of the 1-m measurements along each transect were created to visualize sediment depths along the transects. Quadrat maximum hardbottom relief was also tabulated for comparison with baseline monitoring results.

To compare hardbottom relief and sediment depth measurements between years, t-tests (assuming unequal variances) were calculated using Microsoft Excel Data Analysis ToolPak to compare hardbottom relief and mean sediment depth.

Delineation of hardbottom and sand along the transects (in meters) was tabulated and figures depicting the distribution along each transect were created. Changes in overall total hardbottom and sand length along transects were compared to determine potential changes in distribution.

3.2.4 Nearshore Edge of Hardbottom Analysis

Post-processing and export functions within the hydrographic survey software were used to export navigational data from nearshore edge of hardbottom mapping to geographic information system (GIS) software (ArcGIS 10.3.1). Once imported into ArcGIS, data were displayed in relation to aerial imagery from 2019 and other spatial features. To facilitate comparison of the 2019 mapped edge with the baseline survey in 2018, both edge lines were overlaid on the figures.

Qualitative video data collected along the nearshore edge of hardbottom were reviewed by a marine scientist who made notes while viewing the videos to provide a description of the edge habitats. The description included estimates of physical, vertical relief (m), presence and degree of thickness of sediment veneers, identification of most frequently encountered algal species, and presence of various fauna of interest.

4.1 NARRATIVE DESCRIPTION OF QUADRAT DATA IN 2018

4.1.1 Percent Cover of Major Benthic Categories

Results from percent cover (cover) assessments within quadrats sampled in 2019 showed Total NL substrate was the most abundant category overall (**Figure 3**, mean 53.4% [±2.6% Standard Error, SE]). Non-Living substrate cover ranged from 42.9% (±5.0% SE) to 67.9% (±7.3% SE), on transects R-12 and R-14.2, respectively. This dominance was observed along all transects except R-9.5, and R-12, where total algae cover was greater, (52.6% and 52.8% [±6.6% SE], respectively). Algal cover ranged from 28.0% (±5.6% SE) to 52.8% (±5.9% SE), on transects R-14.2 and R-12, respectively.

Fauna were found in less abundance than NL substrate and algae, achieving a mean cover of 4.1% (±0.9% SE), ranging from 1.6% (±0.8% SE) on transect R-9.5 to 14.1% (±5.9% SE) on transect R-16.9. Cyanobacteria were only observed on transects R-10 and R-16.9, compiling a mean of 0.3% (±0.2% SE) overall. **Appendix A** displays mean percent cover of all taxa and NL substrate types from all quadrats along each transect and summarized into overall project means.

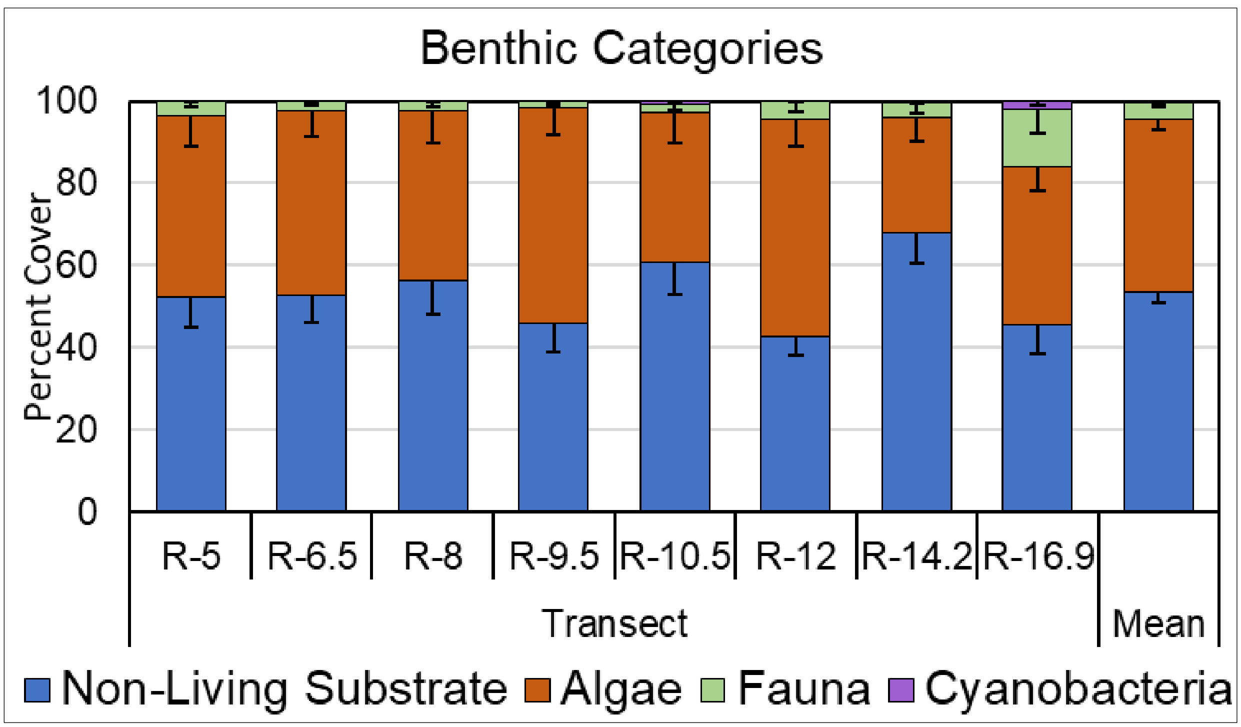

Figure 3. Mean percent cover (- standard error) of major categories within quadrats surveyed for the Sebastian Inlet District Sand Bypassing Project: 2019 Immediate Post-Construction Hardbottom Monitoring Survey.

4.1.2 Percent Cover of Non-Living Substrate Types

Within the NL substrate category, sediment over hardbottom (thin veneer of sediment ≤1 cm thick over hardbottom) was the most frequently encountered substrate type (28.1% [±1.8% SE]), with the exception of transects R-8 and R-14.2 where unconsolidated substrate (primarily sand) had the greatest cover (**Figure 4**, 31.7% [±12.0% SE] and 45.0% [±11.5% SE]). Mean cover of sediment over hardbottom was greatest along transect R-10.5 at 36.9% (±5.2% SE). Mean cover of hardbottom (exposed, uncolonized bare rock) was low overall, 0.8% (±0.3% SE), and was <3% on all transects.

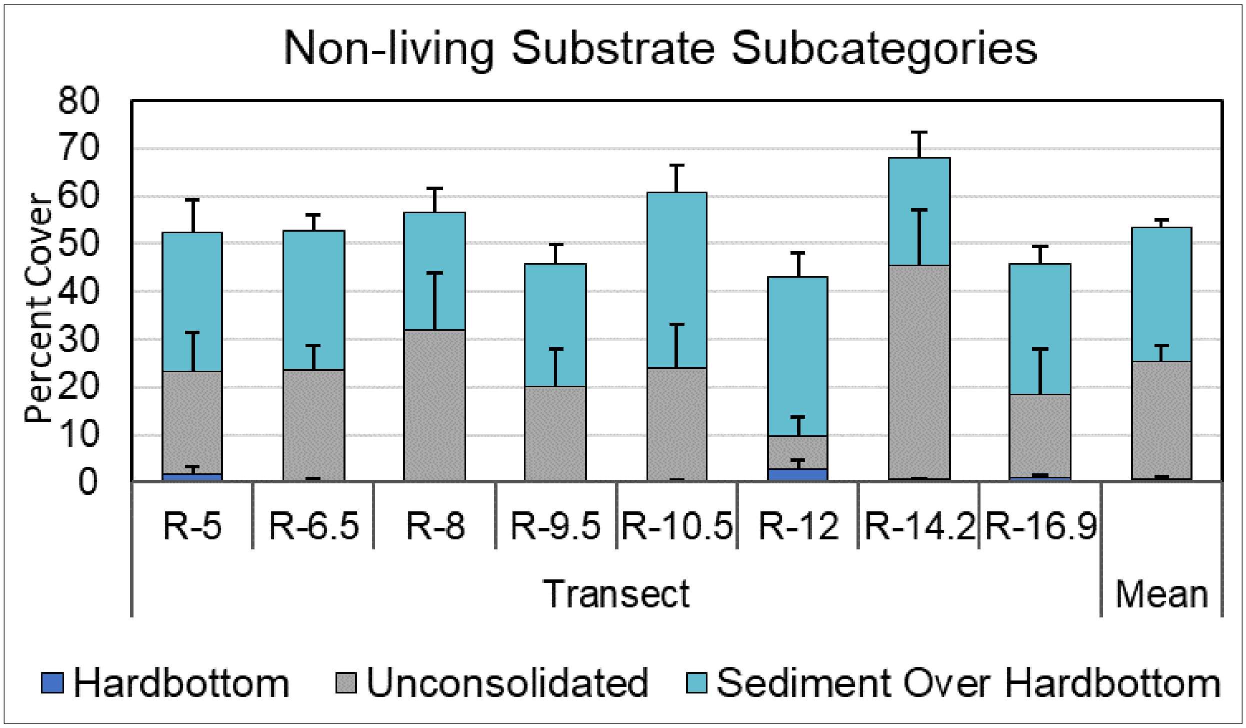

Figure 4. Mean percent cover (+ standard error) of non-living substrate subcategories within quadrats surveyed for the Sebastian Inlet District Sand Bypassing Project: 2019 Immediate Post-Construction Hardbottom Monitoring Survey.

4.1.3 Percent Composition of the Algal Community

Percent cover of total algae was assessed in more detail to differentiate algal sub-categories: turf algae and taxonomic macroalgal divisions of Chlorophyta, Phaeophyta, and Rhodophyta, and predominance of certain species. Rhodophyta (red algae) was the most abundant macroalgal division on all transects (**Figure 5**). Cover of Rhodophyta ranged from 16.4% (±4.0% SE) on R-14.2 to 38.1% (±5.0% SE) on R-9.5. The most frequently observed Rhodophyta were *Bryothamnion seaforthii*, *Bryocladia cuspidata* and *Botryocladia occidentalis,* which together accounted for most of the algal cover (**Appendix A**). Overall, turf algae were second in mean cover at 7.2% (±1.4% SE), Chlorophyta (green algae) amassed 4.9% (±0.7% SE) and Phaeophyta (brown algae) was the least abundant division, 4.0% (±0.8% SE), overall. Taxa of abundance consisted of *Spatoglossum schroederi* and *Dictyota* spp. within the Phaeophyta, while Chlorophyta were most represented by *Ulva lactuca* and five species of *Caulerpa.*

A summary of all algae encountered during the 2019 survey revealed a total of 40 distinct taxa (**Table 5**). All macroalgal divisions were represented in the data set, with 11 Chlorophyta taxa, 5 Phaeophyta taxa, and 27 Rhodophyta taxa as well as turf algae.

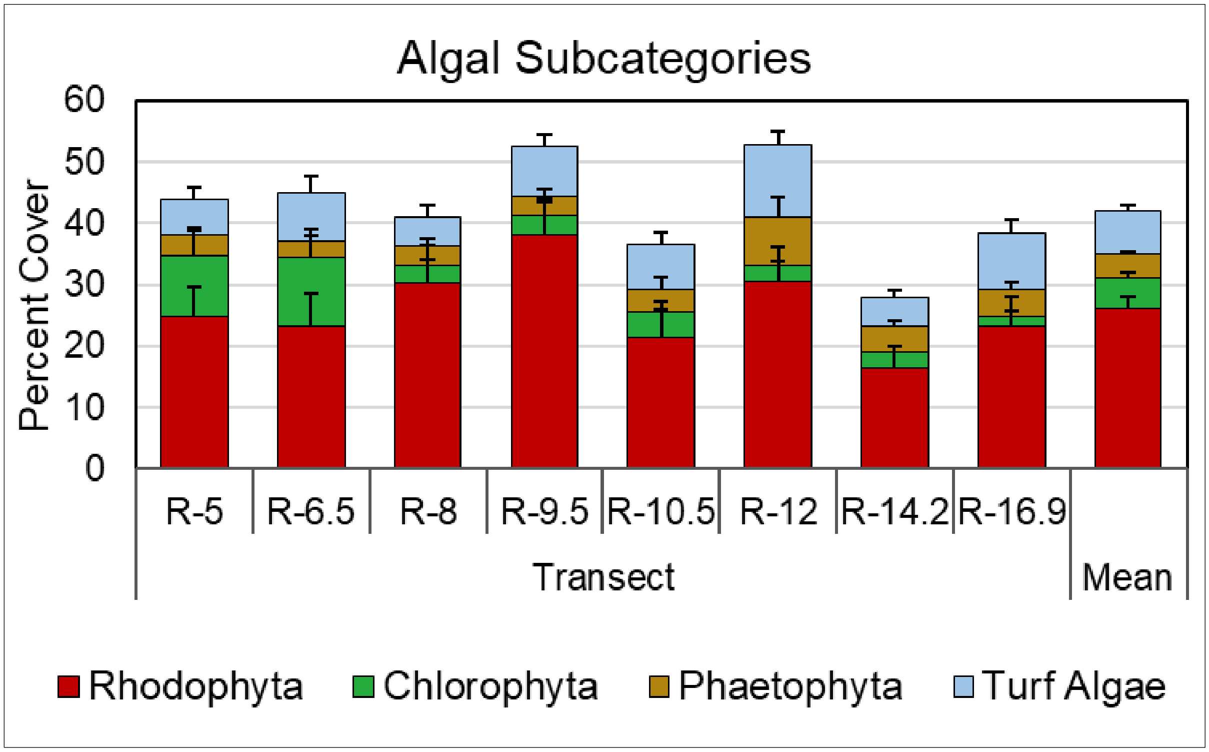

Figure 5. Mean percent cover (+ standard error) of algal subcategories within quadrats surveyed for the Sebastian Inlet District Sand Bypassing Project: 2019 Immediate Post-Construction Hardbottom Monitoring Survey.

Table 5. Algal taxa identified from *in situ* quadrats surveyed for the Sebastian Inlet District Sand Bypassing Project: 2018 Pre-Construction and 2019 Immediate Post-Construction Hardbottom Monitoring Surveys.

