United States Department of the Interior

FISH AND WILDLIFE SERVICE
Mountain-Prairie Region

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FWS/R6/

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06E00000-2018-F-0

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APR 1 3 2018

Mr. David J. Ponganis
Director of Programs Directorate
U.S. Army Corps of Engineers, Northwest Division
P.O. Box 2870
Portland, Oregon 97208-2870

Dave
Dear Mr. Ponganis:

Please find enclosed the Final Biological Opinion concerning the Operation of the Missouri River Mainstem Reservoir System, the Operation and Maintenance of the Bank Stabilization and Navigation Project, the Operation of Kansas River Reservoir System, and the Implementation of the Missouri River Recovery Management Plan. The U.S. Fish and Wildlife Service (Service) transmitted the draft to the USACE on February 8, 2018 and the USACE subsequently transmitted the draft BiOp to the Independent Science Advisory Panel (ISAP) of the Missouri River Recovery Implementation Committee (MRRIC). The ISAP presented the results of their review to the MRRIC plenary session March 27, 2018 and the USACE formally transmitted the ISAP response along with USACE supporting information to the Service on April 3, 2018. The Service wants to thank the USACE for their continued collaborative approach to what is a ground breaking process of evaluating a highly complex adaptive management process through section 7 of the Endangered Species Act.

The Service has taken the ISAP and USACE comments under advisement and have made numerous improvements to the document as a result. As you are aware the draft BiOp did not have a fully developed Incidental Take Statement (ITS). The Service provided concept papers to the USACE and MRRIC at the MRRIC plenary session mentioned above. While there was not an explicit charge to the ISAP to review and comment on the ITS both the USACE and the Service received review comments on the ITS on April 4, 2018. In summary the ISAP expressed concern over using survival of pallid sturgeon as the metric for the ITS, particularly in the lower river. Service and USACE staff have been working very closely on addressing ISAP concerns. The Service also continued to engage our fisheries professionals on how to address the ISAP concerns. At the end of the day the Service has concluded to continue to utilize survival estimates of pallid sturgeon as a metric in both the upper and lower Missouri River. However, in light of the ISAP comments the Service has developed a second metric in the lower Missouri river that relies on catch per unit effort as was suggested by the ISAP. Further explanation of the rationale can be found in the Final BiOp. The Service anticipates that as a result of monitoring and evaluation through the adaptive management process refinements to one or both of those metrics is likely.

There remains two process documents that will need to be completed prior to completion of the Record of Decision. The first is a process and procedures document that will describe how subsequent step down consultations will be addressed in the future. The second is a process mechanism for the Service to provide to the USACE a periodic progress review regarding overall implementation of the Final BiOp. Both our staffs are aware of these and will be turning to develop those shortly.

In closing, I would like to thank you and USACE staff for working so closely with the Service on developing a very complex and cutting edge program to further conservation of threatened and endangered species within the Missouri River Basin. The Service firmly believes that this approach will improve conditions for protected species through time while ensuring the USACE's ability to meet the authorized purposes on the Missouri River and allowing better opportunities to address human considerations throughout the basin.

If you have any questions please feel free to contact me at 303-236-4210 or Ms. Kimberly Smith at 303-236-4347.

Sincerely,

Assistant Regional Director – Ecological Services

Enclosure: Final Biological Opinion concerning the Operation of the Missouri River Mainstem Reservoir System, the Operation and Maintenance of the Bank Stabilization and Navigation Project, the Operation of Kansas River Reservoir System, and the Implementation of the Missouri River Recovery Management Plan

Cc: U.S. Fish and Wildlife Service, Regional Director – Region 6
U.S. Fish and Wildlife Service, Regional Director – Region 3
Rocky Mountain Regional Office, Office of the Solicitor – Attn: Lori Caramanian

BIOLOGICAL OPINION

Operation of the Missouri River Mainstem Reservoir System, the Operation and Maintenance of the Bank Stabilization and Navigation Project, the Operation of Kansas River Reservoir System, and the Implementation of the Missouri River Recovery Management Plan

TAILS No. 06E00000-2018-F-0001

FISH AND WILDLIFE SERVICE
Mountain Prairie Region
Denver, Colorado

Assistant Regional Director for Ecological Services ______________________

Date April 13, 2018

EXECUTIVE SUMMARY

This biological opinion (BiOp) is issued in response to the U.S. Army Corps of Engineers' (USACE) request for initiation of section 7 consultation on October 30, 2017. This BiOp supersedes the 2003 Amended BiOp and associated ITS dated December 16, 2003, which addressed the effects of Operation of the Missouri River Mainstem Reservoir System, Operation and Maintenance of the Missouri River Bank Stabilization and Navigation Project, Operation of the Kansas River Reservoir System. The USACE has described its proposed changes to the Project and the effects of these changes in the revised amended BA dated October 30, 2017 and in their letter dated January 19, 2018. Where appropriate, we have incorporated its descriptions and analysis into this BiOp. The Proposed Action that we are evaluating in this BiOp is the Operation of the Missouri River Mainstem Reservoir System, the Operation and Maintenance of the Bank Stabilization and Navigation Project, the Operation of Kansas River Reservoir System, and the Implementation of the Missouri River Recovery Management Plan. The Science and Adaptive Management Plan, a component of the Proposed Action, describes the formal process led by Service and USACE in implementing the Missouri River Recovery Management Program.

The U.S. Fish and Wildlife Service (Service) has been consulting with the USACE on Missouri River Mainstem Reservoir System operations since 1986 following the listing of the interior least tern (*Sternula antillarum*) and piping plover (*Charadrius melodus*) under Endangered Species Act (ESA or Act). Although consultation activities began with the Missouri River System operations, they expanded to include Bank Stabilization and Navigation Project (BSNP) operations and maintenance and Kansas River reservoir operations within the scope of the Proposed Action and also included evaluation of effects to pallid sturgeon (*Scaphirhynchus albus*) following its ESA listing in 1990. Consultation activities occurring through 2003 are described in detail in the 2000 BiOp (Service 2000) and 2003 Amended BiOp (Service 2003). The 2003 Amended BiOp included a jeopardy opinion with a Reasonable and Prudent Alternative for pallid sturgeon and a non-jeopardy opinion for interior least tern and piping plover. The 2003 Amended BiOp also called for development of a framework for resource management actions on the Missouri River, acknowledging critical uncertainties about how the species will respond to implemented management actions.

In 2005, USACE established the Missouri River Recovery Program (MRRP). It is the umbrella program that coordinates the USACE efforts in the following:

- Compliance with the 2003 Amended BiOp on the Operation of the Missouri River Mainstem Reservoir System, Operation and Maintenance of the BSNP, and Operation of the Kansas River Reservoir System;
- Acquiring and developing lands to mitigate for lost habitats as authorized in Section 601(a) of WRDA 1986 and modified by Section 334(a) of WRDA 1999 (collectively known as the BSNP Fish and Wildlife Mitigation Project); and
- Implementation of WRDA 2007 including the Missouri River Recovery Implementation Committee (MRRIC) and Section 3176, which allowed USACE to use recovery and mitigation funds in the upper basin states of Montana, Nebraska, North Dakota, and South Dakota.

The MRRIC makes recommendations and provides guidance to federal agencies on the existing MRRP. The MRRIC is composed of over 70 members representing various interests, Tribes, states, and agencies from within the Missouri River basin.

In 2011, the MRRIC and USACE established the Independent Science Advisory Panel (ISAP). This panel is charged with independent science support and technical oversight by providing advice on specific topics. Doyle et al. (2011) identified the need for the MRRP to incorporate new scientific information that has become available since the issuance of the 2003 Amended BiOp. An Effects Analysis study, recommended by Murphy and Weiland (2011), was initiated in 2013 to synthesize new scientific information specific to these three species and concluded that considerable uncertainty remains regarding the type and extent of management actions ultimately needed to lead to population growth for each of the three species. Given the high level of uncertainty regarding the necessary actions to address the listed species' needs, USACE and Service agreed that proceeding under a rigorous and progressive adaptive management plan would provide the most effective, efficient, and accountable way to manage risks to the species, address key uncertainties, and identify the scope and scale of actions ultimately required to achieve the MRRP objectives. The Effects Analysis study results and products informed the development of the Draft Missouri River Recovery Management Plan-Environmental Impact Statement (MRRMP-DEIS) alternatives and the comprehensive adaptive management approach recommended by the ISAP.

In December 2016, the USACE published its MRRMP-DEIS pursuant to the National Environmental Policy Act of 1969 (USACE 2016b). The MRRMP-DEIS evaluated a range of alternative management actions and identified an initial suite of actions that will be implemented to meet the objectives of the MRRP. The MRRMP and the accompanying Science and Adaptive Management Plan provide the roadmap for the implementation of the selected alternative and for the identification of subsequent management needs to ultimately achieve the objectives. The Proposed Action that we are evaluating in this BiOp is the Operation of the Missouri River Mainstem Reservoir System, the Operation and Maintenance of the Bank Stabilization and Navigation Project, the Operation of Kansas River Reservoir System, and the Implementation of the Missouri River Recovery Management Plan.

The Science and Adaptive Management Plan identifies the process and criteria to implement the initial management actions, assess hypotheses, and introduce new management actions should they become necessary. The Science and Adaptive Management Plan's objectives are to: 1) increase pallid sturgeon recruitment to age 1 and to maintain or increase numbers of pallid sturgeon as an interim measure until sufficient and sustained natural recruitment occurs, 2) maintain sufficient emergent sandbar habitat (ESH) for long-term population persistence, population growth, productivity, and maintaining geographic distribution of the piping plover and interior least tern on the Missouri River. In addition, as a part of the Proposed Action, the USACE committed to the implementation of conservation measures and a Section 7(a)(1) plan that will further avoid and minimize effects to the listed species. Therefore, the Proposed Action will stabilize or improve the population abundance, and increase survival of the pallid sturgeon, piping plover, and interior least tern through implementation of the Science and Adaptive Management Plan, conservation measures, and the Section 7(a)(1) plan.

Our conclusion is that the Proposed Action will not jeopardize the continued existence of the pallid sturgeon, piping plover, and interior least tern and will not destroy or adversely modify designated critical habitat for the piping plover.

On February 12, 2018, USACE provided a copy of the draft Biological Opinion to the U.S. Institute for Environmental Conflict Resolution for formal transmittal to the Independent Science Advisory Panel (ISAP) for their scientific review. Overall, the ISAP concluded that the draft biological opinion is consistent with the best available science, that there are no technical flaws that compromise the Service's determinations, and that the Service properly interpreted the data used in the draft biological opinion.