Observed Algal Taxa					
Year	2018	2019	Year	2018	2019
Rhodophyta			Chlorophyta		
Acanthophora muscoides	•	•	*Bryopsis plumosa*	•	--
Agardhiella subulata	•	•	*Bryopsis* sp.	•	•
Botryocladia occidentalis	•	•	*Caulerpa laetevirens*	•	•
Bryocladia cuspidata	•	•	*Caulerpa mexicana*	•	•
Bryothamnion seaforthii	•	•	*Caulerpa microphysa*	•	•
Chondria sp.	•	•	*Caulerpa prolifera*	•	•
Chondracanthus saundersii	--	•	*Caulerpa racemosa*	•	•
Crustose coralline algae	•	•	*Caulerpa sertularioides*	•	•
Cryptonemia seminervis	•	--	*Codium isthmocladum*	•	--
Dictyurus occidentalis	•	•	*Halimeda* sp.	•	•
Gelidiopsis sp.	•	•	*Ulva lactuca*	•	•
Gelidium sp.	•	•	Phaeophyta		
Gracilaria blodgettii	•	•	*Colpomenia sinuosa*	--	•
Gracilaria cervicornis	•	•	*Dictyopteris* sp.	•	•
Gracilaria damaecornis	•	•	*Dictyota* spp.	•	•
Gracilaria mammillaris	•	•	*Padina* sp.	•	•
Gracilaria sp.	•	•	*Sargassum platycarpum*	•	•
Grateloupia sp.	•	•	*Spatoglossum schroederi*	•	•
Halymenia elongata	•	--	Turf algae	•	•
Halymenia floresii	•	--	Total Number of Taxa	2018	2019
Heterosiphonia gibbesii	•	•	Chlorophyta	11	9
Hypnea musciformis	•	•	Phaeophyta	5	6
Hypnea sp.	•	•	Rhodophyta	27	24
Hypnea spinella	•	•	Turf algae	1	1
Jania sp.	•	•	Total Taxa	44	40
Laurencia sp.	•	•			
Sebdenia flabellata	•	--			
Solieria filiformis	•	--			
Spyridia sp.	--	•			

--= no data.

4.1.4 Percent Cover of Fauna

Sessile biota other than algae were generally low in percent cover and when grouped together as total fauna, the greatest percent cover (14.1% [±6.0% SE]) occurred on transect R-16.9, composed mainly of wormrock, which was most abundant within the four southernmost transects (**Figure 6**). Wormrock was the most abundant faunal organism throughout the project area; achieving a mean percent cover of 2.1% overall. Sponges amassed 1.1% (±0.2% SE) cover overall, while Hydroids were 0.5% (±0.1% SE) and both were most prevalent along transect R-5, at 4.5% (±1.8% SE) and 3.8% (±1.8% SE), respectively. Tunicates and bryozoans each contributed 0.2% or less overall, with tunicates achieving the greatest percent cover along transect R-16.9 (1.1% [±0.5% SE]) (**Appendix A**).

Motile fauna such as holothuroids and urchins were not assessed as percent cover and while a few individuals were observed along transects, none were observed within quadrats.

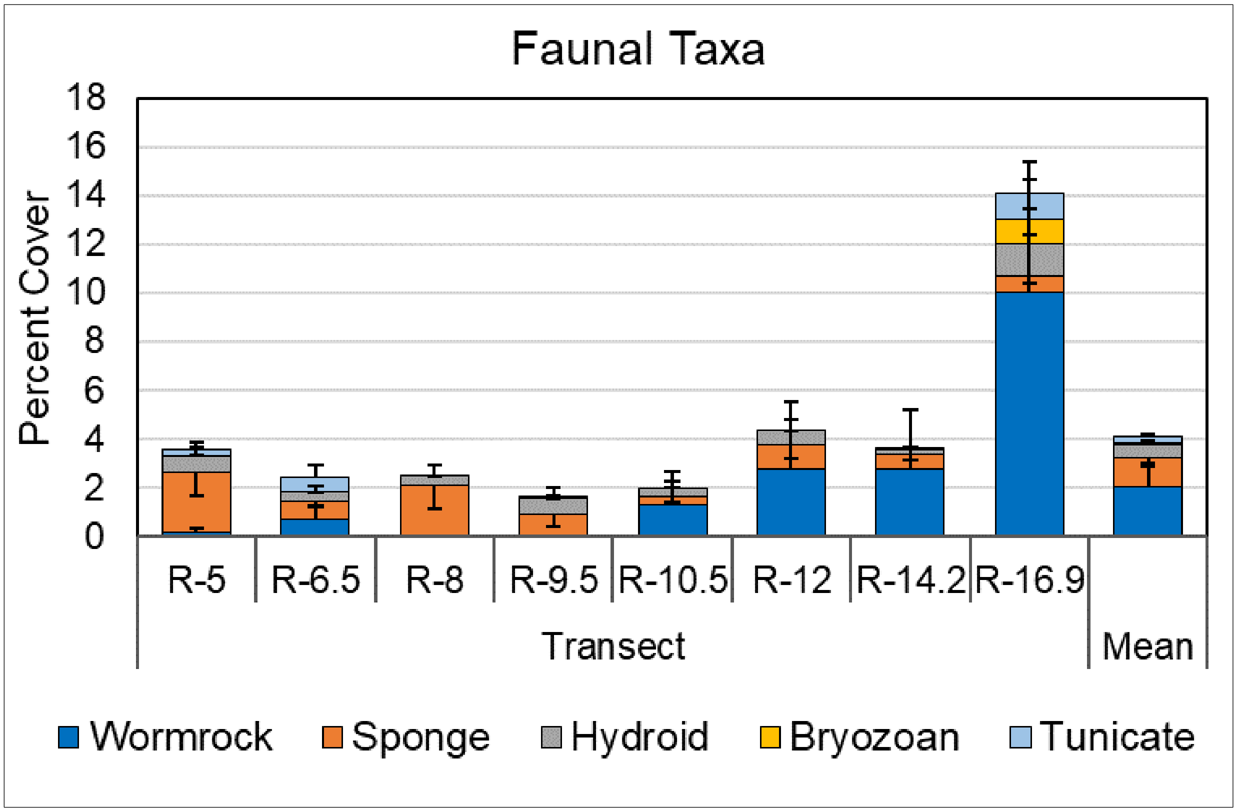

Figure 6. Mean percent cover (+ standard error) of faunal taxa within quadrats surveyed for the Sebastian Inlet District Sand Bypassing Project: 2019 Immediate Post-Construction Hardbottom Monitoring Survey.

4.2 HARDBOTTOM RELIEF AND SEDIMENT DEPTH

Because impacts from increased sedimentation could manifest as decreased relief of hardbottom, maximum hardbottom relief was measured within each quadrat. Mean maximum hardbottom relief was 24.2 cm (±2.0 cm SE), and ranged from 17.3 cm (±2.8 cm SE) on transect R-5 to 37.3 cm (±5.0 cm SE) on transect R-16.9 (**Figure 7**). A significant geographic gradient from north to south was visible in the dataset with the lowest mean maximum hardbottom relief measured along the two transects in the northern project area R-5 (17.3 cm [±2.8 cm SE]) and R-8 (17.8 cm [±3.9 cm SE]); while greatest mean maximum hardbottom relief was measured along two transects in the southern project area R-12 (32.2 cm [±3.3 cm SE]) and R-16.9 (37.3 cm [±6.9 cm SE]). The zero-meter quadrat on transect R-16.9 provided the greatest vertical relief in the survey (80 cm). The greater percentage of reef-forming wormrock in the southern half of the survey area was a likely contributor to the increased hardbottom relief, as large, meter high and 3+ meter diameter wormrock formations were observed along transect R-16.9.

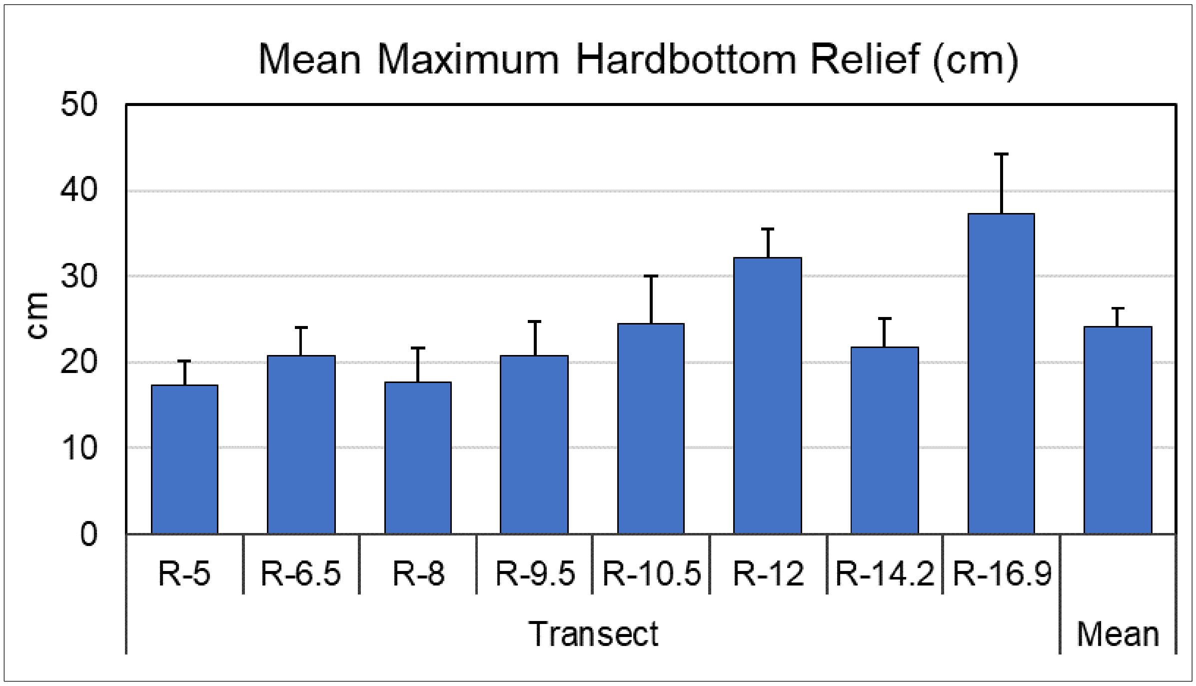

Figure 7. Mean maximum hardbottom relief (+ standard error) for quadrats surveyed for the Sebastian Inlet District Sand Bypassing Project: 2019 Immediate Post-Construction Hardbottom Monitoring Survey.

4.2.1 Mean Sediment Depth Within Quadrats

In general, transect mean sediment depth from measurements within quadrats was low (3.6 cm [±0.4 cm SE] overall) and ranged from 2.4 cm (±0.4 cm SE) on R-9.5 and R-12 to 7.0 cm (±1.4 cm SE) on R-14.2 (**Figure 8** and **Appendix B**). However, transect R-14.2 proved anomalous, as the remaining transects were all below 4.0 cm, and four were 2.8 cm or less. Transect R-14.2 also had the greatest amount of unconsolidated substrate (45.0% [±11.5% SE]) observed during the transect survey which indicates a greater number of quadrats contained sand on R-14.2 than along other transects. The shallowest sediment depths (on transect R-12) coincided with second greatest hardbottom relief in the survey area, which would decrease the amount of area for sand to settle. No other general trends were observed within the quadrat sediment depth dataset.

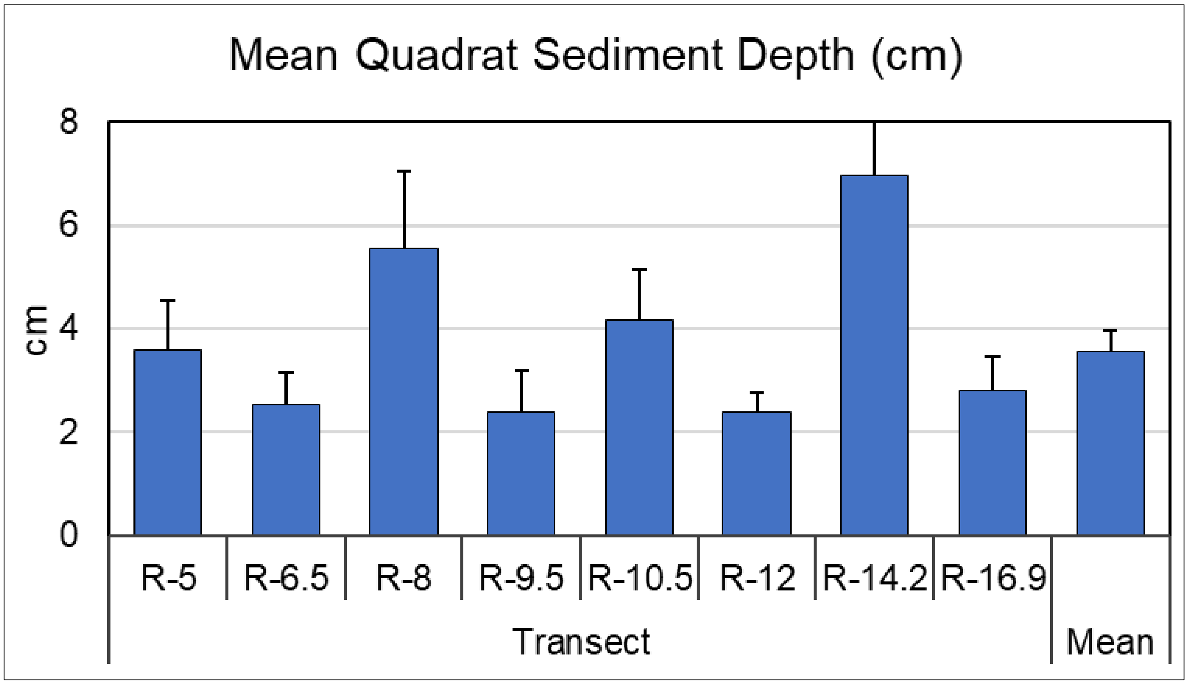

Figure 8. Mean sediment depth within quadrats (+ standard error) surveyed for the Sebastian Inlet District Sand Bypassing Project: 2019 Immediate Post-Construction Hardbottom Monitoring Survey.

4.3 LINE-INTERCEPT AND SEDIMENT ACCUMULATION

4.3.1 Line Intercept

The line-intercept data recorded along each transect are presented in **Appendix C**, which provided delineation and the total meters of hardbottom and sand along each transect. The greatest amount of hardbottom (and therefore also least sand) was recorded along transect R-9.5, with 61.0 m, while the least hardbottom (and most sand) was recorded on transect R-16.9 with 29.0 m (**Table 6**). **Figure 9a** to **c** provides a visualization of the line intercept data comparing the 2018 baseline and 2019 Immediate Post-construction conditions, and **Appendix D** display the line intercept data on maps compiled from the geospatial dataset of each transect.

Table 6. Total hardbottom and sand along each monitoring transect, derived from the line-intercept surveys.