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INTRODUCTION

Origin and Purpose of Consultation

In section 7 of the ESA, 16 U.S.C. §§1531 *et seq.*, Congress required that every federal agency "*....insure that any action authorized, funded or carried out by such agency, is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat ... determined to be critical*...[critical habitat]....."[1]*(*16 U.S.C. §§1536(a)(2). That is the standard for a section 7(a)(2) finding under the ESA.

To meet this standard, Congress required that the action agencies engage in consultation with the United States Fish and Wildlife Service (Service) or National Marine Fisheries Service and seek their BiOp regarding whether the proposed action by the action agency meets this standard. Congress further instructed that "each agency shall use the best scientific and commercial data available" when implementing the Act [Act, section 7(a)(2)]. Regulations promulgated in 1986 established specific agency responsibilities and process for moving through consultation (50 CFR§402).

Action agency responsibility in consultation – likely effects of the action

To accomplish meeting the 7(a)(2) standard, the action agency defines its action area, seeks a species list from the Service for species that may be present in the action area, and then sets about predicting the likely effects to those species (or critical habitat) from the proposed action. During this phase of consultation, the action agency may request and receive technical assistance from the Service regarding information on the listed resources and ways to reduce effects to those resources.

All of the information on effects of the action is gathered together and transmitted to the Service with a request for consultation and a BiOp. When presented to the Service the action agency's documents must include a description of the proposed action and the specific action area, the species or critical habitat impacted, and the probable biological effects to those resources, and other relevant information on the action of impacts. The document containing that information is typically referred to as a biological assessment (BA), and must use the best scientific or commercial data available. Assuming the necessary information is present in the request for consultation, the Service begins consultation.

Service's responsibility in consultation - development of the Biological Opinion

The consultation and Service's BiOp are not a review of the prudency of the proposed action or judgment regarding its value or effectiveness relative to other potential projects, or of the action

[1] Jeopardize the Continued Existence of "…to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species."

Destruction or adverse modification "... means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features."

agency taking no action. It is not a specific assessment of the recovery value of the project.[2] The Service's responsibility in consultation is to take the action agency's analysis of how the proposed action is likely to affect the species in the action area and determine if, when examined against the species condition at a listed entity scale, the action agency's project is likely to violate the jeopardy or destruction or adverse modification standard. Thus, the Service's charge under 7(a)(2) is legally mandated, narrow, and specific.

To address the threshold question of whether an agency action is likely to violate the 7(a)(2) standard, the Service evaluates the following four categories of information.

<u>Status of the Species</u> - This category represents the biological or ecological information relevant to formulating a BiOp and focuses on the current condition of the species (i.e. numbers, reproduction, distribution). The information is a broad and general examination of the species biology and condition at the scale of its range as described in its listing. This also includes a review of any factors that have, and are, influencing the species status.

<u>Environmental Baseline</u> - This category is similar to the status of the species in that it describes the condition of the species and its habitat, but is focused and limited to the action area (the areas where the proposed action will modify the land, water or air). Information also includes a review of any factors that have and are influencing the species condition at the scale of the action area.

<u>Effects of the Action</u> - This category of information is the Service's review of the action agency's analysis and discussion of how the proposed action (modifications to land, water, and air) are likely to result in an effect to the species (individuals of the species), in the action area. The analysis is the responsibility of the action agency and is required as part of the materials submitted to the Service when requesting formal consultation (50 CFR §402.14). It describes how the proposed action modifies the environment, whether listed species will be exposed to those modifications, what the species' response will likely be if exposure occurs and then what biological effect (if any) is likely to result from the response.

<u>Cumulative Effects</u> - This category describes the effects to the species (if any) from any future non-federal actions that are reasonably certain to occur in the action area.

The 7(a)(2) Conclusion

The Service reviews the effects from the proposed action and examines whether those effects resonate at the scale of the listed entity in such a way as to be likely to meet the elements in the definition of Jeopardy (... *to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species.*" 50 CFR §402.02). If critical habitat is affected, the definition of Destruction or Adverse Modification is examined ("... *means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential*

[2] Separate from the consultation requirement of 7(a)(2), Federal action agencies are already required by Congress, under 7(a)(1) of the Act, to use their authorities to conserve (recover) listed species.

to the conservation of a species or that preclude or significantly delay development of such features.")

If the opinion of the Service is that the proposed action is not likely to violate the 7(a)(2) standard, then consultation is complete and this will inform the action agencies' decision on whether to move forward with the action. If the proposed action is not Jeopardy, but anticipates effects to some individuals meeting the Act's definition of 'take' (under section 9), the Service enumerates that take and exempts it from the Act's prohibition in an Incidental Take Statement (ITS). ITSs include mandatory measures (RPMs) to reduce effect of the take.

If the Service finds that the proposed action is likely to violate the 7(a)(2) standard, the Service, working with the action agency, must develop a reasonable and prudent alternative (RPA) to the proposed action. However, the options for developing this RPA are not unlimited. By regulation (50 CFR §402.02), it must meet the following criteria.

1) The alternative action can be implemented in a manner consistent with the intended purpose of the action.
2) The alternative action can be implemented in a manner consistent with the scope of the Federal agency's legal authority and jurisdiction.
3) The alternative action is economically and technologically feasible.
4) It must avoid the likelihood of jeopardizing the continued existence of listed species.

If the action agency decides to move forward with an RPA as an alternative to their proposed action, the now modified action has satisfied the 7(a)(2) requirement and can proceed.

Continuing obligation after Consultation

In all cases where discretionary Federal involvement or control over the action has been retained or is authorized by law, the action agency is responsible for monitoring the progress of its action and re-initiating the consultation if any of the following four conditions are met.

1) If the amount or extent of taking specified in the ITS is exceeded;
2) if new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered;
3) if the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the BiOp; or
4) if a new species is listed or critical habitat designated that may be affected by the identified action. (50 CFR §402.16)

Legal construct and review of biological assessments and biological opinions

Because section 7 consultations are a mandate under a statute reflecting public policy articulated by Congress in the ESA and associated federal regulations, BiOps and BAs are first and foremost legal documents. Therefore, when challenged and brought under judicial review, BiOps are measured against a standard of whether the "decision" is arbitrary or capricious. This is a legal review; it is not a review of scientific support or proof. Decisions have been found to be arbitrary and capricious if they:

(1) relied on factors which Congress did not intend the Service to consider;
(2) entirely failed to consider an important aspect of the problem;
(3) offered an explanation for the conclusion that runs counter to the evidence before the court;
(4) offered a conclusion that is so implausible that it could not be ascribed to a difference in view or the product of expertise; or
(5) failed to articulate a satisfactory explanation for a conclusion.

The use of "best scientific and commercial data available" in biological assessments and biological opinions

Consultation documents, required by law as part of Section 7(a)(2) consultation, must be constructed using a legal framework, however the ESA also requires that "*each agency shall use the best scientific and commercial data available*" [Act, section 7(a)(2) (emphasis added)]. This is a broader concept than established scientific facts. Scientific facts are established through use of the scientific method where a specific hypothesis is tested using carefully designed and controlled experiments. The results are then subjected to statistical analysis. It is often the case that the available body of information necessary to inform a predicted outcome of a proposed action may be information that has not been subjected to the scientific method, partially because that proposed action has not been implemented and therefore outcomes have not been observed.

The Service recognized this situation when it published its policy on information standards (Fed. Reg. Vol. 59, no. 126 July 1, 1994). The policy notes that information comes from a wide variety of sources, some of which is anecdotal, oral, unpublished gray literature and published articles from juried professional journals. All of this information can be evaluated and used in decisions under the Act.

Consultation in the face of limited information and uncertainty

The action agency and Service often face a situation where there is limited information specific to the type of action being proposed. Also the available data is likely to vary in its origin, degree to which it has been subjected to statistical analysis, and strength of any causal or correlative relationships found among variables. Where the data is particularly scant, the agencies may have to use information from different, but similar, projects to produce a reasonable prediction for future effects caused by the proposed action.

Given these circumstances, limiting data for use in consultations to only data that has been subjected to strict hypothesis testing, statistical analysis and publication would often times leave little to no data for use. In the face of the Act's direction, the Service and the action agency use a "weight of the evidence" approach to judge the relevance and strength of all available data. Weight of evidence uses information presented on an issue and judges (weighs) whether or to what degree, the information favors one line of thinking, or another. It merges inferences from qualitative and quantitative information (including published data if available).

The Service can then analyze what the data represents, interpret the meaning and value of that data to build a specific line of reasoning to predict future effects to listed species or critical habitat. The predicted effects are then applied to the legal threshold question of whether the future project is likely to jeopardize the listed species or cause the destruction or adverse modification of its designated critical habitat. Courts have referred to this chain of logic, support and rationale as "connecting the dots."

The Act prescribes that the action agency's consultation and the Service's preparation of a BiOp will take place in a total of 135 days. This creates a tension around the consultation timeframe and the information available, and the certainty of the agency's analysis. Congress recognized this problem and addressed it in a House conference report as follows.

> *"As currently written, however, the law could be interpreted to force the Fish and Wildlife Service and the National Marine Fisheries Service to issue negative biological opinions whenever the action agency cannot guarantee with certainty that the agency action will not jeopardize the continued existence of the listed species or adversely modify its critical habitat. The amendment will permit the wildlife agencies to frame their Section 7(b) opinions on the best evidence that is available or can be developed during consultation. If the biological opinion is rendered on the basis of inadequate information then the federal agency has a continuing obligation to make a reasonable effort to develop that information.*
>
> *This language continues to give the benefit of the doubt to the species, and it would continue to place the burden on the action agency to demonstrate to the consulting agency that its action will not violate Section 7(a)(2). Furthermore, the language will not absolve Federal agencies from the responsibility of cooperating with the wildlife agencies in developing adequate information upon which to base a biological opinion. If a Federal agency proceeds with the action in the face of inadequate knowledge or information, the agency does so with the risk that it has not satisfied the standard f Section 7(a)(2) and that new information might reveal that the agency has not satisfied the standard of Section 7(a)(2)."* (H.R Rep. 96-697, at 12 (1979) (Conf. Rep.)

Congress' clear understanding was that even after a BiOp was rendered, the action agencies had a continuing obligation to ensure compliance with 7(a)(2), and that this responsibility "...continues to give the benefit of the doubt to the species..." This obligation might include development of additional information or confirmation of assumptions made. The regulations at 50 CFR § 402.16 supported this obligation by requiring the agency to reinitiate consultation if certain circumstances arose, including if new information "*...reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered*..." (emphasis added).

Form of this Consultation

This consultation and the resulting BiOp is complex because the Proposed Action has a long duration and includes both immediate actions and a Science and Adaptive Management Plan to test hypotheses, determine most effective actions, assess impacts of actions and propose changes in management of the Missouri River system. It is also unusual in that the intent of the adaptive management process is to Operate the Missouri River Mainstem Reservoir System, Operate and Maintain the Bank Stabilization and Navigation Project, and Operate the Kansas River Reservoir System while also implementing the Missouri River Recovery Program with the goal of improving the potential for survival and recovery of the pallid sturgeon, piping plover, and interior least tern. These conditions present a challenge to the consultation documents and process.

The challenge is fulfilling the Service's responsibility for making a 7(a)(2) opinion while recognizing that not all future actions and their probable effects are known at this time. In 2015 the Service promulgated an addition to the regulations on Interagency Cooperation (50 CFR §402) that was designed to deal with conflicting court cases regarding incidental take in consultations. The concepts discussed in the preamble to the regulations and the regulatory definitions promulgated at that time can inform the challenge of the current consultation.

One of the terms added to the regulation for purposes of issuing an ITS is for a "Mixed Programmatic Action." The regulations describe a mixed programmatic action as "… a Federal action that approves action(s) that will not be subject to further section 7 consultation, and also approves a framework for the development of future action(s) that are authorized, funded, or carried out at a later time, and any take of a listed species would not occur unless and until those future action(s) are authorized, funded, or carried out and subject to further section 7 consultation." The USACE Proposed Action analyzed in this consultation fits the description of a mixed programmatic action because it includes immediate actions and anticipates (through the Science and Adaptive Management Plan) future actions that will be subject to section 7 consultation, if necessary.

The USACE actions that will not require additional review are those actions currently described in the Proposed Action. The analysis of their effects will be completed within this Programmatic BiOp. However, there is a group of actions that while they can be anticipated and analyzed in a general way, sufficient details for exact effects or exemption of any anticipated incidental take cannot be known specifically at this time.

As those future actions are further defined, and if they may cause an effect to a listed species, the consultation requirement under 7(a)(2) would be triggered. Even though those future actions are intended (by definition) to be actions to improve the likelihood of survival and recovery of listed species, an examination of their effects through would be necessary. The Service and USACE are currently working on a streamlined process to coordinate these projects to ensure consistent and timely reviews across several offices. This site-specific review process and associated forms/checklists will be included in the Final EIS.

The most appropriate and efficient way to review those actions would be as part of an annual reporting and review. From a consultation perspective, such an annual report represents an examination from the action agency of how the past activities aligned with the action proposed under the consultation. At the same time, the proposed changes or additional actions for the immediate future are identified. To insure consistency with the framework of this programmatic consultation, the Service will use that opportunity to assist the USACE in satisfying any needed additional compliance with 7(a)(2). This is likely to take the form of a statement or document of consistency with the framework and conclusions of this BiOp and a statement of exemption of take as necessary.

Our regulations support consulting on the USACE's action as a "mixed programmatic action." This distinction allows for an ITS to be issued for those parts of the action that are specific enough that we can meet the regulatory burden of reasonable certainty to issue a take exemption. Where that degree of certainty is not met regarding take, the Service can still judge the action against the 7(a)(2) standard, make a 7(a)(2) conclusion, but not have to exempt take (since the Service can't meet the reasonable certainty burden).

Reliance on the regulation this way depends upon specific actions under the Missouri River Program being subject to section 7(a)(2) as necessary. This will become part of the annual review process that is already a component of the Science and Adaptive Management Plan (USACE 2017, Appendix I). At that time the Service will issue either a concurrence with original consultation or a separate "tiered" or "stepdown" BiOp along with an ITS exempting take for the specific future actions.

In this consultation, the task of the Service is to offer a BiOp as to whether the Proposed Action is likely to jeopardize the continued existence of the pallid sturgeon, interior least tern, or piping plover or destroy or adversely modify the critical habitat designated for the Northern Great Plains Population of the piping plover. This BiOp does not address critical habitat for pallid sturgeon or interior least tern because none have been designated.

The Service and USACE staffs have worked closely to share information on the project, species life history, monitoring and associated topics. Records of that coordination are included in our consultation file. The following is a list of the major consultation events. Additional details on the consultation history of this project can be found in the USACE's 2017 biological assessment (USACE 2017, pp. 10-12), Service's 2000 BiOp and 2003 Amended BiOp on the Operation of the Missouri River Mainstem Reservoir System, Operation of the Kansas River Projects, and the Operation and Maintenance of the Bank Stabilization and Navigation Project.

CONSULTATION HISTORY

1986-1989	Service and USACE consulted informally on Operation of the Missouri River Mainstem Reservoir System under the 1979 Master Manual.
October 1987	USACE prepared its BA on Operation of the Missouri River Mainstem Reservoir System based on the 1979 Master Manual.
May 26, 1989	USACE provided an information report to the Service to supplement the 1987 BA for System operations and requested initiation of formal consultation.
November 14, 1990	Service completed consultation and issued a jeopardy opinion for the interior least tern and piping plover and a non-jeopardy opinion for the bald eagle (*Haliaeetus leucocephalus*). The pallid sturgeon, listed as endangered species on September 6, 1990, was not addressed by that opinion.

December 4, 1998	USACE transmitted a BA to the Service on the effects of the operation of the Missouri River Mainstem Reservoir System under the 1979 Master Manual on listed species, as well as the effects of certain Kansas River Reservoir System projects as they relate to mainstem operations. USACE concluded that operations are likely to adversely affect the pallid sturgeon, piping plover, and interior least tern, and requested consultation.
April 19, 1999	USACE transmitted a BA for the Operations and Maintenance of the Missouri River Bank Stabilization and Navigation Project. USACE concluded that the project is likely to adversely affect the pallid sturgeon and interior least tern and requested consultation.
November 30, 2000	Service issued a BiOp to the Northwestern Division of USACE on the Operation of the Missouri River Mainstem Reservoir System, Operation and Maintenance of the Missouri River Bank Stabilization and Navigation Project, and Operation of the Kansas River Reservoir System. The BiOp concluded that current operations would jeopardize the continued existence of the interior least tern, piping plover, and pallid sturgeon, but not jeopardize the bald eagle. The Service provided USACE with a Reasonable and Prudent Alternative (RPA) to their action that, if implemented, would preclude jeopardizing these three species.
November 3, 2003	USACE requested reinitiating consultation and provided a BA in support of the request. The USACE cited new information on the effects of the action and newly designated piping plover critical habitat as triggers for reinitiation of consultation. The USACE stated its commitment to implement the RPA found in the 2000 BiOp but proposed replacing certain elements of the RPA.
December 16, 2003	Service amended the 2000 BiOp which retained several RPA elements from the 2000 BiOp. The 2003 Amended BiOp included a jeopardy opinion for pallid sturgeon and a non-jeopardy opinion for interior least tern and piping plover. The 2003 Amended BiOp provided a RPA to avoid jeopardy, and also included an ITS identifying anticipated take that would occur after implementation of the RPA, RPMs to minimize the take, and terms and conditions to implement the RPMs.
October 23, 2009	Service formally revised portions of the RPA "Flow Enhancement below Fort Peck Dam – Intake Montana River Restoration" in the 2003 amended BiOp, in a letter to USACE, in part, deferring shallow water habitat restoration targets by four years as a result of implementing the Yellowstone Intake Diversion Dam Modification project.
October 2012	Service transmitted letter to USACE endorsing the 2011 Independent Science Advisory Panel (ISAP) recommendations stating, "We have determined that aggressive pursuit of completing the recommendations

	laid out by the ISAP is the best path forward to ensure we are using the available scientific data to achieve the intent of the 2003 Amended BiOp and species recovery."
February 6, 2013	Service revises a 2003 Amended BiOp RPA entitled "Flow Enhancement below Fort Peck Dam – Intake Montana River Restoration" element c. to "As resources are being used for construction at Intake, the 2024 shallow water habitat milestone will be deferred beyond year 2024 for a period equal to the time from commencement to completion of construction; not to exceed three years" (up to year 2027).
July 31, 2015	USACE transmits letter to the Service confirming the agencies mutual understanding that they are engaged in consultation on the 2003 Amended BiOp and that the Missouri River Recovery Management Plan and Environmental Impact Statement, developed jointly by the agencies in collaboration with Missouri River Recovery Implementation Committee (MRRIC), serves as the ongoing medium for the consultation.
September 29, 2015	Service transmits letter to USACE concurring with USACE's understanding of the status of consultation described in the July 31, 2015 USACE letter.
October 30, 2017	USACE transmits letter to the Service requesting initiation of formal consultation and submittal of their BA.
November 17, 2017	The Service responded to USACE that we received all necessary information to begin formal consultation.
January 19, 2018	USACE transmits letter to the Service formally amending the Proposed Action in the 2017 BA and the Science and Adaptive Management Plan. The Proposed Action will address new information related to pallid sturgeon condition on the lower Missouri River and will prioritize hypotheses related to flows out of Fort Peck Dam to benefit the pallid sturgeon in the upper Missouri River.
February 8, 2018	Service provided a draft BiOp to the USACE concerning the Operation of the Missouri River Mainstem Reservoir System, the Operation and Maintenance of the Bank Stabilization and Navigation Project, the Operation of Kansas River Reservoir System, and the Implementation of the Missouri River Recovery Management Plan.
February 12, 2018	USACE provided a copy of the draft BiOp to the U.S. Institute for Environmental Conflict Resolution for formal transmittal to the Independent Science Advisory Panel (ISAP) for their scientific review.

February 22, 2018	USACE provide initial comments to the draft BiOp to the Service at a meeting in Kansas City, Missouri.
March 22, 2018	ISAP provided their scientific review of the draft BiOp to the USACE.
April 3, 2018	USACE provided recommendations to the Service on each of ISAP's substantive review recommendations.
April 6, 2018	USACE provided recommendations to the Service on ISAP's BiOp review Addendum #2.

BIOLOGICAL OPINION

1. DESCRIPTION OF PROPOSED ACTION

USACE has provided a detailed description of the Proposed Action (USACE 2017, pp. 21- 72). In the following section, the Service has either taken directly or summarized enough information from the BA for the reader to understand the action. The Proposed Action includes Missouri River Mainstem Reservoir System operations, BSNP operations and maintenance, and Kansas River operations, and the Missouri River Recovery Management Program. The Missouri River Recovery Program includes implementation of management actions for the benefit of the pallid sturgeon, interior least tern, and piping plover within an adaptive management framework. As such, the Proposed Action includes a comprehensive and integrated set of measures proposed by USACE to be undertaken in consultation with Service to abate the effects of the Missouri River Mainstem Reservoir System operations on threatened and endangered species. While these management actions are based upon the best available science, uncertainty regarding the effectiveness of the actions, especially those targeting pallid sturgeon (Jacobson et al. 2016b), necessitates management actions be determined and undertaken within an adaptive management framework that allows flexibility and modifications to actions as new information becomes available. USACE is proposing implementation of the Science and Adaptive Management Plan to guide species-specific management actions (USACE 2017, Appendix I). The Science and Adaptive Management Plan also includes a mechanism for collaboration with states, Tribes, and other stakeholders via the Missouri River Recovery Implementation Committee (this engagement is supplemental to and does not replace existing statutory requirements). USACE has also developed a Section 7(a)(1) Conservation Plan that would be implemented complementary to the other actions identified (USACE 2017, Appendix D). The components of the Proposed Action are described in Sections 1.2 to 1.9 below.