Transect	Substrate type	Meters 2018	Meters 2019	Change
R-5	Total Hardbottom	60.0	58.0	-2.0
	Total Sand	40.0	42.0	2.0
R-6.5	Total Hardbottom	61.0	51.0	-10.0
	Total Sand	39.0	49.0	10.0
R-8	Total Hardbottom	59.0	51.0	-8.0
	Total Sand	41.0	49.0	8.0
R-9.5	Total Hardbottom	64.0	61.0	-3.0
	Total Sand	36.0	39.0	3.0
R-10.5	Total Hardbottom	55.1	58.0	2.9
	Total Sand	44.9	42.0	-2.9
R-12	Total Hardbottom	50.0	45.0	-5.0
	Total Sand	50.0	55	5.0
R-14.2	Total Hardbottom	54.1	40.0	-14.1
	Total Sand	45.9	54.0	8.1
R-16.9	Total Hardbottom	39.0	29.0	-10.0
	Total Sand	61.0	71.0	10.0
Total Project	Total Hardbottom	442.2	393.0	-49.2
	Total Sand	357.8	401.0	43.2

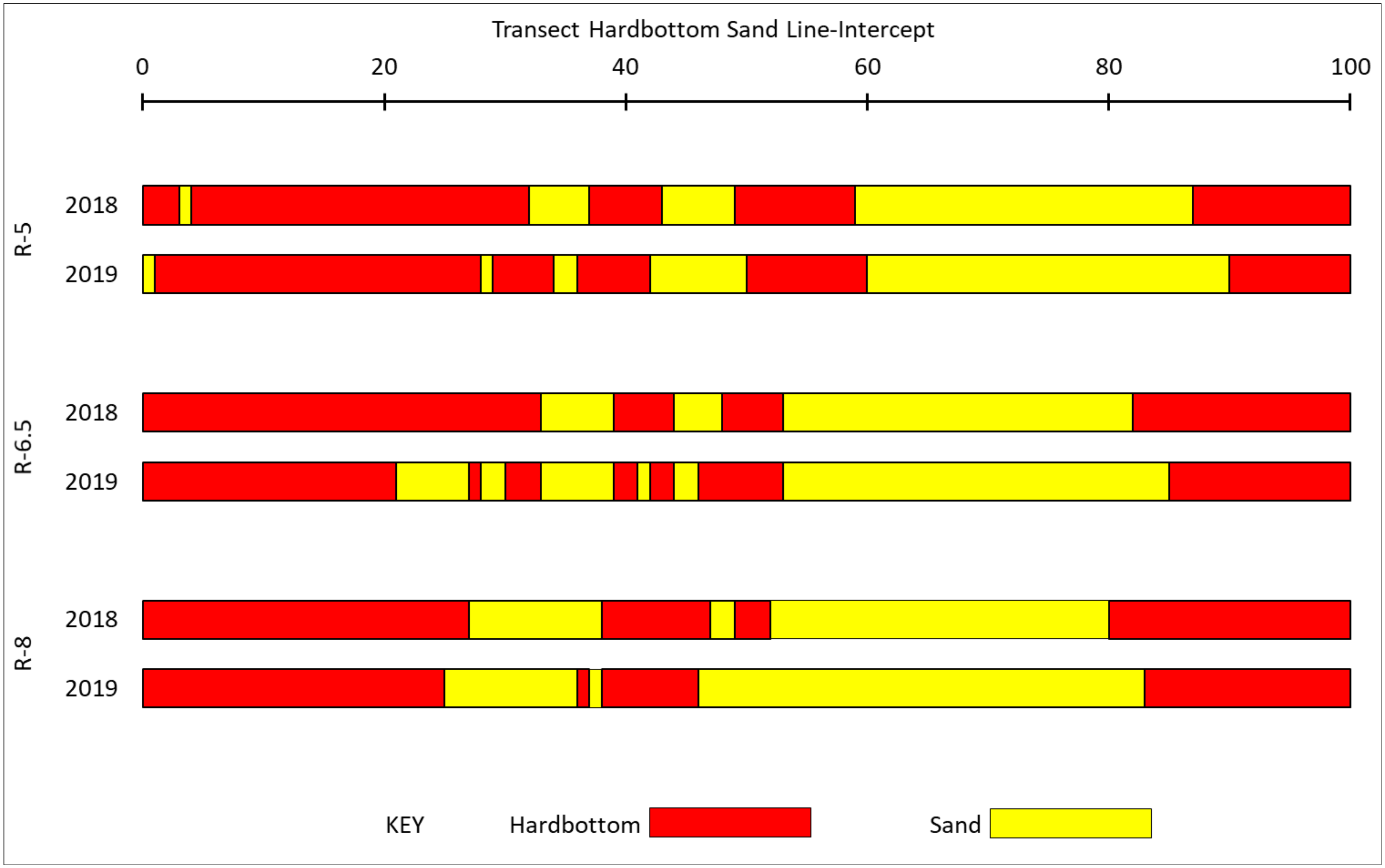

Figure 9a. Hardbottom and sand delineation along monitoring transects R-5, R-6.5, and R-8 from the line intercept surveys in 2018 and 2019.

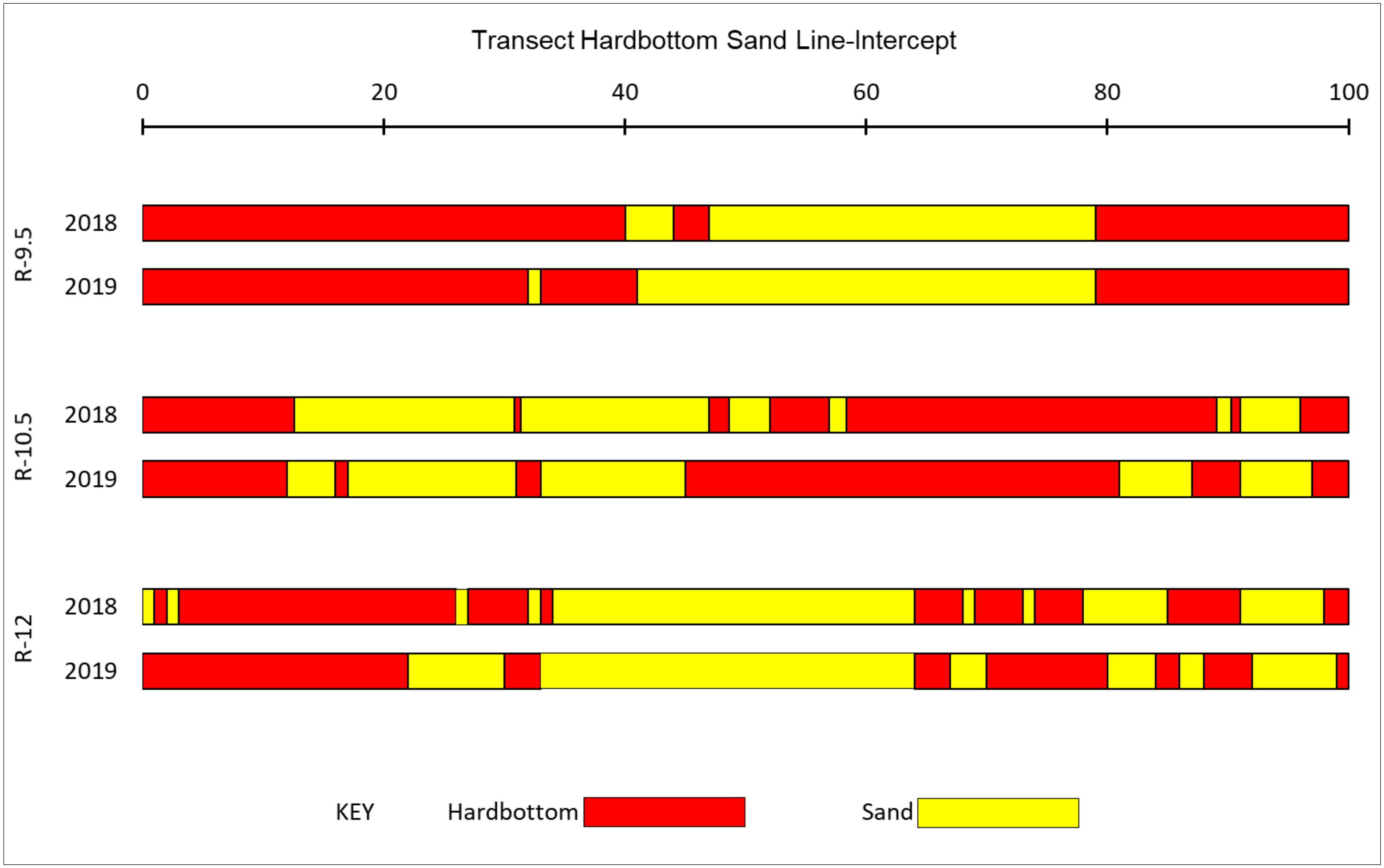

Figure 9b. Hardbottom and sand delineation along monitoring transects R-9.5, R-10.5, and R-12 from the line intercept surveys in 2018 and 2019.

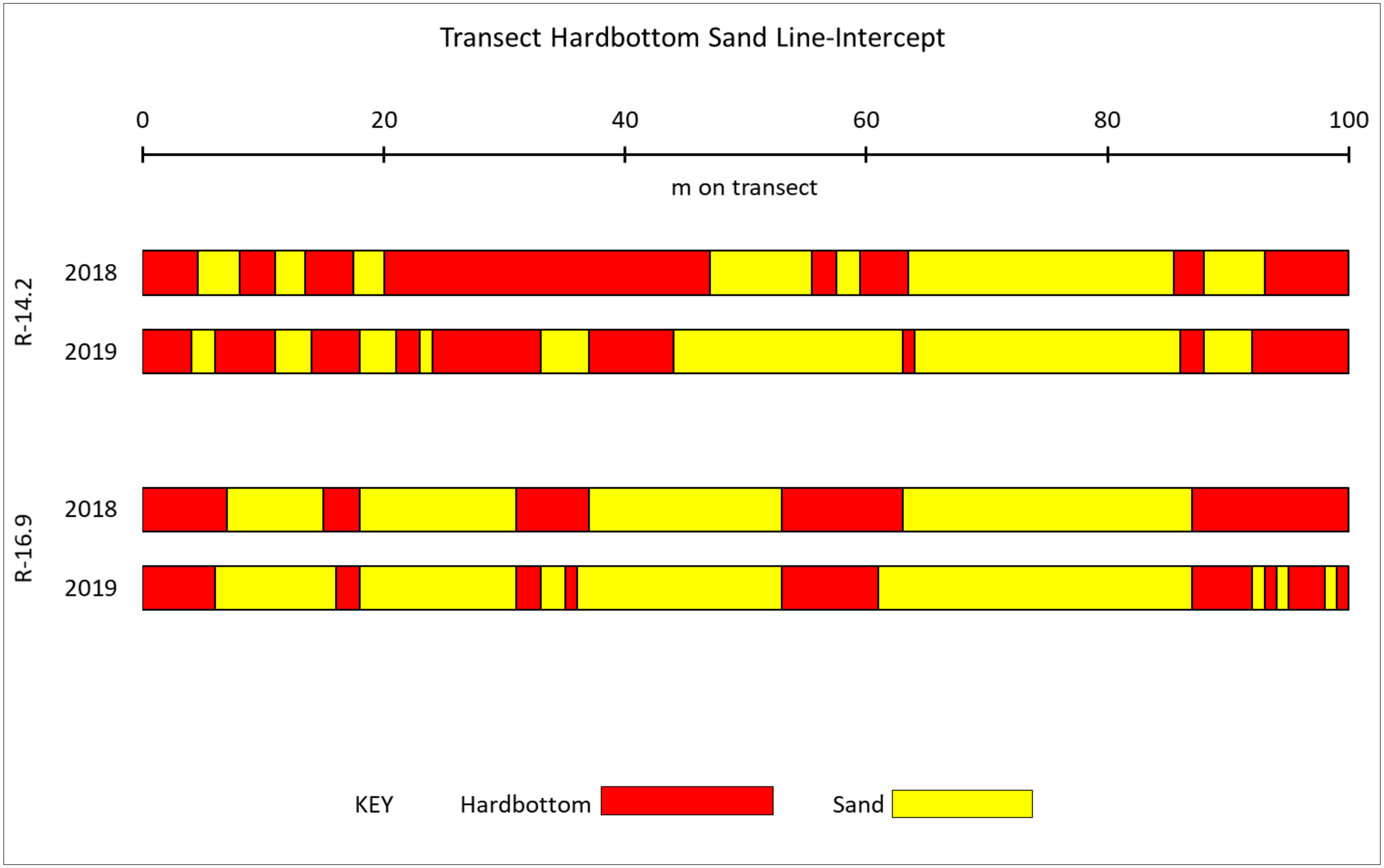

Figure 9c. Hardbottom and sand delineation along 2019 monitoring transects R-14.2 and R-16.9 from the line intercept surveys in 2018 and 2019.

4.3.2 Transect Sediment Depths

In addition to the quadrat survey, sediment accumulation was also measured at 1-meter intervals along each transect. These data provide the annual information on transect sediment depths to allow diagnostic comparison over time to identify potential sediment encroachment onto the nearshore hardbottom.

Sediment depths as measured at 1-meter intervals along transects are tabulated and shown graphically in **Appendix E.** Sediment depths on transects ranged from 0.0 to >30.0 cm (reported as 30.0 cm). Greatest mean sediment depth via this method was found on transect R-16.9 at 17.4 cm (±1.2 cm SE), while the least was found on transect R-10.5 at 9.5 cm (±1.1 cm SE). The remaining transect sediment depth means were all <14.8 cm. Again, transect R-16.9 was the most distinct from other transects, owing to the prevalence of sand and lack of exposed hardbottom along much of the transect.