The Proposed Action includes the initial suite of management actions, research, and monitoring USACE would implement over the 15 years following signing of the MRRMP-EIS Record of Decision (ROD). The suite of actions is aimed at achieving objectives for the pallid sturgeon, piping plover, and interior least tern. It is possible that in the future, the Adaptive Management process will conclude that additional actions which were not part of the Proposed Action may be warranted and feasible for implementation.

The Proposed Action, as described below, is a continuation of ongoing actions along with the implementation of a new Science and Adaptive Management Plan. The past effects of those ongoing actions are included in the environmental baseline for each species (Sections 3, 8, and 13). Effects of the Proposed Action for each species are analyzed in this BiOp in Sections 4, 9, and 14.

1.1 Action Area

The action area is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action. The Service agrees with the description of the action area as described in the USACE's BA for this project (Figure 1). The action area is defined as the Missouri River mainstem and portions of major tributaries including the Kansas and Yellowstone Rivers where listed species could be influenced by USACE operations. USACE Missouri River Mainstem Reservoir operations primarily affect the area of the Missouri River and its reservoir system from the headwaters of Fort Peck Lake in Montana downstream to the mouth of the river near St. Louis, MO, River Mile 0 at the confluence with the Mississippi River. In addition, tributary inflows influence operations. The BA focuses primarily on the Missouri River mainstem from the headwaters of Fort Peck Lake to its confluence with the Mississippi River. The action area ends at the confluence of the Missouri and Mississippi River because we determined that impacts from the proposed action beyond the confluence are not discernible. The Service finds that the BA's described action area is appropriate and finds no need to modify it for this BiOp.

The Missouri River is the longest river in North America and historically, was very complex and composed of multiple channels, chutes, sloughs, backwater areas, side channels and migrating islands and sandbars (Service 2014). The construction of six dams and impoundments between 1937 and 1963 and subsequent operation; bank armoring, stabilization, and channelization; and floodplain development have all altered the natural dynamics of the Missouri River. Floodplain habitat has been altered (approximately 3 million acres), sediment transport dramatically reduced, damming and channelization of most tributaries, amplitude and frequency of peak flows reduced, natural vegetation communities including cottonwoods reduced, and benthic invertebrate and native fish production severely reduced (NRC 2002).

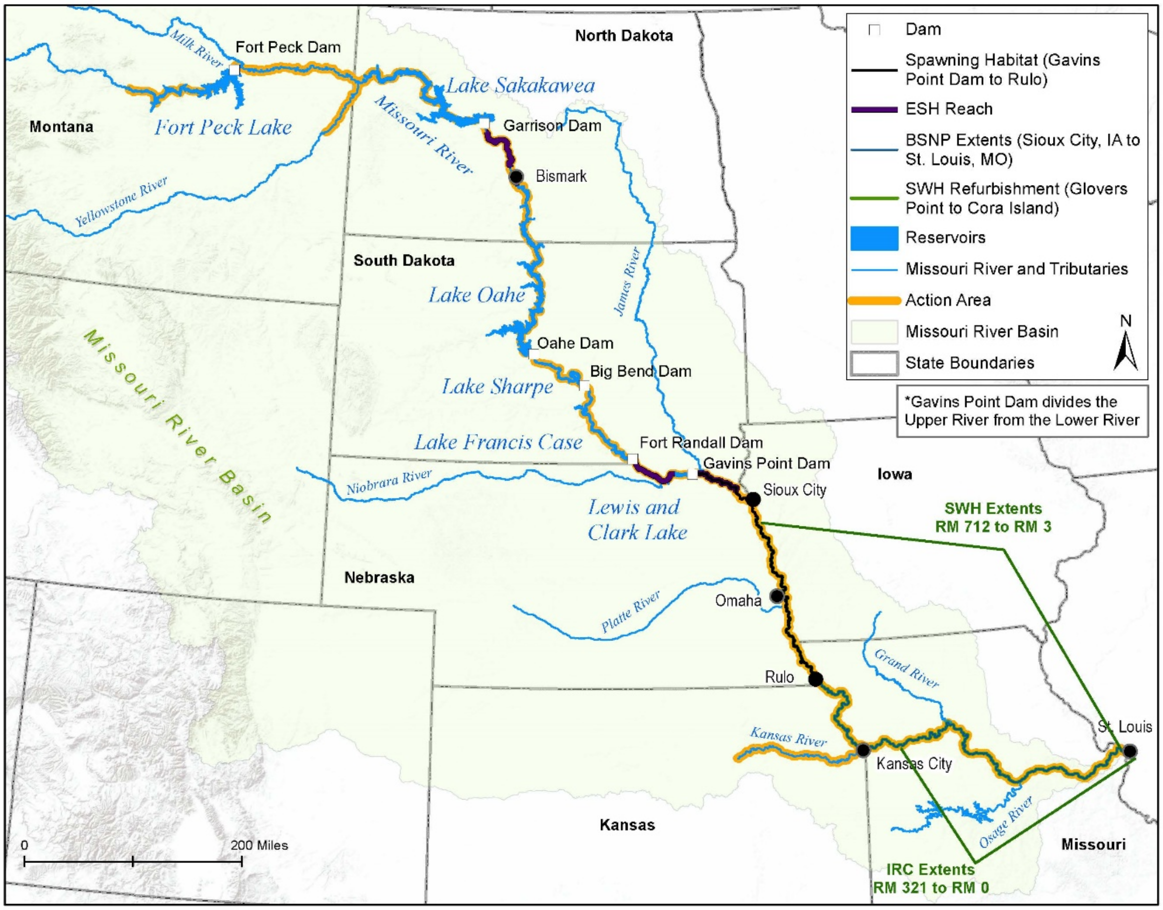

Figure 1. Action Area for the Operation of the Missouri River Mainstem Reservoir System, the Operation and Maintenance of the Bank Stabilization and Navigation Project, and the Operation of Kansas River Reservoir System

1.2 Missouri River Mainstem Reservoir System Operations

The system entails six mainstem dams and reservoirs identified starting at the headwaters and going downstream towards confluence with Mississippi River: Fort Peck Reservoir and Dam in Montana, Lake Sakakawea and Garrison Dam in North Dakota, Lake Oahe and Dam in south Dakota, Lake Sharpe and Big Bend Dam South Dakota, Lake Francis Case and Fort Randall Dam in South Dakota, and Lewis and Clarke Lake and Gavins Point Dam on the South Dakota-Nebraska state line. The System is regulated to serve the Congressionally-authorized purposes of flood control, navigation, hydropower, irrigation, water supply, water quality, recreation, and fish and wildlife. The six large reservoirs have a storage capacity of 72.4 million acre feet, the largest storage project in North America and overall System regulation follows the “water control plan” presented in the Missouri River Mainstem Reservoir System Master Water Control Manual (USACE 2006). Each of the six system dams also has an individual water control manual that presents more detailed information on its regulation.

1.3 BSNP Operations and Maintenance

The BSNP is an open channel, self-scouring project that is composed of a system of approximately 7,000 river training structures in the Lower River. The existing project extends

1,182 km from Sioux City, IA to the mouth of the Missouri River near St. Louis, MO, and maintains a 2.7 m deep by 91 m wide channel (Figure 1). The project consists mainly of revetments along the outsides of bends and transverse dikes along the insides of bends to force the river into a single active channel that is self-maintaining. Approximately 200 million tons of stone was placed during original construction (75 million in the Omaha District and 125 million in the Kansas City District).

USACE proposes to continue to maintain the BSNP from Sioux City, Iowa, to the mouth of the Missouri River near St. Louis, Missouri. Structures have multiple configurations and were typically pile only, pile and rock fill, or rock fill only. Routine maintenance of the BSNP can be divided into two categories; maintenance of the existing rock filled structures and adjustment of the footprint of the structures in response to changes in the bed and banks of the river at the bend or individual structure scale.

Kenslers Bend, located from River Mile 752 to 735, includes river structures to transition the river channel from the upstream Missouri National Recreational River to the start of the navigation channel at Sioux City. Maintenance actions within Kenslers Bend are included within USACE BSNP activities.

The related BSNP Fish and Wildlife Mitigation Project is discussed in the section entitled "Habitat Development and Land Management on MRRP Lands" below.

1.4 Kansas River Operations

Clinton, Perry, Tuttle Creek, Milford, Wilson, and Kanopolis are the primary downstream flood control dams in the Kansas River basin. Each is located on one of the major tributaries. Specific operations for various reservoir purposes (flood control, water supply and water quality, recreation, fish and wildlife, navigation, and irrigation) are described in detail (USACE 2017, pp. 41-45).

1.5 Interior Least Tern and Piping Plover Management Actions

- **Mechanical Emergent Sandbar Habitat Creation** - any activity constructing in-river habitat without the use of flows.
- **Vegetation Management** - The primary and preferred method of vegetation control and removal is application of pre- and/or post-emergent herbicides to selected sandbars. Herbicides may be applied by spraying from all-terrain vehicles or by hand in smaller, less vegetated areas. Herbicides are sprayed by air in large, densely vegetated areas. Additional vegetation control and removal methods include cutting, mulching, disking, mowing, raking, burning, and removing vegetation from sandbars.
- **Predator Management** - Direct management actions include the lethal or non-lethal removal of predators and are typically deployed when the level of predation is high.
- **Human Restriction Measures** – This includes posting signs that restrict access to breeding areas, placing barricades to exclude human access, and outreach efforts.
- **Flow Management to Reduce Take** – This entails adjusting releases to avoid impacts to nesting areas.

- **Monitoring and Research** – USACE monitors annual trends in population and productivity for piping plover and interior least tern, as well as loss of adults, eggs and/or chicks due to USACE operations at the dams.
- **Nest and Chick Relocation** – This management action is for the protection of interior least tern and piping plover nests and chicks threatened with termination due to natural events, likely inundation under normal system operation, or flood control operations.

1.6 Pallid Sturgeon Management Actions

(USACE 2017, pp. 53-66)

1.6.1 Propagation and Augmentation

USACE proposes to continue to assist in pallid sturgeon propagation and augmentation efforts as guided by the current Propagation Plan (Service 2008) or if revised, the most recent.