4.4 CHARACTERIZATION OF THE NEARSHORE EDGE OF HARDBOTTOM

4.4.1 Mapping Data

The nearshore (western) edge of hardbottom mapping results from the 2019 survey collected from 15 to 21 August are displayed in **Figures 10** to **15**. To facilitate comparison of the 2019 mapped edge with the previous baseline survey (2018), the lines are displayed by contrasting colors. The nearshore edge of hardbottom from R-monuments R-4 to R-17 was mapped by divers with underwater visibility ranging from 0.6 to 2.5 m. Representative still frame grabs from qualitative video collected during the nearshore edge of hardbottom mapping survey are shown in **Photos 3** to **5.**

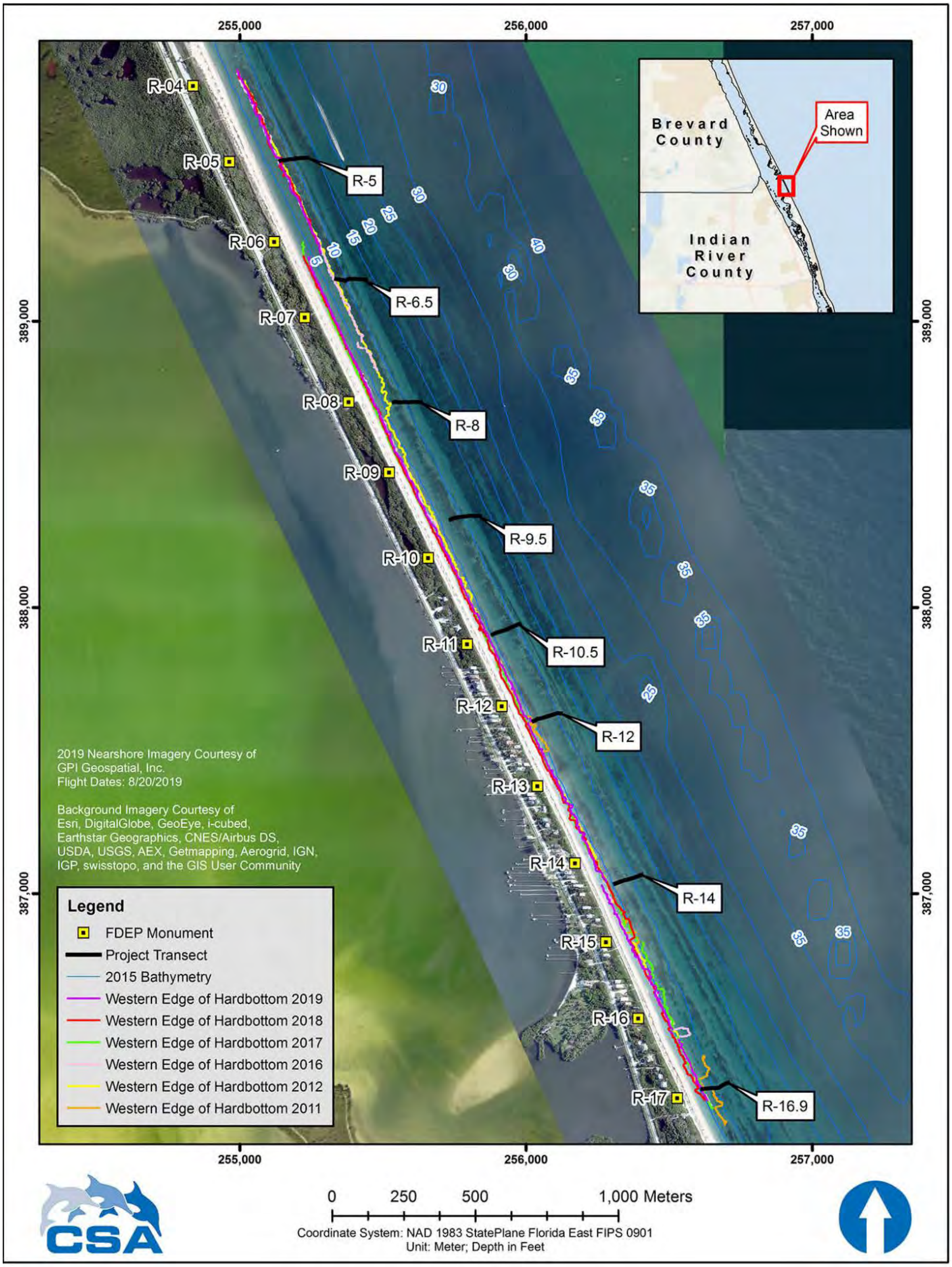

Figure 10. Overview of the nearshore (western) edge of hardbottom surveyed in 2018 and 2019 for the Sebastian Inlet District Sand Bypassing Project.

Figure 11. Portion of the nearshore (western) edge of hardbottom from R-5 to R-7.8 mapped in 2018 and 2019 for the Sebastian Inlet District Sand Bypassing Project. PTOF = permitted toe of fill.

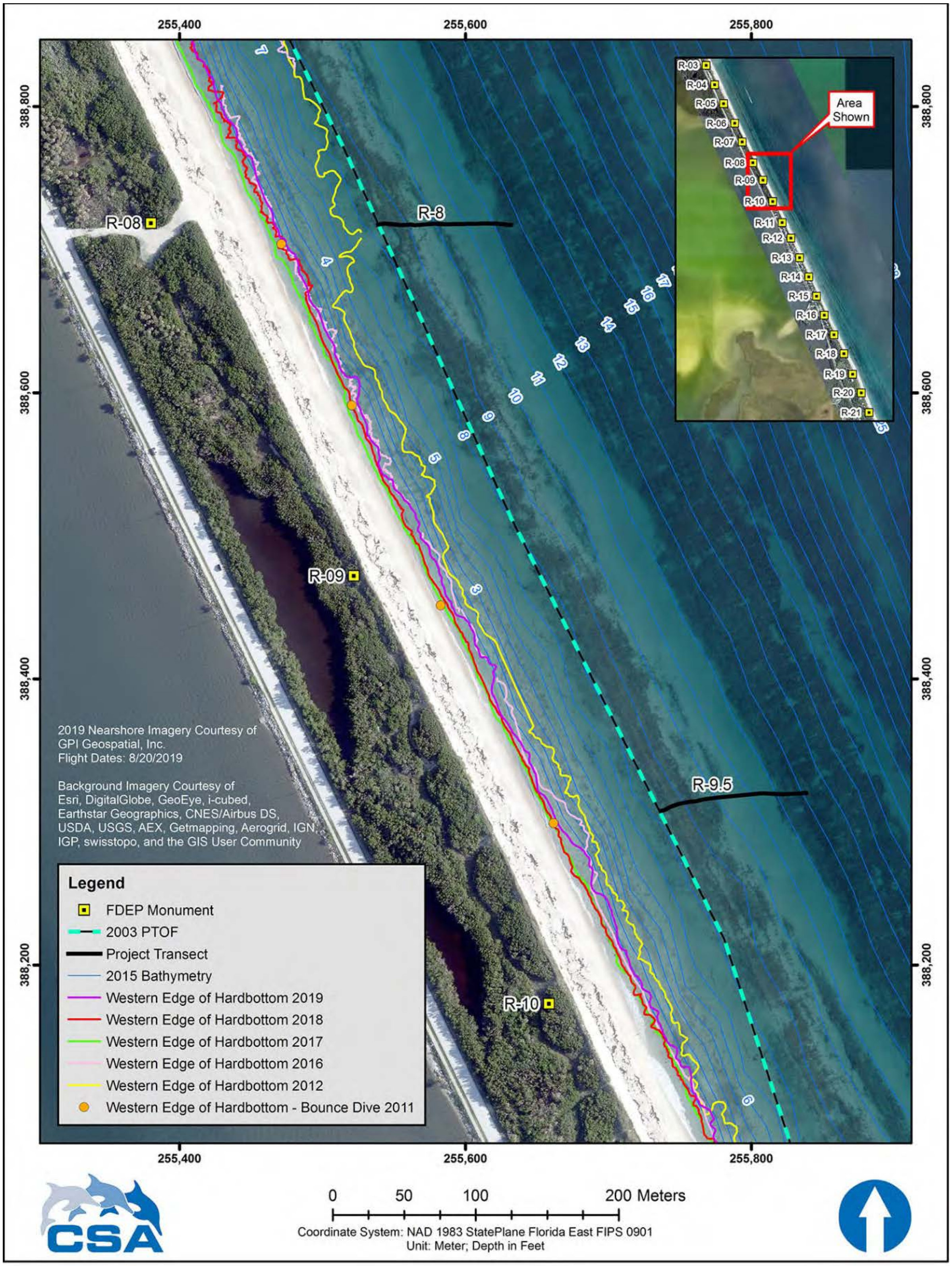

Figure 12. Portion of the nearshore (western) edge of hardbottom from R-8 to R-10, mapped in 2018 and 2019 for the Sebastian Inlet District Sand Bypassing Project. PTOF = permitted toe of fill.

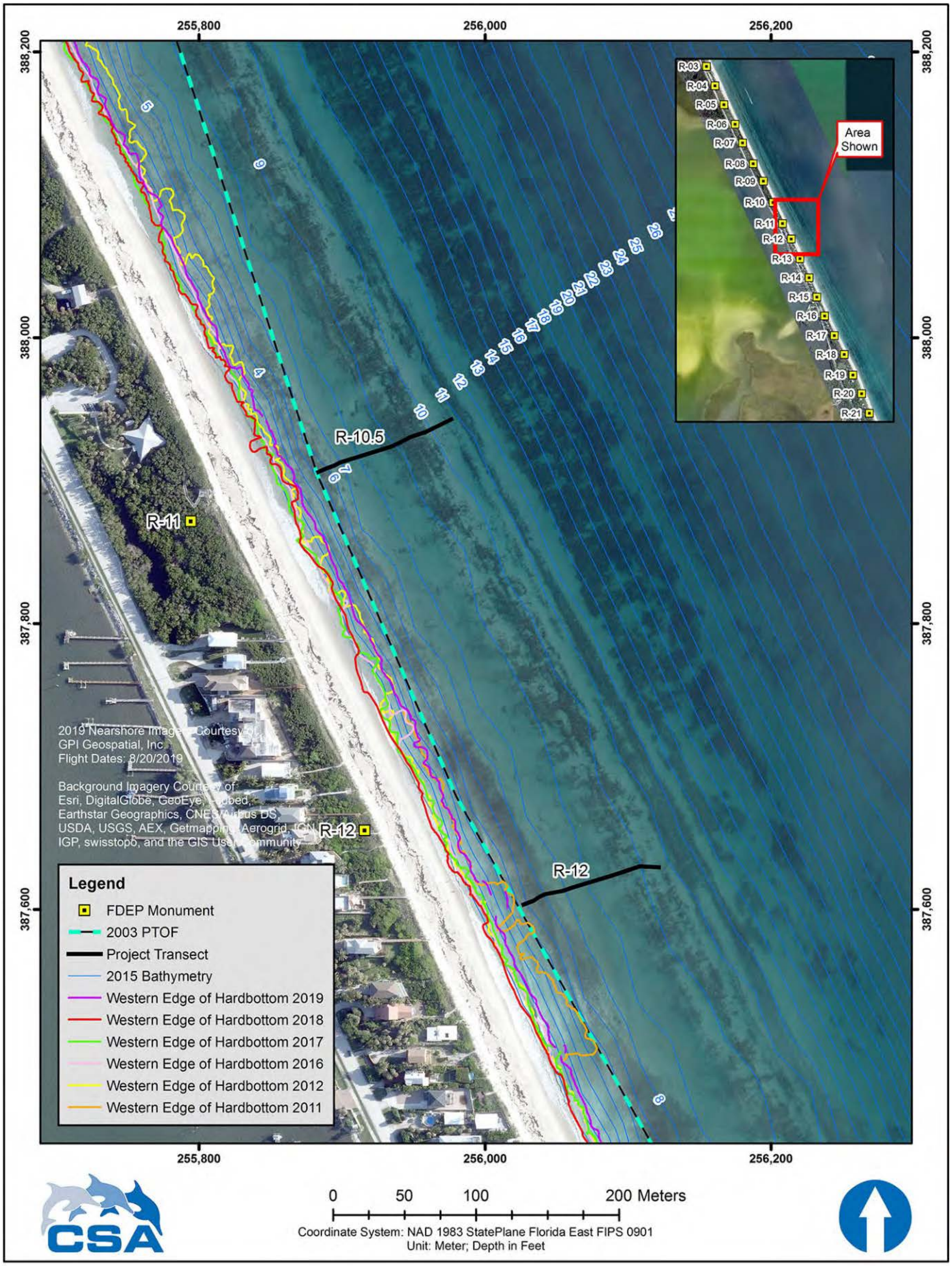

Figure 13. Portion of the nearshore (western) edge of hardbottom from R-10 to R-12.8 mapped in 2018 and 2019 for the Sebastian Inlet District Sand Bypassing Projects. PTOF = permitted toe of fill.

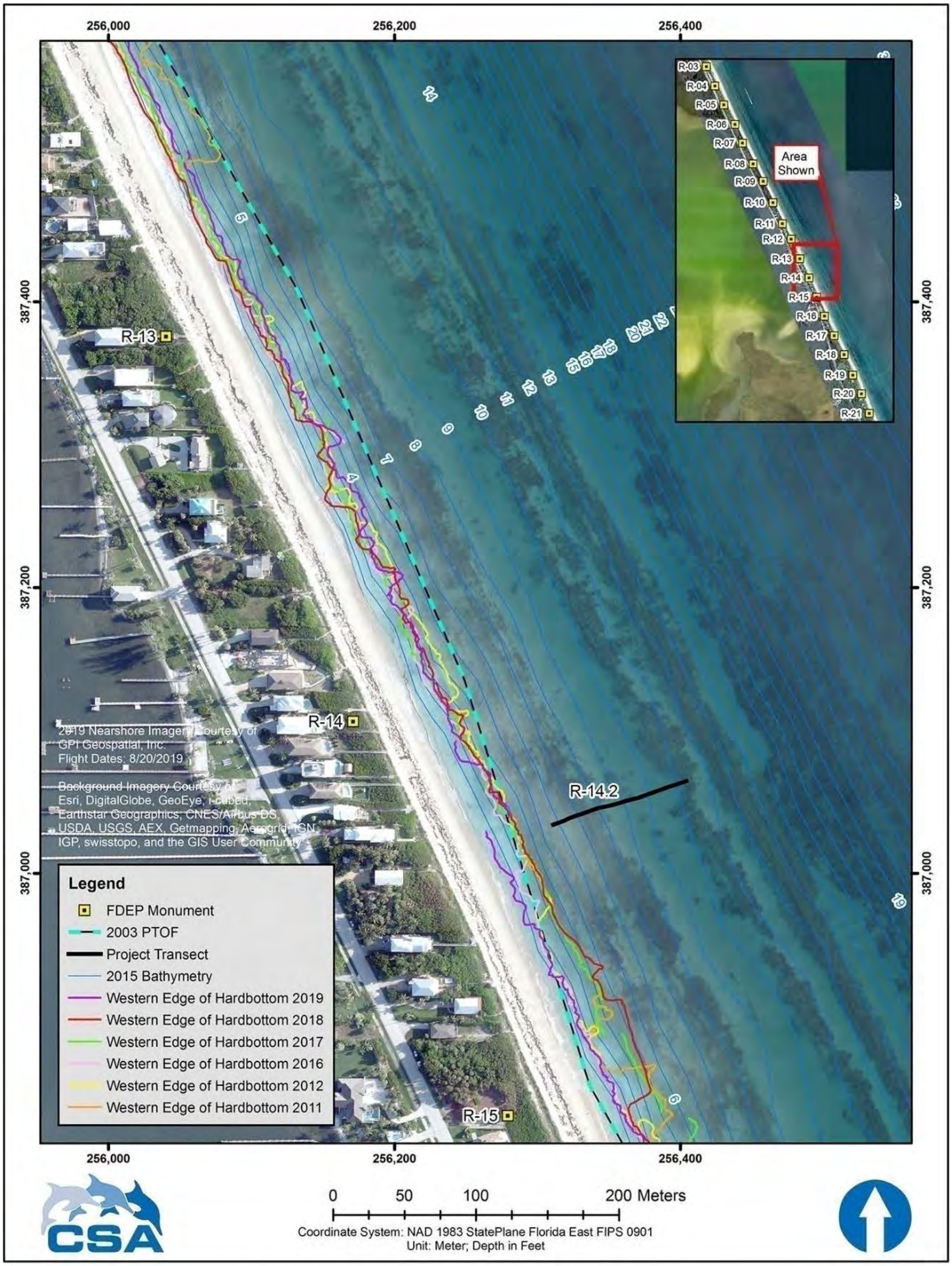

Figure 14. Portion of the nearshore (western) edge of hardbottom in from R-12 to R-15 mapped in 2018 and 2019 for the Sebastian Inlet District Sand Bypassing Projects. PTOF = permitted toe of fill.