1.6.2 Pallid Sturgeon Population Assessment Project

The new population monitoring design (PSPAP v. 2.0) for the MRRP will focus on providing the data needed to track progress of meeting the program's objectives. Redesign of the Pallid Sturgeon Population Assessment Program (PSPAP) to PSPAP v. 2.0 is intended to update population assessment to support adaptive management of the MRRP. PSPAP v. 2.0 is considered a necessary part of the pallid sturgeon monitoring strategy, but it is not considered sufficient for all monitoring needs. Instead, the PSPAP v. 2.0 is designed to complement three additional monitoring and assessment components: effectiveness monitoring, focused research studies, and a collaborative population model (Jacobson et al. 2016b).

The PSPAP 2.0 adjusts the geographic scope of the monitoring by removing two reaches previously sampled through PSPAP 1.0; the Kansas River Reach (Segment 11) and the Fort Randall Reach (Segments 5 and 6). The Kansas River Reach sampling has resulted in the capture of only 19 pallid sturgeon during the last 11 years (McDaniel et al. 2017), indicating the Kansas River is rarely utilized by pallid sturgeon. The Fort Randall Reach has been labeled a founder population for the Great Plains Management Unit (established to protect upper basin pallid sturgeon genetics from unforeseen stochastic events; Service 2008) with a very low probability of becoming self-sustaining through natural reproduction and recruitment (Steffensen et al. 2014). An apparent lack of drift distance for developing free embryos and an absence of management actions that would result in recruitment or a self-sustaining population (supported by an absence of working management hypotheses for this population in the EA; Jacobson et al. 2016a, 2016b) provides a rationale for exclusion of this reach from the annual population monitoring through PSPAP 2.0.

1.6.3 Level 1 and 2 Studies

As part of the Science and Adaptive Management Plan, USACE proposes to implement Level 1 and 2 studies to better understand factors limiting pallid sturgeon populations. Level 1 studies are research focused and do not change the System (laboratory studies or field studies under ambient conditions). Level 2 studies would focus on in-river testing of actions at a level sufficient to expect a measurable biological, behavioral, or physiological response in pallid sturgeon, surrogate species, or related habitat response. The spawning cue test release is discussed in this section. The adaptive management process will annually evaluate the prioritization and pace of the science activities.

1.6.4 Spawning Habitat Construction and Monitoring

This entails re-engineering the channel morphology in selected reaches to create optimal spawning conditions (substrate, hydraulics, and geometry) and to increase probability of successful spawning, fertilization, embryo incubation, and free-embryo retention. General location of where construction is planned is denoted in Figure 1.

The Effects Analysis study (Jacobson et al. 2016b) hypothesized that channel reconfiguration could increase quality and availability of spawning habitat. Improvements of spawning habitats through channel reconfigurations could achieve a combination of conditions that would be more attractive to reproducing pallid sturgeon. These improvements include creating hydraulic conditions that are favorable for egg deposition and fertilization and a hydraulic and sediment transport regime that allows for successful incubation and hatch. Spawning habitat would be developed where it could be used by migrating reproductive pallid sturgeon. Based on documented upstream migrations of reproductive adults and downstream dispersal of free embryos it is clear that spawning sites should be upstream from areas occupied by later life stages; but it is not clear if any of the documented locations would produce greater chances of hatch and survival than others (USACE 2017, p. 176).

1.6.5 Channel Reconfiguration for Interception and Rearing Complex (IRC) Habitat and Structure Modifications and Monitoring

This entails construction of complex areas that include hydraulics to intercept drifting free embryos combined with food-producing habitats and foraging habitats. This also includes modifications to existing Missouri River control structures, new structures, chutes, channel widening, and modifications of existing shallow water habitat projects to restore processes that may create IRC habitat (See Figure 1 for general location of these projects). USACE proposes to modify twelve river bends to create IRC habitat. It is anticipated that these twelve projects will be constructed downstream of River Mile 321, the uppermost location where an age-0 pallid sturgeon has been captured, ensuring IRC projects are co-located in the reach of river that is most likely to harbor age-0 pallid sturgeon transitioning from drifting free embryos to the benthic feeding stage (USACE 2017, p. 61). Monitoring will be included to evaluate the response of age-0 sturgeon to these activities.

The effects analysis team (Jacobson et al. 2016b) defined IRCs as complex areas that include hydraulics to intercept drifting free embryos combined with food-producing habitats and foraging habitats. Any of these three habitat types could be limiting to growth and survival, and a limiting role could shift over time as proportions of the habitats shift or as population grows (USACE 2017, p. 60). Channel reconfiguration to create IRC habitat is hypothesized to increase food producing habitats, increase availability and quality of foraging habitat, and improve interception of free embryos

(Jacobson et al. 2016b). This hypothesis is based on the assumption that free embryos cannot transition to exogenously feeding larvae and thrive while in the thalweg. However, there are many uncertainties related to IRCs including those related to how those habitats have been defined, which project designs most effectively create the desired habitats, and the importance of those habitats to pallid sturgeon survival (USACE 2017, p. 178).

1.6.6 Habitat Development and Land Management on MRRP Lands

The acquisition of land for implementation of habitat creation consistent with the Missouri River BSNP fish and wildlife mitigation plan described in the 2003 Record of Decision (ROD) and authorized by the Water Resources Development Act (WRDA) of 1986, 1999, and 2007. Land requirements include using (1) existing public lands if the state or Federal agency owning the property is willing to cooperate with USACE on the project; or (2) land acquired in fee title from willing sellers.

Conversion of predominantly agricultural lands to native floodplain habitats may increase localized in-river primary and secondary productivity, which could provide a long-term, indirect benefit for pallid sturgeon. The nature of these benefits would be expected to be proportional to the amount of land acquisition associated with the creation of IRC habitat (USACE 2017, p. 179).

1.7 Science and Adaptive Management Plan

(USACE 2017, pp. 66-86 and Appendix I)
The MRRP is undergoing a transformation resulting from 2011 recommendations by the ISAP and the MRRIC. An Effects Analysis study [Jacobson et al. (2016b), Buenau et al. (2015) and Fischenich et al. (2014)] established the best available scientific information and provided the foundation for a Science and Adaptive Management Plan (Fischenich et al. 2016) that addresses uncertainties and improves management decisions while determining and ultimately implementing actions that avoid jeopardizing the three federally listed species in the system. The Science and Adaptive Management Plan defines adaptive management as "a decision process that promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes advances scientific understanding and helps adjust policies or operations as part of an iterative learning process." The Science and Adaptive Management Plan further states that the MRRP intends to follow a collaborative adaptive management approach, which is defined as "A systematic management paradigm that assumes natural resource management policies and actions are not static, but are adjusted based on the combination of new scientific and socioeconomic information. Management is improved through learning from actions taken on the ecosystem being affected. A collaborative adaptive management approach incorporates and links credible science and knowledge with the experience and values of stakeholders and managers for more effective management decision-making" (Sims and Pratt-Miles 2011).

This Science and Adaptive Management Plan includes a process for resolving critical uncertainties using a framework consisting of four implementation levels: 1) research, 2) in-river testing of hypotheses, 3) scaled implementation of select management actions, and 4) full implementation (referred to as Levels 1, 2, 3, and 4). The decision criteria for moving to higher levels of implementation are defined. An initial suite of actions are identified that will be implemented to meet the objectives of the Missouri River Recovery Management Program. This Science and Adaptive Management Plan accompanies the Draft Missouri River Recovery Management Plan-Environmental Impact Statement and provides the roadmap for the implementation of the selected alternative and for the identification of subsequent management needs should the initial suite of actions fail to meet objectives. Each year, the science is updated by rigorously testing hypotheses, reporting on project and program performance, describing species status, and modeling the effects of alternative management actions (see Annual Strategic Review below). The science update process feeds into an annual revision of a five-year Strategic Plan for the MRRP developed collaboratively with the MRRIC. The Science and Adaptive Management Plan will be implemented collaboratively by the USACE, the Service, and MRRIC following the governance process outlined in the Science and Adaptive Management Plan.

In the context of the Science and Adaptive Management Plan, monitoring is the process of measuring attributes of the ecological, social, or economic system. Monitoring has multiple purposes, including: to provide a better understanding of spatial and temporal variability, to confirm the status of a system component, to assess trends in a system component, to improve models, to confirm that an action was implemented as planned, to provide the data used to test a hypothesis or evaluate the effects of a management action, and to provide an understanding of a system attribute that could potentially confound the evaluation of action effectiveness.

The Science and Adaptive Management Plan outlines the methods for reporting out and incorporating new information, considering data from monitoring activities, and summarizing how information will be used to inform decision making. The following is a summary of these processes described in the Science and Adaptive Management Plan:

- An annual science update process which involves a Fall Science meeting and Adaptive Management Workshop (Section 2.4.3, Science Update process). Related activities will summarize and report out on information from previous year’s studies in an annual Adaptive Management Report which will inform ongoing learning and adjustments to decisions.
- A process for the incorporation of new information that has not yet been prioritized/planned, though is recognized as needing to be considered in the adaptive management process. Section 2.5.4, "Procedure for addressing significant new information", describes how new information can be introduced and peer reviewed when it was not initially planned in the adaptive management process (i.e., on a shorter time line to ensure that the best available data is used to inform adaptive management decisions). Subsequent chapters also outline how new information that is planned through the ongoing adaptive management process gets integrated into the annual Adaptive Management Report (see Section 3.5.5, Section 5.6.4 and Section 6.2.5).
- A process for implementing science activities, as well as management actions at a scale that will have a measurable effect on the species. Section 4.2.1, “Pallid sturgeon framework” describes the four levels of this framework and the criteria to help guide discussions about how the evidence supports moving from a science activity to implementation (i.e., from Level 1, 2, 3, and 4).

- Includes a description of monitoring for plovers and terns (Section 3.3, Monitoring), as well as action effectiveness (Appendix E) and population monitoring activities (Appendix D) for pallid sturgeon. These components provide details around how monitoring activities link to testable hypotheses, big questions, and broader goals of the adaptive management program. Section 3.5, "Evaluation" and Section 4.5, "Evaluate", summarize how monitoring results will be evaluated to inform decision making for birds (plovers and terns) and pallid sturgeon, respectively.

Annual Strategic Review

The Annual Strategic Review is the process of developing the Annual Report on the BiOp. These reports synthesize information on project actions and monitoring, to assess progress toward program goals, and to describe lessons learned to assist the Science and Adaptive Management Program decisions and to maximize action effectiveness (Fischenich et al. 2016). The annual Adaptive Management Report for the MRRP serves two primary purposes: it documents activities undertaken on the Missouri River by the USACE to fulfill requirements of the ESA, and it provides the foundation for discussions and decisions regarding adjustments to the MRRP Strategic Plan under an Adaptive Management framework (USACE 2018). Although not currently defined in the Adaptive Management Report, the Service and the USACE are working together to develop criteria/processes that will be used to evaluate whether the Proposed Action is being implemented as described and whether the priorities are being met and at a pace that will support meeting the objectives outlined in the Science and Adaptive Management Plan. This review process will be finalized prior to the Record of Decision and amended to this BiOp.

Pallid Sturgeon

The fundamental objective for pallid sturgeon is to keep actions from jeopardizing the continued existence of pallid sturgeon in the Missouri River. Sub-objectives are to increase recruitment to age 1, and to maintain or increase numbers of pallid sturgeon as an interim measure until sufficient and sustained natural recruitment occurs. Metrics have been defined for these sub-objectives, but targets for these metrics are still to be determined.

The Effects Analysis study evaluated available reports and models, as well as other scientific literature, to provide an integrated assessment of the current state of the science and understanding of the potential benefits of management actions for pallid sturgeon in the Missouri River, and associated uncertainties in that assessment. The Effects Analysis study also introduces development of a collaborative population dynamics model developed to support the Science and Adaptive Management Plan.

Uncertainties for pallid sturgeon identified in the Effects Analysis study have been expressed as Big Questions related to potential management actions with underlying hypotheses. The process of how these hypotheses were developed is described in Jacobson et al. (2016a). There are Big Questions for the Upper River and the Lower River, and each Big Question includes underlying hypotheses. These are summarized in Tables 4 and 5 in the Science and Adaptive Management Plan for the Upper Missouri River and Lower Missouri River, respectively. New information may arise which leads to a re-examination of hypotheses from the reserve list of Effects Analysis hypotheses, the addition of new hypotheses, the revision of existing hypotheses, or the removal of some of the existing hypotheses in the event of strong evidence against them. From this broader set of Big Questions and hypotheses, actions were proposed for the Upper and Lower Missouri River. The Science and Adaptive Management Plan (USACE 2017, Appendix I) contains details of the Level 1 and 2 science components and associated decision criteria. For those science components prioritized for the first five years after the Record of Decision, decision criteria are summarized in the Appendix I of the BA in Table 43 for the Upper Missouri and Table 44 for the Lower Missouri. The initial suite of actions includes:

In the Upper Missouri River, the USACE amended the Proposed Action to prioritize hypotheses related to flows out of Fort Peck Dam to benefit the pallid sturgeon. In addition to Level 1 and 2 studies, the USACE will continue to fund population augmentation and the Pallid Sturgeon Population Assessment Program.

In the Lower Missouri River, the USACE amended the Proposed Action to address new information related to pallid sturgeon condition. In addition to the Level 1 and 2 studies, the following actions are components of the Proposed Action: population augmentation, interception and rearing habitat construction and monitoring, spawning habitat construction and monitoring, and spawning cue test release (if warranted).

Piping Plovers and Interior Least Terns

The fundamental objective for both piping plovers and interior least terns is to avoid jeopardizing the continued existence of the piping plover and interior least terns due to the USACE actions on the Missouri River. Because of the greater ESH acreage needs for piping plovers which defend territories for nesting and foraging, compared to colonially-nesting interior least terns, it was determined that piping plover habitat targets will also fulfill habitat needs for interior least terns on the Missouri River. Therefore, habitat targets for interior least terns have not been specified at this time. The sub-objectives are as follows:

Sub-objective 1 (Distribution). Maintain a geographic distribution of piping plovers in the river and reservoirs in which they currently occur in both the Northern Region (Missouri River from Fort Peck Lake, Montana to Fort Randall Dam, South Dakota, including reservoir shorelines) and Southern Region (Missouri River from Fort Randall Dam, South Dakota to Ponca, Nebraska).

Sub-objective 2 (Population). Maintain a total population number of Missouri River piping plovers that has a 95 % probability that at least 50 individuals will persist for at least 50 years within both the Northern and Southern Regions.

Sub-objective 3 (Population Trend). Maintain a stable or increasing long-term trend in population size within both regions.

Sub-objective 4 (Reproduction). Maintain fledgling production of breeding pairs at least sufficient to meet the population growth rate objectives within both regions.

The Effects Analysis study collected reliable scientific information, including observations about the stressor(s), the range of stressor conditions and information on population sizes and trends, and used the information and tools collected to provide an integrated assessment of the effects of management actions on piping plovers and interior least tern habitat and populations in the Missouri River. It also documents and synthesizes the uncertainties in the assessments.

Management actions for birds serve three general functions: 1) create habitat with construction or flows, 2) improve habitat quality or availability through construction, modification, or flows, or 3) directly protect nests, chicks, and/or adults to improve survival. A set of potential actions for birds was identified and evaluated in the Effects Analysis study and a subset of these actions were evaluated as part of the management alternatives in the draft environmental impact statement for the project.

1.8 Section 7(a)(1) Conservation Plan

(USACE 2017, Appendix D)

The USACE provided a conservation plan that describes how the USACE Kansas City and Omaha Districts will use their authorities to carry out certain conservation strategies for pallid sturgeon, interior least tern, piping plover, gray bat (*Myotis grisescens*), Indiana bat (*Myotis sodalis*), and northern long-eared bat (*Myotis septentrionalis*) within the Missouri River basin. The plan currently includes the following conservation strategies:

1. Identify opportunities to operate the System to benefit listed species.
2. Support the Pallid Sturgeon Propagation and Augmentation Program in addition to the BA's Proposed Action.
3. Identify opportunities to maintain the BSNP in a manner that could contribute beneficially to aquatic habitat.
4. Prioritize lands for acquisition that contribute to meeting pallid sturgeon habitat requirements when consistent with BSNP Fish and Wildlife Mitigation Program authority.
5. Consider Indiana bat and northern long-eared bat habitat needs in planning of site-specific habitat development for Mitigation Program lands.
6. Evaluate potential for levee modifications at existing and future mitigation sites.
7. Determine if there is potential to operate the Kansas River projects in a manner that would increase benefits to native species.
8. Avoid adverse impacts to gray bat, Indiana bat, and northern long-eared bat while maintaining District projects.
9. Coordinate, communicate, and cooperate among entities responsible for conserving pallid sturgeon, interior least tern, and piping plover.

1.9 Conservation Measures

In the BA, the USACE proposed the following measures to further the recovery of the pallid sturgeon and interior least tern. These actions will be taken by the USACE and serve to avoid, minimize or offset project effects to the listed species.

Pallid Sturgeon

Pallid sturgeon spawning locations on the lower Missouri River are monitored annually as part of the USACE-funded Comprehensive Sturgeon Research Project led by the U.S. Geological Survey (USGS). Individual pallid sturgeon of both sexes have been documented returning to the same section of river to spawn (Delonay et al. 2010; Delonay et al. 2012). However, long-term (5–10 years) tracking of individual pallid sturgeon is required to assess the level of spawning site fidelity and the role this geographic specificity may play in preserving the population genetic structure (Delonay et al. 2016).

USACE will use the results of ongoing monitoring of pallid sturgeon spawning behavior on the lower Missouri River to evaluate if seasonal restrictions on maintenance activities are warranted. USACE will implement seasonal restrictions on maintenance activities if monitoring identifies important spawning site(s) based on evidence of spawning site fidelity linked with successful spawning.

- Seasonal restrictions will likely include the restriction on revetment rock placement during the period from May 1 to June 15 for the portion of an outside revetted bend that comprises the documented spawning site. There may be some years when USACE will not be able to comply with seasonal restrictions. Examples of issues that could prevent implementation of the revetment restriction include the requirement to quickly perform repairs at a revetment that has high damage levels, equipment or rock supply issues have shortened the available work period, high flows have restricted the rock placement period, or work sequencing (e.g., adjacent dike work is being performed near the revetment that requires repair) does not allow for scheduling an additional trip to the revetment site.

Interior Least Tern

The Service's 5-year review of interior least tern recommends delisting due to recovery (Service 2013). The Service, in cooperation with the states, is required to monitor a species delisted due to recovery for a minimum of five years following its removal from the protections of the ESA. If delisted, USACE has committed to continue to survey interior least terns on the Gavins Point/Lewis and Clark Lake/Fort Randall reaches, Lake Oahe, the Missouri River below Garrison Dam, Lake Sakakawea, and the Missouri River below Fort Peck Dam for a minimum of five years post delisting of the species (USACE 2017, pp. 67, 144).

2. PALLID STURGEON - STATUS OF THE SPECIES

2.1 Introduction

The status of the species section presents the biological or ecological information relevant to formulating the BiOp. Appropriate information on the species' life history, its habitat and distribution, and other data on factors necessary to its survival, is included to provide the background for analyses in later sections (Service 1998 p. 4-19). The scale of the Status section is at the scale of the listed entity or range of the species. The Environmental Baseline section (Section 3 below) will provide similar types of information, but at the action area scale (50 CFR §402.02, Service 1998 p. 4-22).

Information in this section is drawn largely from the Service's Revised Pallid Sturgeon Recovery Plan (Service 2014).

2.2 Legal status

The pallid sturgeon was listed as endangered under the ESA of 1973 (as amended (16 U.S.C. §1536)) on September 6, 1990. No critical habitat for this species has been designated under the Act. Threats identified at that time were habitat alteration, commercial harvest, environmental contaminants and other factors (Jordan et al. 2016)

2.3 Species Description

The pallid sturgeon is a large river fish that can reach 1.8 meters (m) in length, weigh up to 80 pounds and can live 50 years and perhaps much longer. For thousands of years it has lived, fed, and bred in the Missouri, Yellowstone, and Mississippi. They are a bottom-oriented, large river obligate fish. They are similar in appearance to the more common shovelnose sturgeon. Both species inhabit portions of the Missouri and Mississippi river basins. Although similar in appearance, Porreca et al. (2017a) found subtle physiological and morphological differences between shovelnose and pallid sturgeon that affected their ecological success. Ruelle and Keenlyne (1994) provided a detailed analysis of the similarities and differences between these two species. Gosch et al. (2018) determined that age-0 shovelnose sturgeon may be an appropriate diet surrogate but cautioned that more studies were needed due to the limited sample size in their study. Shovelnose sturgeon may not be an adequate surrogate for pallid sturgeon for habitat use studies (Bramblett and White 2001). Deslauriers et al. (2016a) determined that the use of age-0 shovelnose sturgeon was an appropriate surrogate for pallid sturgeon in temperature-dependent studies. This suggests that there should be careful consideration when using the shovelnose sturgeon as a surrogate for the pallid sturgeon in scientific studies of natural history and physiology.

2.4 Habitat

Research into habitat use produced useful insights for many portions of the pallid sturgeon's range. However, much of these data are based on habitat characterizations in altered environments, in some cases substantially altered environments, including an altered hydrograph and temperatures, suppression of fluvial processes, stabilized river banks, loss of natural meanders and side channels, fragmented habitats, and increased water velocities. Thus, information and current understanding of habitat use may not necessarily reflect preferred habitats for the species, but rather define habitats pallid sturgeon utilize within an altered ecosystem (Jordan et al. 2016).