Figure 15. Portion of the nearshore (western) edge of hardbottom edge from R-15 to R-17.5 mapped in 2018 and 2019 for the Sebastian Inlet District Sand Bypassing Projects. PTOF = permitted toe of fill.

The western edge of hardbottom at the northernmost section of the survey area, from R-4 to R-6.5 was in approximately 2 to 3.5 m water depth. The hardbottom consisted primarily of low relief (vertical relief <0.5 m) patchy hardbottom, with many small sand gaps 2 to 3 m in length encountered along the northernmost 600 m of the survey area (**Photo 3**), and numerous patches of medium relief (vertical relief 0.5 to 1.0 m) hardbottom.

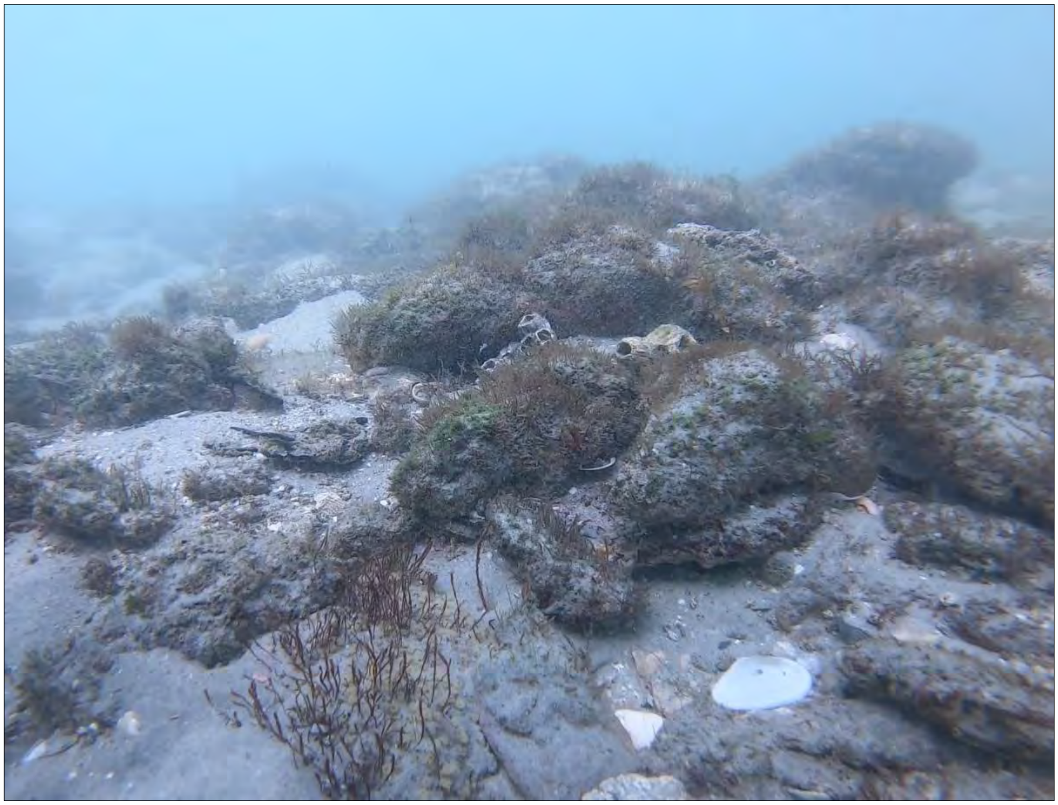

Photo 3. Low relief portion of the patchy nearshore hardbottom edge near R-5, showing turf algae, *Bryocladia cuspidata, Caulerpa prolifera,* and the invasive barnacle, *Megabalanus* spp. Image scale approximately 2.5 m^2.

The nearshore edge of hardbottom from approximately R-6.5 to R-12.5 consisted of primarily discontinuous low-relief hardbottom with occasional areas of medium-relief hardbottom. Much of the nearshore edge in this section was located closer to shore relative to other sections, primarily in the intertidal zone (**Photo 4**) where water depths were 2 m or less. The mapping in this section was done by carrying the DGPS transmitter and antenna while wading in 0 to 0.5 m water depth. Exposed portions of hardbottom were generally contiguous, particularly from R-6 to R-10; from R-10 to R-12 more small sand gaps (>30 cm sediment depth) between hardbottom patches, ranging from 1 to 3 m in length were observed. Most areas of hardbottom consisted of scoured bare hardbottom with little to no sediment veneer arising from constant exposure to wave activity. No large sand gaps (>10 m length) were recorded within the northern end of the survey area. Overall, this section of the nearshore edge of hardbottom had the lowest relief in the survey area, excepting areas of large wormrock formations which typically reached 1 m of relief.

From approximately R-12 to R-17, the nearshore edge of hardbottom was mainly patchy and discontinuous, with areas of contiguous hardbottom interspersed between sand gaps (1 to 5 m

in length). Relief along this section ranged from low to medium-relief ledges with some higher relief (>1 m) areas throughout. These areas of high relief were usually associated with the presence of large colonies of wormrock (**Photo 5**). A large formation of hardbottom provided the base of the high relief segment which made up the nearshore hardbottom edge from R-14 to R-15, while generally low to medium-relief, patchy hardbottom was prevalent from R-15 to R-17. Sediment veneer on hardbottom was not as prevalent as in the northern 300 m of the project area; however, areas of sand surrounding the smaller hardbottom patches were deeper and sand gaps between hardbottom patches were longer.

Photo 4. Location on shore (a) of low-relief, patchy, low tide exposed hardbottom near R-10, and (b) submerged hardbottom near R-9 showing brown *Spatoglossum* sp., *Ulva lactuca,* and red turf algae.

Photo 5. Medium relief (1 m), hardbottom outcrop near R-16, showing turf algae, *Bryocladia cuspidata,* unidentified red macroalgae, sand, and shell hash along the nearshore hardbottom edge.

4.4.2 Nearshore Hardbottom Edge Biota

Within the algal community, turf algae were dominant along the nearshore edge of hardbottom from R-4 to approximately R-6, including the turf-like red algae *B. cuspidata* (**Photo 3**). Overall cover of macroalgae along this portion of the edge was fairly low; however, on the higher relief rocks, green algae, including C*aulerpa prolifera, C. microphysia,* and *C. mexicana*, were prevalent, as were brown algae such as *Dictyota* spp. and *Padina* sp. Other species of macroalgae occasionally observed were red algae *Hypnea musciformis*, *Hypnea spinella*, and *Gracilaria* spp., and the green alga *Halimeda* spp. Only small amounts of wormrock were observed in this portion of the nearshore edge of hardbottom. Drift *Sargassum* sp. was also observed in abundance along the nearshore edge, hampering visibility in the surge prone habitat.

From approximately R-6.5 to R-12, percent cover of total algae was lower compared to the northern section (R-4 to R-6.5), likely due to the location of the edge of hardbottom near or in the intertidal zone and higher resultant wave action and periodic emersion. The algal community here was dominated by very short turf algae and crustose coralline algae. Algae were dominated by intertidal species such as the green alga *U. lactuca* and filamentous turf (**Photo 4**). Much of the intertidal area consisted of scoured, bare limestone hardbottom. Wormrock increased in cover when compared to the more northern portion of the project area, particularly from R-10 southward, except on the exposed rocks mapped to the mean low water line in 0.3 m water depth.

From approximately R-12 to R-17, the algal community was also dominated by turf algae; however, cover by macroalgae was greater compared to more northern portions of the nearshore edge of hardbottom, with isolated areas of very high cover, likely due to the increased water depths. The macroalgal community was dominated by brown algae, including *S. schroederi* and *Padina* spp., red algae including *Gracilaria* spp. and *B. seaforthii*. Other commonly observed species included red algae *H. musciformis and B. occidentalis,* and green algae *Halimeda* spp. and *C. prolifera*. Large, healthy colonies of wormrock were abundant in localized areas along the nearshore edge of hardbottom notably from R-10 to R-15, and near R-16.5 (**Photo 6**). Drift macroalgae were observed in abundance, amassed on the landward edge of hardbottom in large patches, occasionally obscuring hardbottom up to 1 m in relief.

Fish species observed during the survey of the nearshore edge of hardbottom were typical members of the nearshore hardbottom community, and included hairy blenny (*Labrisomus nuchipinnis*), sheepshead (*Archosargus probatocephalus*), porkfish (*Anisotremus virginicus*), juvenile grunts (*Haemulon* spp.), spottail pinfish (*Diplodus holbrookii*), Atlantic guitarfish *(Rhinobatos lentiginosus*). Invertebrate fauna observed included colonial tunicates, encrusting and boring sponges (including *Cliona* spp.), encrusting bryozoans, holothuroids, hydroids, and sabellariid wormrock (*Phragmatopoma lapidosa*). Several juvenile green sea turtles (*Chelonia mydas*) were also observed along the nearshore edge of hardbottom.

Photo 6. Atlantic guitarfish *(Rhinobatos lentiginosus*) observed near R-6.5 along the nearshore hardbottom-sand interface. Patchy hardbottom is visible close by, image scale approximately 2.5 m^2.

5.0 Discussion

Data from the SID Sand Bypassing Project: Pre-Construction Monitoring Survey (baseline) from 2018 are displayed alongside data from the Immediate Post-Construction Monitoring Survey in 2019. The discussion and statistical analyses compared the 2018 baseline survey and the 2019 Immediate Post-construction survey.

Project-related environmental impacts from sand bypassing could result in both direct and indirect impacts on nearshore hardbottom communities, some of which may be cumulative in nature. Conversely, these effects may be temporary or, in cases where sediment cover persists, long lasting. Through the Sebastian Inlet maintenance process, sand is bypassed to the downdrift shoreline to mitigate for long-term, inlet-related impacts to natural littoral drift, but this process has the potential for ecological effects, including changes in the biological community (i.e., reduced percent cover or decreased taxonomic richness), which could occur in the following ways:

- Burial and subsequent mortality of sessile biota;
- Increased time of burial during ephemeral burial events with varying degrees of sessile biota mortality;
- Seaward change in nearshore edge of hardbottom location – a geographically specific form of burial;
- Increased sediment depth over hardbottom, with higher mortality for low-profile or encrusting biota;
- Reduced relief, i.e., low spots filling with sand, resulting in reduced shelter habitat for fishes and cryptic biota; and
- Increased sand as a source of increased sedimentation and/or turbidity, causing scour and/or reduced light levels, and thus degraded hardbottom habitat quality.

A key sign of impact in time-series data is a change in temporal variance (Underwood, 1992; Clarke et al., 2006). Here, the nearshore zone is highly variable on multiple temporal scales, making change in temporal variance more difficult to resolve (e.g., macroalgae cover and abundance changes seasonally, and large patches of sand can move meters in a few days) (Lybolt and Tate, 2008). Furthermore, indirect results of sand bypassing such as movement of sand offshore may postpone direct, nearshore impacts by months or even years. Therefore, the following important caveats should be considered when evaluating potential impacts from this project:

- Portions of nearshore hardbottom habitat in the study area are ephemerally exposed and buried, and sediment movement is naturally highly dynamic, based on changing wave conditions and current regimes regardless of sand placement practices;
- The northern portion of the Project area from R-4 to R-9.5 (especially offshore portions of transects) is influenced by migrations of the bypassing sand bars associated with the inlet's ebb shoal which bring sand southward and nearer to shore through natural littoral processes (Zarillo et al., 2003; Zarillo et al., 2018);
- The nearshore area and sediment dynamics were likely strongly influenced by Hurricane Irma in 2017 as well as swells or increased wave energy from passing storm events. The effects from these storms may have influenced those data sets;
- A single annual monitoring event is only a snapshot of a dynamic system;

5.1 NARRATIVE DESCRIPTION OF QUADRAT DATA

5.1.1 Percent Cover of Major Benthic Categories

Quadrat data provide the most highly resolved measurements of sessile biota in this survey. Mean percent cover of major benthic categories (substrate, algae, fauna, and cyanobacteria) are displayed in **Figure 16**.

Mean percent cover of major benthic categories differed between 2018 and 2019 (**Figure 16**). Total algae were the most abundant percent cover type in 2018; however, substrate was the numerical dominant in 2019 on all but two transects (R-9.5 and R-12). Mean percent cover of fauna was low in both surveys, but was bolstered by greater wormrock cover in 2018, especially within the four southernmost transects R-10, R-12, R-14.2, and R-16.9. These same transects still had the greatest faunal cover in 2019 albeit in lower percentages. The naturally mediated annual fluctuations in wormrock cover are well understood (Eckelbarger, 1976) and likely to indicate differences may have arisen from natural annual variability within the faunal community, as corresponding increases in algae were apparent on those transects with less fauna.

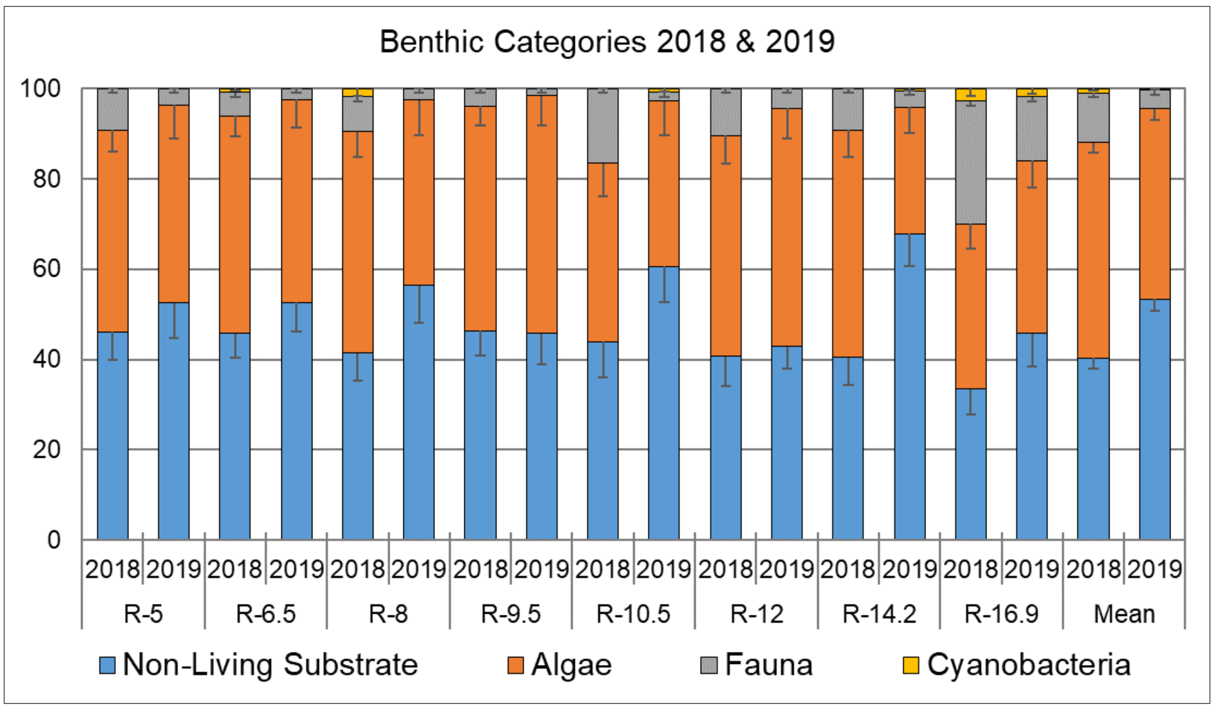

Figure 16 Mean percent cover (-standard error) of major categories surveyed for the 2018 Sebastian Inlet District Sand Bypassing Project: Pre-Construction Survey and the 2019 Immediate Post-Construction Monitoring Survey.

Because NL substrate dominated cover of major categories on most transects surveys, figures depicting percent cover of the constituent sub-categories (hardbottom, sediment over hardbottom, and unconsolidated substrate [composed mainly of sand, but also inclusive of shell hash and rubble]) were created to help visualize which constituent(s) were important to the overall category. Percent cover of and unconsolidated substrate increased from 2018 to 2019, sediment over hardbottom exhibited little change, while bare hardbottom decreased. (**Figure 17**). This is possibly due to migration of unconsolidated substrate onto hardbottom, from

changes within the transverse sand channels which intersect most transects. The sand channels can act as conduits of sediment movement south from the ebb shoal (Zarillo et al., 2018). This increase in unconsolidated substrate onto the hardbottom could arise from natural as well as anthropogenic origins and based on other transect data, is a more likely scenario than additional unconsolidated substrate moving onto previously exposed rock or benthos.

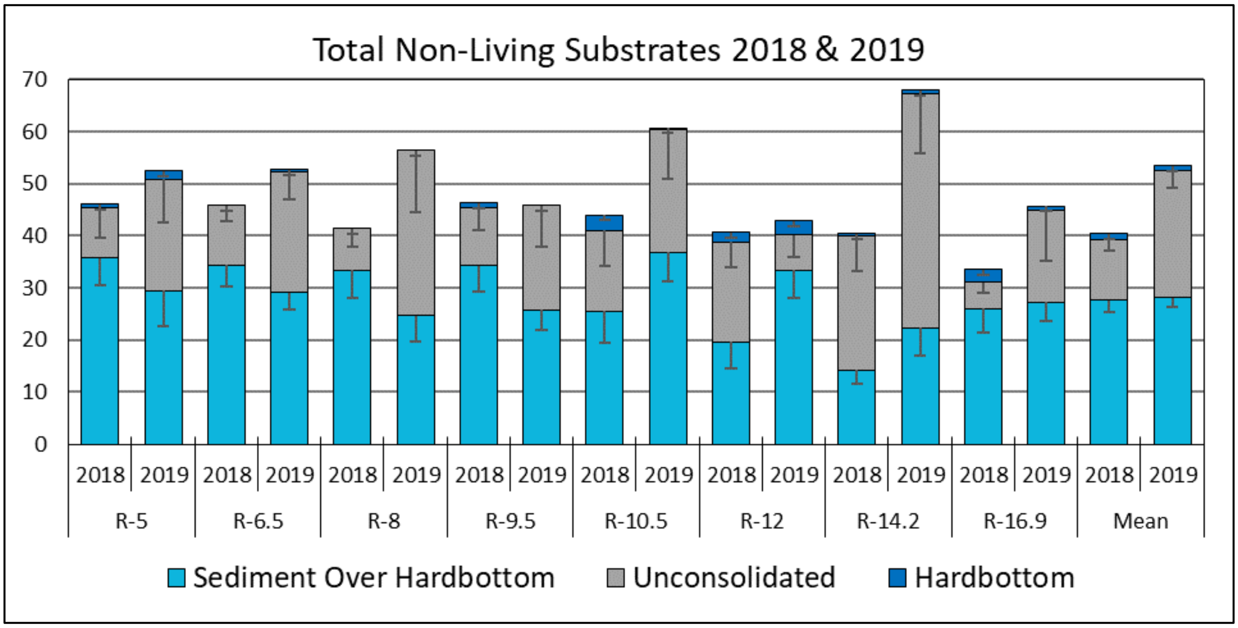

Figure 17. Mean percent cover (-standard error) of non-living (substrate) subcategories surveyed for the 2018 Sebastian Inlet District Sand Bypassing Project: Pre-Construction Survey and the 2019 Immediate Post-Construction Monitoring Survey.

The ebb shoal of the Sebastian Inlet has been an important additional source of sediment in the northern portion of the Project area and may also have influenced sediment movement onto the hardbottom.

Throughout the many previous data sets, cover of NL substrate types fluctuated, as may be expected for a dynamic and ephemeral system. Interestingly, greater fluctuations in substrate types occurred on the offshore portions of transects, where more persistent hardbottom communities are typically found. It is possible that sand bars associated with the ebb shoal of the Sebastian Inlet may be influencing sediment dynamics in the survey area.

5.1.2 Percent Cover of Algae

Algae are the most prevalent biota in the nearshore hardbottom community off central Florida, as consistently observed in the Project area throughout many years of surveys. Between 2018 and 2019, algal percent cover has undergone minor decreases along most transects, with R-14.2 decreasing the most, by nearly half (**Figure 18**). Variability within the algal community is naturally mediated through succession, herbivory, nutrient availability and incoming light levels. Slight increases in algal cover were observed along R-9.5 and R-12, resulting from increases in red algae on both transects and turf algae on R-12. The loss of wormrock along R-12 would have provided additional area for algal colonization, which would be initiated by turf algae. This

confounds any assignment of impact due to increases in turf algae, and is more likely a natural change, as turf algae became less important to the overall Project area mean algal cover.

5.1.3 Composition of the Algal Community

Changes in the algal community may be reflected as changes in relative contributions to percent cover of total algae by the various macroalgal divisions (Chlorophyta, Phaeophyta, and Rhodophyta) as well as turf algae. The algal community was dominated by Rhodophyta in both years (**Figure 18**).

Algal community composition has displayed fluctuations in relative abundance of individual species over the course of the project. Typically, a phase-shift towards turf algae from macroalgal dominance would indicate higher sedimentation and possibly be interpreted as a sub-lethal impact. Slightly fewer algal taxa were recorded in 2019 (40) as compared to 2018 (44), within Rhodophyta and Chlorophyta. (**Appendix A**). One additional Phayophyceae species, *Colpomenia sinuosa* was recorded in 2019. Conspicuously absent from the Rhodophyta were two species of *Halymenia, H. elongata, and H. floresii*. The only decrease in Chlorophyta could have resulted from placement of *Bryopsis plumosa* into the genera category with *Bryopsis* spp. The most frequently encountered species include red algae *B. cuspidata, B. seaforthii* and *Hypnea* spp.; the green alga *C. prolifera,* and the brown alga *S. schroederi.*

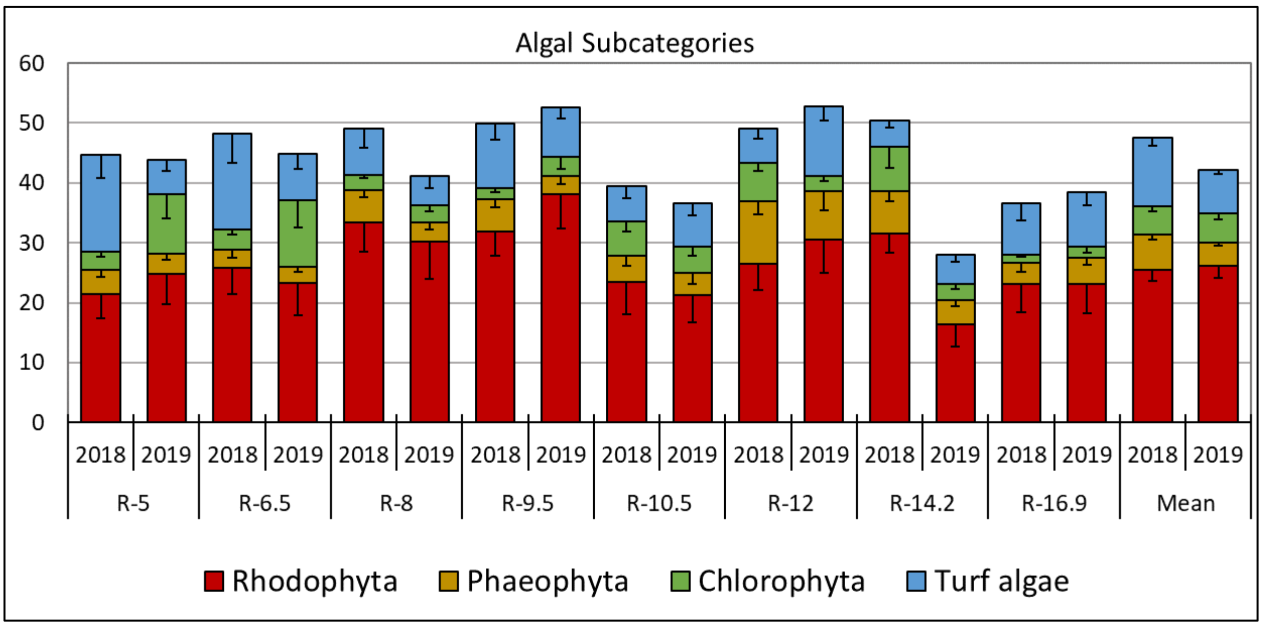

Figure 18. Mean percent cover of algal subcategories surveyed for the 2018 Sebastian Inlet District Sand Bypassing Project: Pre-Construction Survey and the 2019 Immediate Post-Construction Monitoring Survey.

5.1.4 Percent Cover of Fauna

Mean percent cover of total fauna varied between surveys but was low overall in both years; however, the mean percent cover of total fauna was considerably less in 2019 than in 2018 among nearshore transect portions (**Figure 19**). Evaluating changes in faunal cover in relation to potential impacts may not be biologically relevant for this study area when considering the variable overall percent cover and the patchy distribution of the most dominant taxa, wormrock, and sponges. Wormrock contributed less to percent cover of fauna in 2019 than in 2018, and over the years of surveying the Project area has shown a bimodal or semi-annual abundance pattern (CSA, 2015). In years when the percent cover of wormrock was lower, sponges became the dominant sessile biota. The contribution of other faunal types underwent decreases as well, but their relative proportions remained similar. Tunicates, bryozoans, and hydroids all displayed decreases in 2019 from their already minor contributions to percent faunal cover in 2018.

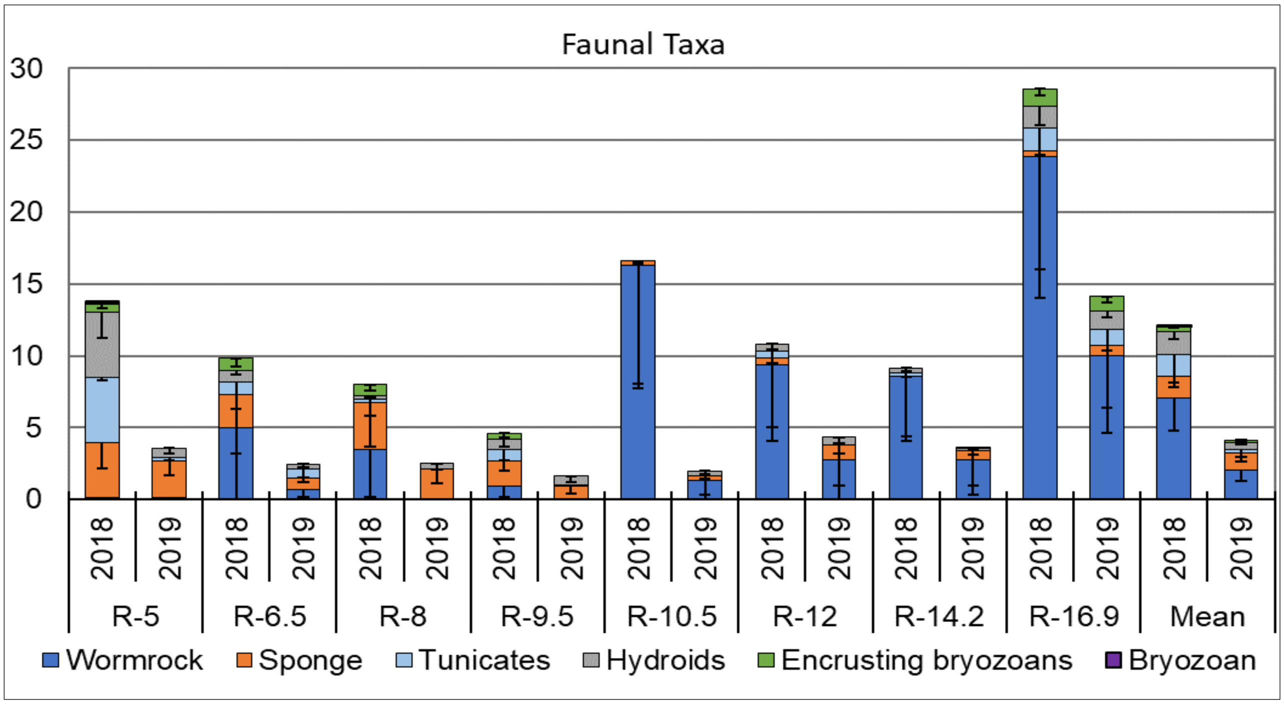

Figure 19. Mean percent cover of total fauna for the 2018 Sebastian Inlet District Sand Bypassing Project: Pre-Construction Survey and the 2019 Immediate Post-Construction Monitoring Survey.

5.2 STATISTICAL ANALYSES OF QUADRAT PERCENT COVER DATA

To visualize potential patterns or differences between the 2018 and 2019 data sets, a Bray-Curtis similarity matrix (Bray and Curtis, 1957) was created from fourth root transformed quadrat percent cover data and subjected to multi-dimensional scaling (MDS) and cluster analyses. When individual transects for a given year were plotted in MDS by year, the two years were different from one another, except for R-16.9 which clustered together, and separate from the remaining groups (**Figure 20**). This is the disparate clustering one would expect if the two years were significantly different. However, the amount of similarity among all transects was 66.4% similar. Interestingly, the transect groupings within the years were the same, as the four northern transect group together, the three southern transects group together, and R-16.9, which is outside of the project area by itself.