Egg - Eggs are demersal[3], adhesive, and dark colored, adhering to substrate at the spawning site (Delonay et al. 2016). Currently, it is unknown how substrate characteristics, adhesion, and hydraulic conditions interact to influence survival and development of fertilized eggs in the river (USACE 2017, p. 102, Jacobson et al. 2016b).

Free Embryo/Larvae - Young of year *Scaphirhynchus* spp. in the lower Missouri River were found in habitats associated with the main channel border with velocities 0.5 to 0.7 meters per second and depths 1.8 to 2.8 m (USACE 2017, p. 102; Ridenour et al. 2011). In another study, average depths at age-0 sturgeon capture sites in the lower Missouri River were 3 m (Gemeinhardt et al. 2016). Age-0 *Scaphirhynchus* spp. in the Middle Mississippi River were more often found in channel border and island-side channel habitats and distributions were positively associated with velocities approximately 0.1 meters per second, depths ranging from 2.0 to 5.0 m, and sand substrate. Preference of fast velocity, which has been found for wintering age-0 juveniles of other sturgeon species, may be a winter foraging strategy to select habitat that brings drifting invertebrates to young sturgeon without having to expend energy to forage (USACE 2017, p. 102, Kynard et al. 2011). Wintering habitat is critical to survival and

[3] Demersal egg – an egg which remains on the bottom, either free or attached to the substrate.

recruitment because age-0 juvenile sturgeon remain in this habitat for 5–6 months (USACE 2017, p. 102; Kieffer and Kynard 2012).

Juvenile - The habitat use of juvenile hatchery-reared pallid sturgeon was studied by Gerrity (2005) above Fort Peck Dam where they were found in water depths from 2.3 to 2.5 m, most commonly in locations at approximately 80 % of the maximum channel cross-section depth, with channel bottom velocities typically about 0.5 meters per second and a sand/fine substrate (USACE 2017, p. 103). Their home range varied from about 1 to 70 river kilometers (km). Juveniles were associated with islands, alluvial bars, and main channels, but did not appear to select side channels. In the Fort Randall reach, juvenile pallid sturgeon were more likely to occur in areas with deeper water (> 3 m) and a higher proportion of sand substrate; they generally avoided areas with bottom velocities > 1.20 meters per second (USACE 2017, p. 103;Spindler et al. 2012). In the laboratory, juvenile pallid sturgeon used sand substrate more than gravel substrate, deeper areas more than shallow areas, and darker areas more than lighter areas (Allen et al. 2007). Juvenile (age-1 and age 4) hatchery reared pallid sturgeon in the channelized Missouri River, Nebraska avoided outside bends and thalweg habitats with velocity greater than 1 meters per second^{-1}. In the same reach, age-1 pallid sturgeon selected off-channel and inside bend habitat (shallow water habitats with slow water velocity) (Eder et al. 2016). Apparent survival for these stocked age-1 to age-4 hatchery pallid sturgeon in this reach in the summer and fall of 2014 was 98.6 % (Eder et al. 2015).

Adult - Floodplains, backwaters, chutes, sloughs, islands, sandbars, and main channel waters formed the large-river ecosystem that met the habitat and life history requirements of pallid sturgeon and other native large-river fishes. Pallid sturgeon are benthic fish and have been documented over a variety of available substrates, but are often associated with sandy and fine bottom materials in deep, flowing water. Pallid sturgeon primarily utilize main channel, secondary channel, and channel border habitats throughout their range. Juvenile and adult pallid sturgeon are rarely observed in habitats lacking flowing water outside of the main channel (Jordan et al. 2016). Adults may generally reside in small habitat patches only tens of feet in size or roam large areas (USACE 2017, p. 103; Delonay et al. 2016). Specific patterns of habitat use and the range of habitat parameters used may vary with availability and by life stage, size, age, and geographic location. Porreca et al. (2017b) hypothesizes that alluvial sand dunes may provide important flow refugia for benthic fish such as pallid sturgeon that inhabit high velocity, main channel habitats. In the Yellowstone and Platte rivers, adult sturgeon select areas with frequent islands and sinuous channels while rarely occupying areas without islands or with straight channels (Bramblett and White 2001; Snook et al. 2002; Peters and Parham 2008).

In the middle Mississippi River, sturgeon select for areas downstream from islands (Hintz et al. 2016) that are often associated with channel border habitats and select against main-channel habitats (Hurley et al. 2004). In the lower Mississippi River, adult pallid sturgeon strongly selected island tip and natural bank habitats (Herrala et al. 2014). Other Mississippi River capture locations tend to be near the tips of wing-dikes (an engineered channel training structure), steep sloping banks, and channel border areas (Killgore et al. 2007; Schramm and Mirick 2009). Hintz et al. (2016) reported high abundance in depths ranging from 4.5 to 14 m in the middle Mississippi River, which was consistent with observations in the lower Mississippi River (6.2 to 13.6 m (USACE 2017, p. 103; Herrala et al. 2014). Despite the wide range of depths associated with capture locations, one commonality is that pallid sturgeon are typically found in the lower one-fourth of the water column.

As for velocity, mean water column velocities at pallid sturgeon capture sites in the upper Missouri River were generally 0.64 meters per second, although mean bottom velocities were lower, around 0.46 m/s) (USACE 2017, p. 103; Bramblett and White 2001; Gerrity 2005). In the middle Mississippi River, pallid sturgeon were never captured in velocities > 1.0 meters per second (Hintz et al. 2016) and they preferred velocities of 0.6 to 1.0 meters per second in the lower Mississippi River (USACE 2017, p. 103; Herrala et al. 2014).

2.5 Food

Data on food habits of age-0 sturgeon are limited; however, chironomids (Diptera) were demonstrated as a preferred prey item in laboratory experiments (Rapp 2014). In a hatchery environment, exogenously feeding fry (fry that have absorbed their yolk and are actively feeding) will readily consume brine shrimp suggesting zooplankton and/or small invertebrates are likely the food base for this age group (Jordan et al. 2016). Age-0 *Scaphirhynchus* were collected using benthic otter trawls and the stomach and esophagus examinations supported earlier studies that chironomids (Diptera) are a preferred prey item (Gosch et al. 2018). The diet of young pallid sturgeon in the wild in the Upper Missouri River is Diptera (fly) larvae, Diptera pupae, and Ephemeroptera (mayfly) nymphs (Braaten et al. 2012b).

Data available for larval and juvenile pallid sturgeon indicate aquatic insects and other macroinvertebrates [mayflies (Ephemeroptera), midge and fly larvae (Diptera)] are important (Jordan et al. 2016). Based on the above diet data and habitat utilization by prey items, it appears that sturgeon will feed over a variety of substrates, however, the abundance of Trichoptera (caddisflies) in the diet suggests that harder substrates like gravel and rock material may be important feeding areas (Hoover et al. 2007).

Juvenile and adult pallid sturgeon prey consists of bottom dwelling fish and aquatic insect larvae with a trend toward eating fish as they increase in size (Jordan et al. 2016; Grohs et al. 2009). In the Missouri River above Fort Peck Reservoir, sturgeon and sicklefin chubs comprised the majority of the fish found in juvenile (age-6 and age-7) pallid sturgeon stomachs (Gerrity et al. 2006). Downstream of Fort Randall Dam, fish species found in juvenile (age-1 to age-7) pallid sturgeon stomachs were johnny darter, channel catfish, silver chub, and emerald shiner (Wanner et al. 2007). In the lower Missouri River, stomach contents of the pallid sturgeon contained fish, aquatic insects, copepods, leeches and mussels. Cyprinids (minnows) and Ictalurids (catfish) were abundant prey items (Winders et al. 2014).

2.6 Life cycle

2.6.1 Spawning

Between March and July reproductive adult sturgeon swim upstream in search of a suitable areas to spawn, carry out spawning and return downriver. Based on wild fish, estimated age at first reproduction is 9 to 20 years for females and approximately 7 to 9 years for males (USACE 2017, p. 103; Keenlyne and Jenkins 1993; Steffensen et al. 2010); however, for hatchery fish stocked into the upper Missouri River, the earliest that males are reaching sexual maturity is 10 years of age and females 17 years of age (Upper Basin Pallid Sturgeon Workgroup 2015).

Fisheries biologists speculate that the environmental cues for this movement are the rising and peaking river hydrograph, water temperature, and photoperiod (Jordan et al. 2016). Spawning areas tend to be where firm river bottom substrates occur in deeper water with relatively fast turbulent water flow (without the correct conditions spawning success is reduced). In May during spawning season, pallid sturgeon moved away from sand-dominated substrates to gravel (Koch et al. 2012). Temperatures during spawning are between 16-18 °C (Celsius) (Delonay et al. 2016). Water temperatures influence growth and maturity; colder temperatures in natural environments delay sexual maturity in females by 3 years to around age 9 years (USACE 2017, p. 103; Webb and Doroshov 2011). Spawning takes place when the female sturgeon releases eggs into the river current and nearby males immediately fertilize the eggs by releasing milt directly into the flowing current of the river containing the eggs. The largest upper Missouri River fish can produce as many as 150,000 to 170,000 eggs, whereas smaller bodied females in the southern extent of the range may only produce 43,000 to 58,000 eggs. Female pallid sturgeon appear to spawn every two or three years (USACE 2017, p. 102; Service 2014, p. 9) and males one to three years (Jordan et al. 2016).

2.6.2 Embryos and Free embryos

Embryos are the stage from the time of fertilization to hatching which is typically 5 to 8 days depending on temperature (Jacobson et al. 2016b). The incubation period for pallid sturgeon eggs is about two days but exact period is determined by water temperature (Delonay et al. 2016). The warmer the water temperature the shorter the time it takes for the embryos to hatch. In laboratory studies, Kappenman et al. (2013) determined that acceptable temperature range for incubation was 12 to 24 °C with the optimal range for survival at 17 to 18 °C.

Free embryos (generally 18-19 mm total length) are the period from hatching until the larval fish begins feeding (Delonay et al. 2016; Jacobson et al. 2016b). At hatching, free embryos have a yolk sac attached to their stomach which provides food for approximately the first week (depending on water temperature). After hatching, the free embryos enter the water column and float downstream (Kynard et al. 2007; Braaten et al. 2008). Free embryos drift downstream for 9 to 17 days and in that time can drift long distances depending on water velocity and channel diversity or lack thereof. Duration of drift period is determined by water temperature and rate of development (Delonay et al. 2016). Braaten et al. (2008) found that larval pallid sturgeon could drift 245 to 530 kms depending on water velocity. During this time, the free embryo is predominantly pelagic with very weak swimming ability. Once the free embryos completely absorb their yolk sac, they start to feed on tiny aquatic animals. At this point in their development they are typically referred to as larvae. As free embryos develop into larvae, downstream dispersal ceases as they settle into habitats, and they begin to forage on the bottom.