The similarity matrix was also tested with analysis of similarities (ANOSIM). Results of the one-way ANOSIM analysis (2018 vs 2019) of percent cover data showed significant differences between survey years ($R = 0.374$, $p < 0.01$). The low R value suggests that while there were significant results, they were not good indicators of impacts to the biological variables. R values approaching 1 indicate stronger support of biologically significant results (Clarke, 1993).

Cluster analysis plots agreed with the ANOSIM results, as the temporal (annual) separation was readily observed through Similarity Profile Analysis (SIMPROF) tests (**Figure 20**). Significant clusters were observed at 66% similarity, and most of the 2018 transects separated completely from 2019 transects at this level. Only Transect R-16.9 was similar between years. The geographic differences observed in 2018 were seen again in 2019, as the northernmost four transects grouped together within each year but did not cluster together between year. Although significantly different, the 2018 and 2019 transects also showed separation between the two years in MDS (**Figure 20**), but the 2-D “variance” (2-D Stress = 0.18) on the MDS plots is high, indicating the significant values may be unreliable. Two-dimensional stress in MDS plots above 0.15 are generally regarded as a weak representation of the actual 3-D plot (Clarke and Warwick, 2001).

Similarity percentage routine (SIMPER) analyses are sensitive and capable of detecting small differences in the two annual data sets. SIMPER identified 31 taxa and NL substrates responsible for 71% of the difference between 2018 and 2019 due to greatest change in percent cover of given taxa or NL substrates in one year versus the other. However, the leading five taxa with the greatest percent contributions to dissimilarity were only responsible for approximately 18% of the total dissimilarity between 2018 and 2019. Additionally, the trends were decreases in all five taxa in 2019, which illustrated the changes in macroalgal dominance that were indicated in the graphical analyses. In order of significance, SIMPER identified decreases in the cover of the red alga *H. musciformis,* wormrock, the green alga *U. lactuca,* the red algae *Gelidiopsis* sp. and the brown alga *S. schroederi* as most responsible for the significant dissimilarity between surveys. Interestingly, SIMPER did not indicate increases in any of the Non-living substrate categories as important contributors to the observed dissimilarity.

The results of the SIMPER analysis show decreases in the cover of macroalgae and wormrock, but not cover of sand or sediment over hardbottom which would suggest sediment accretion. The decrease in wormrock in 2019 is illustrative of the semi-annual growth seen typically in this region during many years of monitoring, a two to three-year cycle of growth and subsidence has repeated multiple times and is likely a natural process.

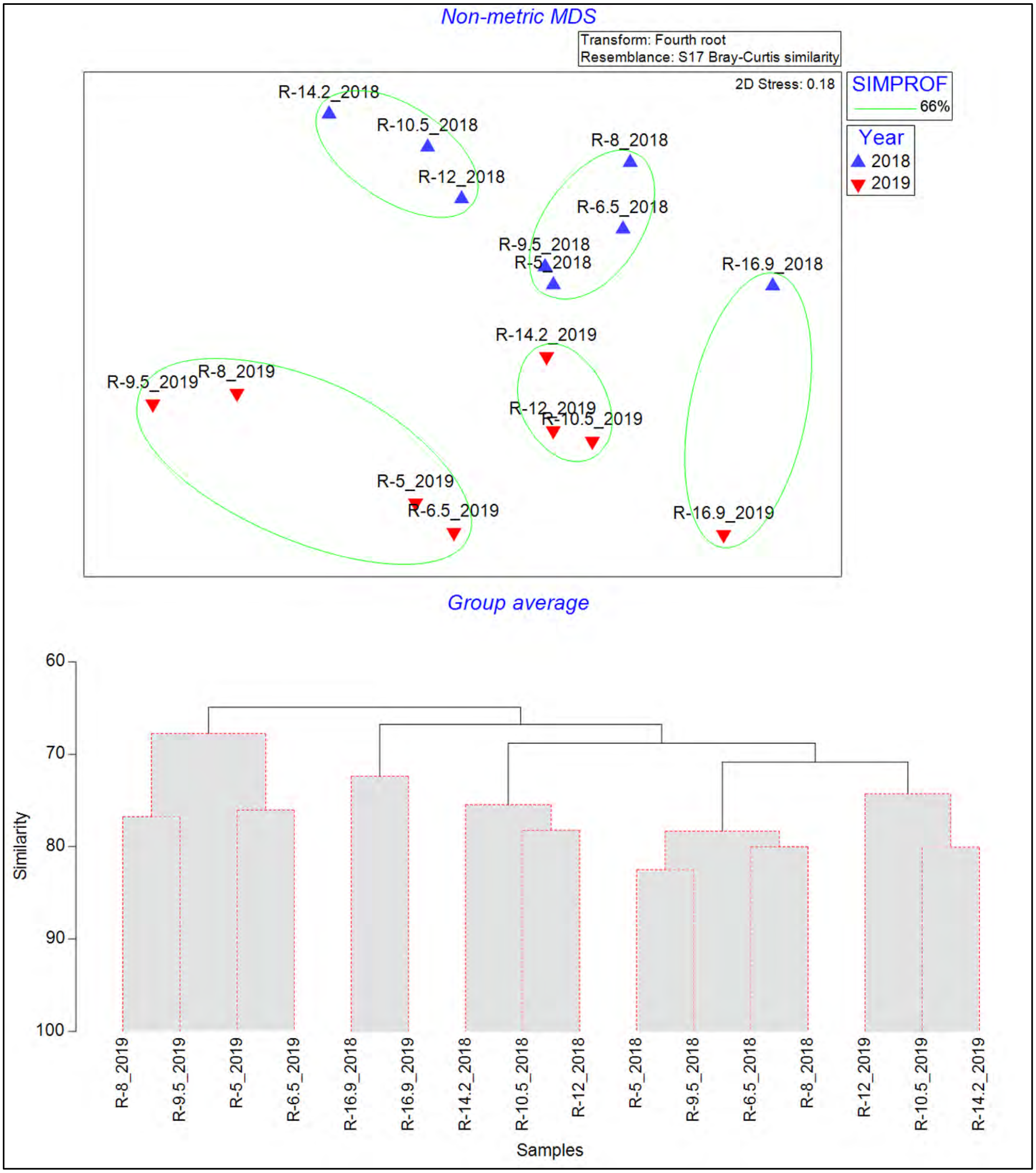

Figure 20. Top: wo-dimensional Multi-Dimensional Scaling analysis of fourth root transformed transect percent cover data for 2018 and 2019 transect pairs; and Bottom: Cluster Analysis of the same data displaying significant differences (black lines) and similarity among transects and years (shaded cells).

5.3 HARDBOTTOM RELIEF

In order to assess potential project-related impact manifested as decreased relief of hardbottom (i.e., in-filling of low areas with sand), mean maximum hardbottom relief was compared between 2018 and 2019 data sets. The mean maximum hardbottom relief in the project area decreased from 29 to 24 cm, which represented a significant decrease (paired two-tailed t-test, *df* = 7, *p* = 0.01) (**Figure 21**). The decrease in maximum hardbottom relief within quadrats corresponds to the increase in mean quadrat sediment depth and indicates overall more sediment within the project area during 2019.

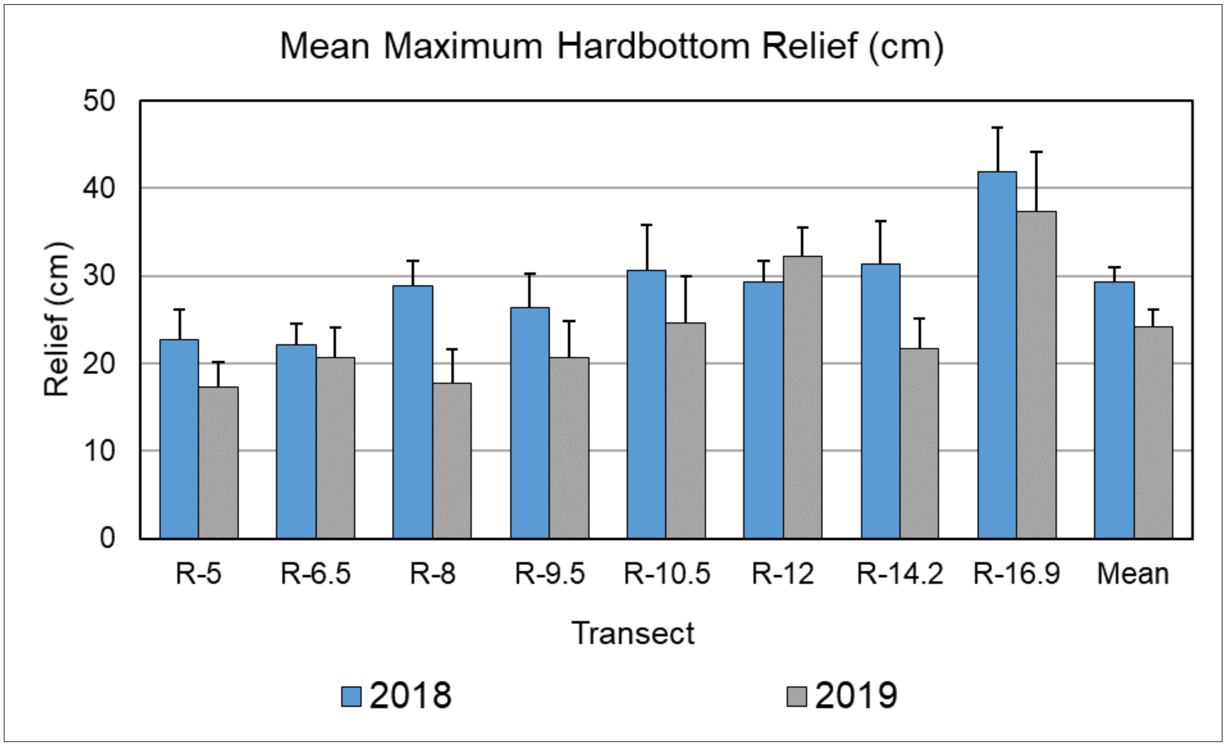

Figure 21. Mean maximum hardbottom relief (+standard error) for quadrats surveyed for the Sebastian Inlet District Sand Bypassing Project: 2018 Pre-Construction and 2019 Immediate Post-Construction Monitoring Survey.

Among the individual transects, most transects displayed minor decreases in hardbottom relief, R-8, R-10.5, and R-14.2 exhibited the most change, which corresponded to the greatest increases in quadrat sediment depth. These two physical data metrics from within quadrats are inversely proportional; thus, not a surprising discovery.

5.4 SEDIMENT ACCUMULATION

5.4.1 Sediment Depths Within Quadrats

Potential project-related impacts from beach nourishment activities could also manifest as increased sediment thickness on nearshore hardbottom communities. Paired t-tests were run to compare quadrat sediment depths recorded from each transect in 2018 and 2019 (**Figure 22**). Significant differences (paired, two-tailed t-test *p* = 0.03) in sediment depth were found between 2018 and 2019 from quadrats.

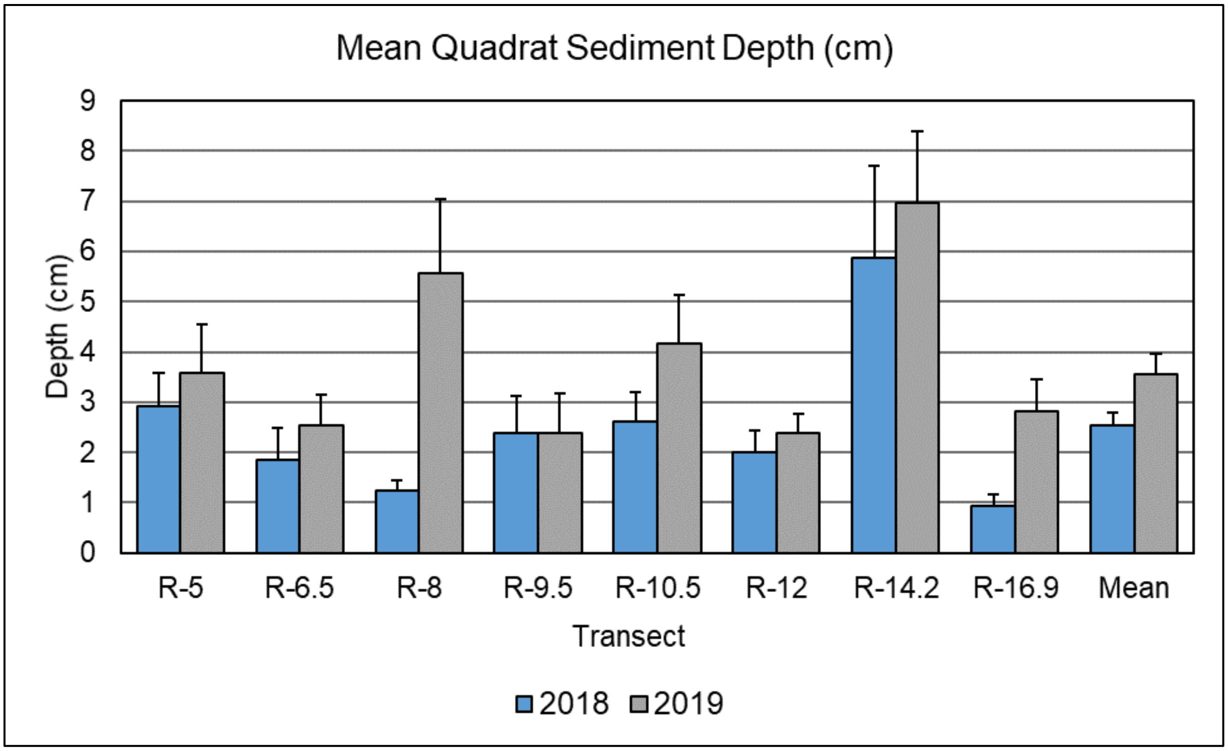

Figure 22. Mean quadrat sediment depth (+SE) for quadrats surveyed for the Sebastian Inlet District Sand Bypassing Project: 2018 Pre-Construction and 2019 Immediate Post-Construction Monitoring Survey.

Variation in sediment depth may be caused by a suite of factors, including wave energy, shoreline profile, bottom topography, natural external sand sources and project-related input of sand to the system. When considered alongside the abiotic category percent cover data from 2019, an increase in unconsolidated sediments was apparent during the Immediate Post-Construction Survey.

5.4.2 Sediment Depths at 1-m Intervals Along Transects

Sediment depth was also measured at 1-meter intervals along each transect in 2018 and 2019 and graphed for comparative purposes (**Appendix D**). All transects showed variable distribution of sediment depths between years, and all transects except R-6.5 and R-16.9 had overall increases in sediment depth in 2019. The most noteworthy increases occurred along Transects R-12 and R-14.2 where sediment depths expanded along the both sides of the large shore parallel trough between hardbottom ridges from approximately 20 to 65 m along the transects. Comparison of sand troughs visible in the aerials from 2018 and 2019 (**Figures 10** to **15** and graphically in **Appendix D**) shows expansion and contraction have occurred in various places, which can have a direct effect on sediment depths and delineation of hardbottom and sand along the transects. As these troughs run north and south, they may represent conduits for littoral drift of sediment in alongshore currents (Kraus and Galgano, 2001; Zarillo et al., 2018), not necessarily related to the beach nourishment.

5.4.3 Hardbottom and Sand Cover Along Transects

In addition to changes in sediment depth, changes in the linear cover of sand along each transect may help assess potential project-related impacts. **Figure 9** depicted the line intercept data, and from 2018 to 2019 linear sand cover increased on all transects in the Project area except R-10.5, where a 2.9 m decrease in sand along the transect was recorded. Overall, divers delineated 49.2 m less hardbottom in 2019 than in 2018. The majority of changes among the transects were along the margins of sand troughs which expand and contract in width and length year to year. Along R-6.5, an existing sand patch just north of the transect expanded to cover the hardbottom from 21 to 27 m and expansion of the larger sand trough offshore covered 4 more meters (82 to 86 m) of exposed hardbottom than in 2018. Gains were observed along R-10.5, where hardbottom was exposed from sand patches and a sand trough recorded in 2018. These contrasting changes each occurred along the margins of transverse sand channels that are found on all transects in the project area in the 50 to 80 m range as well as in other, more variable patches. This illustrates the naturally mediated sediment budget within the project area, as no major losses of hardbottom or burial of hardbottom by sand were evident near the ETOF.

5.5 CHARACTERIZATION OF THE NEARSHORE EDGE OF HARDBOTTOM

5.5.1 Mapping Data

A seaward change in the location of the nearshore edge of hardbottom following beach nourishment activities could signal a direct project-related impact, so the mapped locations of the nearshore hardbottom edge were compared from 2011 through 2019 (**Figures 10** to **15**). The long-term dataset provides visualization of the annual trends in hardbottom edge location, over multiple pre and post construction intervals. The initial pre-construction mapping data from 2011 included bounce dives every 500 ft in unmapped areas collected in December 2011. Bounce dives from 2011 revealed exposed hardbottom in the intertidal zone, approximately 20 to 65 m landward (west) of the nearshore edge of hardbottom in most other surveys. This was originally postulated to be due to the time of year of the survey, winter rather than summer, in which these areas of hardbottom in the intertidal zone were more likely to be exposed by heavy wave action and subsequent beach erosion in winter months, as opposed to during times of beach accretion in summer months, when all other surveys were conducted. However, this intertidally exposed hardbottom was present during the 2017, 2018, and 2019 monitoring surveys, despite the data being collected in summer. This represented a general return to similarity with the 2011 baseline data set, initially observed three years after IRC Sectors 1 and 2 beach fills had ceased. The 2017 and 2018 survey occurred two years after beach construction, with only small sand bypassing volumes, which implies the intertidal sections of the hardbottom edge could be impacted by beach fill. In 2019, while portions of the nearshore edge were still intertidally emergent, it was found slightly offshore of the 2018 mapped locations. For comparison of the 2019 mapped hardbottom edge with long time-series map data, figures retained all the mapping data which was collected since 2011.

The position of the nearshore edge of hardbottom in 2019 was in the same location as in 2018 from R-4 to R-6, where it is approximately 75 m from the shore. To the south, from R-6 to R-10, the 2019 location was very similar to the 2018 edge, with a slight trend offshore by approximately 5 m. However, from R-11 to R-13, the 2019 edge was located further from shore between 10 to 20 m east of the 2018 edge (**Figures 13** to **14**). Further to the south, from R-13 to R-15, the 2019 mapped edge was inshore of the 2018 edge, while meeting back up with it south of R-15, and again trending offshore of the 2018 edge from R-16 to R-17.

The emergent hardbottom mapped in 2019 from R-6 to R-10 coincided well with the same areas mapped in other years (2011, 2017, and 2018). Most importantly, all the tidally exposed hardbottom in the intertidal zone falls inshore of the Permitted Equilibrium Toe of Fill from R-6 to R-14.75.

The 2019 hardbottom edge line was inshore of the 2018 maps from R-14 to R-16 (**Figures 14** and **15**); however, this followed much of the 2012 and 2016 map lines. The re-exposure and burial of these extremely nearshore patches of hardbottom is cyclical and is driven primarily by natural processes, including interannual storms, weather events, and littoral drift but also potentially exacerbated by beach renourishment and sand equilibration.

Finally, from R-16 to R-17 the position of the edge in 2019 was offshore of the 2018 map shown in **Figure 15,** but when compared with other years, the 2018 data was anomalous. A visible sand gap at approximately R-16.1 was mapped differently among years; including swimming across it (2012 and 2018) mapping perpendicular to shore until the next nearest landward edge (2016) and eliminating it from the line (2017 and 2019) but it has not changed much in length or location.

In summary, the position of the 2019 nearshore edge of hardbottom was similar to or slightly offshore of the edge location in 2018 for the majority of the survey area. Sediment deposition, denoted by seaward migration of the edge in 2019, was primarily observed between R-10 and R-13. This area is within the beach fill template and may suggest downdrift and/or cross-shore sediment transport. Other areas where the 2019 edge was offshore of 2018 edge were >5 m different, and not as likely to represent significant sediment influx but more related to interannual variability.

5.5.2 Qualitative Observations and Biota

Project-related impacts could also manifest as changes in the biological community along the nearshore edge of hardbottom due to burial, increased thickness of sediment veneer on hardbottom, increased sedimentation and turbidity.

When comparing years, turf algae were the most frequently observed type of algae along the hardbottom edge in all years, due to the majority of the nearshore edge being exposed to wave action and sediment scouring. Disturbance-tolerant macroalgal species such as *C. prolifera* and *B. cuspidata* were commonly observed in abundance as well. From R-6 to R-12, most of the hardbottom edge was in the intertidal; therefore, crustose coralline algae, cyanobacteria, sea lettuce (*U. lactuca)* and filamentous algae were dominant. Cover of wormwork along the edge was lower than 2018, but large, healthy colonies were still observed in localized areas from R-12 to R-16.9 in 2019.

Fauna regularly observed along the nearshore edge of hardbottom in 2019 were similar among all previous surveys and were species commonly associated with nearshore hardbottom in IRC, including juvenile green sea turtles (*C. mydas*), manatee (*Trichechus manatus*) black margate (*Anisotremus surinamensis*), Gulf flounder (*Paralichthys albigutta*), hairy blenny (*L. nuchipinnis*), sheepshead (*A. probatocephalus*) Atlantic guitarfish, (*R. lentiginosus*), and bonnethead sharks (*Sphyrna tiburo*). Other benthic fauna included sea cucumbers (Holothuroidea), encrusting sponges (including *Cliona celata*), hydroids, tunicates, and sabellariid wormrock (*Phragmatopoma caudata)*. Primary changes to fauna in the hardbottom community from 2018 to 2019 were due the decrease in wormrock in many areas. However, annual and seasonal fluctuations in cover of wormrock are natural and colonies may be easily impacted by storms

(Eckelbarger, 1976). All flora and fauna appeared healthy, with no visible signs of severe stress or disease noted in any of the surveys. In general, qualitative observations since 2011 indicate the biota along the nearshore hardbottom edge are consistent from year to year and have changed very little over time.

6.0 Summary

The Sebastian Inlet District Sand Bypassing Project: Post-Construction Nearshore Hardbottom Monitoring Survey was completed in its entirety from 10 to 25 June 2019. Images from the survey were compiled into **Appendix F** and the weather log of daily events and conditions is provided in **Appendix G**. The nearshore hardbottom biological community was algal dominated; however, non-living sediments composed much of the quadrat percent cover as sediment over hardbottom. Non-living substrates also made up a large amount of the seafloor as >30 cm deep shore parallel sand troughs were evident along most monitoring transects. Red macroalgae and turfs were the most prevalent algae taxa, with wormrock contributing substantially to the fauna. Wormrock abundance followed similar geographic distribution as in 2018 but was significantly lower in percent cover in 2019. Wormrock, however, is known to exhibit annual fluctuations in recruitment and growth, so this is likely a natural process.

The nearshore hardbottom edge mapping showed that much of the landward edge was intertidally exposed low relief limestone covered by filamentous turf algae. Slightly less intertidally exposed area was mapped in 2019, and the general trend was slightly further from shore than in 2018. This intertidally exposed hardbottom has historically shown cycles of exposure and burial, dependent on storm activity and other natural processes. Flora and fauna along the subtidal sections of the nearshore hardbottom edge were similar to those recorded along the monitoring transects and in previous years, dominated by turf algae and wormrock. Areas with canopy-forming macroalgae were also observed throughout the Project area, and drift macroalgae occasionally piled up inside the landward edge of hardbottom, obscuring the benthos.

The 2019 Immediate Post-construction monitoring results were compared to the 2018 dataset through non-parametric means to assess any potential impacts from the 2019 fill project. The analyses indicated the two years were significantly different based on percent cover data; however, no direct link to sediment impacts in the percent cover dataset were evident and decreases in macroalgal and wormrock percent cover were the main factors driving the significant results.

Student's t-tests of the quadrat sediment depth data were also significantly different between 2018 and 2019, indicating significantly greater sediment depths within quadrats for 2019. A suite of naturally mediated processes including wave energy, available sand from ebb shoals and attachment bars, and bottom topography are all factors that could also influence sediment depth in addition to project related sand inputs. However, when considered alongside the abiotic category percent cover data, interval sediment depth measurements and hardbottom sand-delineation from 2019, an increase in unconsolidated sediments was apparent during the Immediate Post-Construction Survey.

Bray, J.R. and J.T. Curtis. 1957. An ordination of the upland forest communities of southern Wisconsin. Ecological Monographs 27(4):325-349.

Clarke, K.R. 1993. Nonparametric multivariate analyses of changes in community structure. Australian Ecology 18:117-143.

Clarke, K.R. and Warwick, R.M. (2001) Change in Marine Communities: An Approach to Statistical Analysis and Interpretation. 2nd Edition, PRIMER-E, Ltd., Plymouth Marine Laboratory, Plymouth.

Clarke, K. R., M.G. Chapman, P.J. Somerfield and H.R. Needham. 2006. Dispersion-based weighting of species counts in assemblage analyses. Marine Ecology Progress Series 320:11-27.

Coastal Data Information Program. 2017. Ft. Pierce, Fl Historic Wave Height – Station 134. http://cdip.ucsd.edu/?nav=historic&sub=data&stn=134&stream=p1. Scripps Institution of Oceanography Integrative Oceanography Division Ocean Engineering Research Group, University of California, San Diego, CA.

CSA International, Inc. 2007. Indian River County Sectors 1 and 2 Beach Nourishment Project: Pre-Construction Baseline Monitoring Report FDEP Permit No. 0166929-007-EM. Prepared for Indian River County Public Works. 51 pp. + app.

CSA International, Inc. 2012a. Indian River County Sectors 1 and 2 Beach Nourishment Project: Year 3 Post-Construction Monitoring Report FDEP Permit No. 0166929-007-EM. Prepared for Indian River County Public Works. 91 pp. + app.

CSA International, Inc. 2012b. Sebastian Inlet District 2012 Sand Bypassing Project: Immediate Post-Construction Monitoring Survey FDEP Permit No. 0270746-001-EM. Prepared for Sebastian Inlet District. 75 pp. + app.

CSA Ocean Sciences Inc. 2013. Sebastian Inlet District 2013 Sand Bypassing Project: Immediate Post-Construction Monitoring Survey FDEP Permit No. 0270746-001-EM. Prepared for Sebastian Inlet District. 59 pp. + app.

CSA Ocean Sciences Inc. 2014. Sebastian Inlet District 2014 Sand Bypassing Project: Immediate Post-Construction Monitoring Survey FDEP Permit No. 0270746-001-EM. Prepared for Sebastian Inlet District. 68 pp. + app.

CSA Ocean Sciences Inc. 2015. Sebastian Inlet District 2015 Sand Bypassing Project: Immediate Post-Construction Monitoring Survey FDEP Permit No. 0270746-001-EM. Prepared for Sebastian Inlet District. 76 pp. + app.

Eckelbarger, K.J. 1976. Larval development and population aspects of the reef-building Polychaete *Phragmatopoma lapidosa* from the east coast of Florida. Bull Mar Sci 26(2):117-132.

Florida Department of Environmental Protection. 2007. Indian River County Beach Nourishment Project Sectors 1 and 2 Biological Monitoring Plan. Permit No. 0166929-007-EM. Bureau of Beaches and Coastal Systems. February 2007 Revision. 7 pp.

Florida Department of Environmental Protection. 2012. Sebastian Inlet Sand Bypassing Project Biological Monitoring Plan. Permit No. 0270746-001-EM. Bureau of Beaches and Coastal Systems. July 2012 Revision. 10 pp.

Florida Department of Environmental Protection. 2016. Standard Operation Procedures For Nearshore Hardbottom Monitoring of Beach Nourishment Projects. Division of Water Resource Management. February 2016 Revision. 75 pp.

Florida Department of Environmental Protection. 2018. Sebastian Inlet Maintenance Dredging and Sand Trap Deepening Project: Hardbottom Biological Monitoring Plan. Permit No. 0270746-006-JC. Beaches, Inlets and Ports Program. 22 August 2018 Revision.11 pp.

Kohler, K.E. and S.M. Gill. 2006. Coral Point Count with Excel extensions (CPCe): A Visual Basic program for the determination of coral and substrate coverage using random point count methodology. Computers and Geosciences. 32(9):1259-1269.

Kraus, N. C., and Galgano, F. A. 2001. Beach erosional hot spots: Types, causes, and solutions. Coastal and Hydraulics Engineering Technical Note CHETN-II-44, U.S. Army Engineer Research and Development Center, Vicksburg, MS. 17 pp.

Lybolt, M., and Tate, S. 2008. Rapid changes in nearshore habitat: is resource burial an appropriate measure of project impact? Environmental Science Conference Proceedings, Shore & Beach 76(1). 5 pp.

Sebastian Inlet District. 2005. Findings and recommendations, Sebastian Inlet Management Plan, Technical Advisory Committee. August 4, 2005. 5 pp.

Underwood, A.J. 1992. Beyond BACI: the detection of environmental impacts on populations in the real, but variable, world. Journal of experimental marine biology and ecology 161 (2), 145-178.

Zarillo, G.A., I.M. Watts, L. Erickson, K.L. Hall and S. Ramos. 2018. State of Sebastian Inlet Report: 2018. An Assessment of Inlet Morphologic Processes, Shoreline Changes, Sediment Budget, and Beach Fill Performance. Florida Inst. of Tech. Melbourne, FL, U.S.A. 112 pp.

Zarillo, G.A. 2003. Morphologic analysis of Sebastian Inlet, Florida: Enhancements to the tidal inlet reservoir model. Proceedings Coastal Sediments ’03. World Scientific Publishing Corp. and East Meets West Productions, Corpus Christi, Texas, U.S.A. 14pp.