2.6.3 Exogenously feeding larvae and age-0

This stage (generally 205 mm total length) occurs when the fish begins to feed until it develops a full complement of rays in all fins (Delonay et al. 2016; Jacobson et al. 2016b). The location of where they begin to search for food is determined by spawning location, temperature, and flow (Delonay et al. 2016). About 20 to 30 days after hatching, sturgeon larvae are considered “Age-0” and look like miniature adult fish.

2.6.4 Juvenile

The young sturgeon are referred to as juveniles (generally 750 mm fork length) after about a year, until they reach sexual maturity at approximately age 9 (Delonay et al. 2016, Jacobson et al. 2016b). During the juvenile stage, pallid sturgeon shift their diet from insects to fish (Gerrity et al. 2006). Temperatures for optimal feeding and growth were 25 to 28° C (Chipps et al. 2008). Survival rates for juvenile pallid sturgeon are similar across portions of the Missouri River and range from approximately 0.4 to 0.5 for age-1 annual survival and are > 0.8 for > age-1 juveniles (Rotella 2015; Steffensen and Mestl 2016).

2.7 Reproductive Strategy

The sturgeon has evolved a breeding strategy where the reproducing adult commits no parental care to eggs or offspring. This results in a naturally high mortality of the early life stages (embryo, free embryo and larvae). Under normal conditions, this strategy is successful and can tolerate a high level of mortality, because the large spawning adults produce as many as 170,000 eggs and can be reproductive for decades. Thus as long as the regular opportunity exists for spawning, and an opportunity for larval drift to allow for transformation of a free embryo into larvae, the success rate for a particular single embryo or free embryo or larvae can be extremely low and still support a population capable of long term survival. The key to reproductive success is having the capability to migrate to desired spawning areas and then downstream dispersal of progeny. This breeding strategy is thwarted when its migration routes are completely blocked and also degrades the sturgeon's long term viability.

2.8 Population Distribution

2.8.1 Historic distribution

The historic distribution as identified in the recovery plan (Service 2014) of the pallid sturgeon includes the Missouri and Lower Yellowstone rivers in Montana downstream to the Missouri-Mississippi confluence and the Mississippi River possibly from near Keokuk, Iowa downstream to the Gulf of Mexico, including the Atchafalaya River. Pallid sturgeon also have been documented in the lower reaches of some of the larger tributaries to the Missouri, Mississippi, and Yellowstone rivers including the Tongue, Milk, Niobrara, Platte, Kansas, Big Sioux, St. Francis, Grand, and Big Sunflower rivers. The total length of the sturgeon's range historically was about 5656 river kms.

2.8.2 Present distribution

The present distribution as described in the recovery plan (Service 2014) indicates that wild pallid sturgeon have been documented in the Missouri River between Fort Benton and the headwaters of Fort Peck Reservoir, Montana; downstream from Fort Peck Dam, Montana to the headwaters of Lake Sakakawea, North Dakota; downstream from Garrison Dam, North Dakota to the headwaters of Lake Oahe, South Dakota; from Oahe Dam downstream to within Lake Sharpe, South Dakota; between Fort Randall and Gavins Point Dams, South Dakota and Nebraska; downstream from Gavins Point Dam to St. Louis, Missouri; in the lower Milk and Yellowstone rivers, Montana and North Dakota; the lower James and Big Sioux River, South Dakota; the lower Platte and Niobrara Rivers, Nebraska; and the lower Kansas River, Kansas. The contemporary downstream extent of sturgeon ends near New Orleans, Louisiana; the middle and lower Mississippi River, and the Atchafalaya River, Louisiana (Jordan et al. 2016). Additionally, the species has been documented in the lower Arkansas River (Kuntz and

Schramm 2012), the lower Obion River, Tennessee (Killgore et al. 2007), as well as navigation pools 1 and 2, downstream from Lock and Dam 3, in the Red River, Louisiana (Slack et al. 2012).

2.9 Recovery and Management

The primary strategy for recovery of sturgeon is to:

1) conserve the range of genetic and morphological diversity of the species across its historical range;
2) fully quantify population demographics and status within each management unit;
3) improve population size and viability within each management unit;
4) reduce threats having the greatest impact on the species within each management unit; and
5) use artificial propagation to prevent local extirpation within management units where recruitment failure is occurring (Service 2014).

The management units[4] identified in the revised Pallid Sturgeon Recovery Plan (Service 2014) are described below (Figure 2). These management units are based on: 1) genetic data; 2) morphological differences; 3) biogeography of other fish species and speciation associated with physiographic provinces; 4) common threats; and 5) the potential need and ability to implement differing management actions to address varying threats within a management unit. As genetic and stock structure data are further refined, these management units may be correspondingly adjusted (Service 2014).

The Great Plains Management Unit (GPMU) is defined as the Great Falls of the Missouri River, Montana to Fort Randall Dam, South Dakota. This unit includes important tributaries like the Yellowstone River, as well as the Marias and Milk rivers. The upper boundary is at the Great Falls of the Missouri River as this is a natural barrier above which sturgeon could not migrate historically. The lower boundary was defined as Fort Randall Dam to ensure consistent management practices on an inter-reservoir reach of the Missouri River.

The Central Lowlands Management Unit (CLMU) is defined as the Missouri River from Fort Randall Dam, South Dakota to the Grand River confluence with the Missouri River in Missouri and includes important tributaries like the lower Platte and lower Kansas rivers.

The Interior Highlands Management Unit (IHMU) is defined as the Missouri River from the confluence of the Grand River to the confluence of the Mississippi River, as well as the Mississippi River from Keokuk, Iowa to the confluence of the Ohio and Mississippi rivers.

The Coastal Plain Management Unit (CPMU) is defined as the Mississippi River from the confluence of the Ohio River downstream to the Gulf of Mexico including the Atchafalaya River distributary system.

[4] Management unit – management subsets of the listed species that are created to establish recovery goals or carrying out management actions.

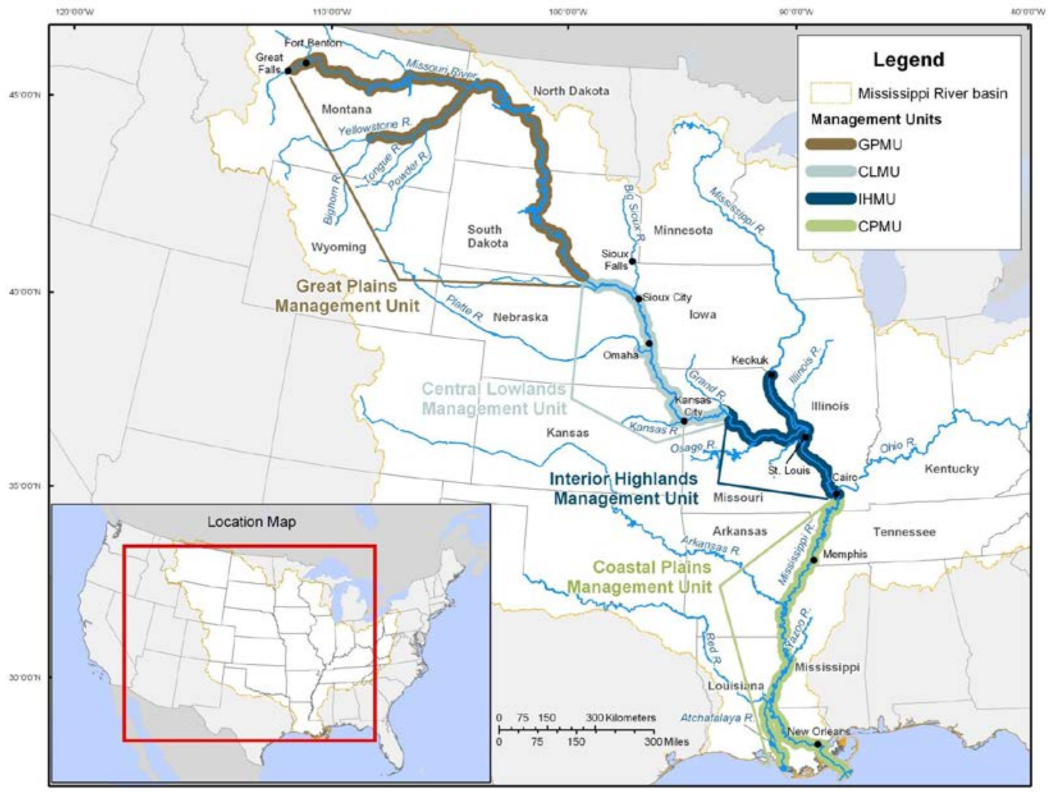

Figure 2. Map depicting Pallid Sturgeon management units (from Service 2014, p.49)

2.10 Population Status by Management Unit

GPMU

This population is isolated by dams and reservoirs and recruitment is currently not evident in this unit, however, reproduction has been documented. This unit is affected by the management of dams that alter water temperatures, flow regimes, and sediment transport. Artificial propagation and stocking is currently maintaining this population. In 2014, USACE awarded a construction contract for a fish passage by-pass channel around the Intake Dam Diversion, however, construction has not moved forward due to a court-ordered injunction (USACE 2017, p.135). On April 4, 2018, the Court of Appeals for the Ninth Circuit vacated the injunction; however, the litigation is ongoing and the future of this project remains uncertain. The goal of the fish passage project at the Intake Diversion Dam, if completed, is to provide additional habitat upstream of the dam for spawning to support successful recruitment (Jordan et al. 2016). For additional information including population numbers in this unit see Section 3.1.

CLMU

This unit is affected by upstream dams resulting in altered water temperatures, flow regimes, and sediment transport. Dams and reservoirs block upstream and downstream movements. Channelization as a result of the Bank Stabilization and Navigation Program has substantially reduced riverine and floodplain habitat. The effects of the dams and channelization are ongoing. Artificial propagation and stocking is currently maintaining this population (Jordan et al. 2016). Hatchery–reared pallid sturgeon can survive in the highly modified lower Missouri River (Steffensen et al. 2016). Reproduction has been documented in this unit. For additional information including population numbers in this unit see Section 3.1.

IHMU
The effects from the upstream dams are diminished in this unit. Some of the ongoing threats in this unit include entrainment, contaminants, hybridization, and navigation (Jordan et al. 2016). There is evidence of natural recruitment (Delonay 2009), however, few pallid sturgeon larvae are being produced in the Middle Mississippi (Boley and Heist 2011). Garvey et al. (2009) summarized the status of the pallid sturgeon in the Middle Mississippi River and indicated that reduced reproductive capacity due to limited rearing and nursery habitat and loss of reproductively mature adults was a likely threat to population recovery. Garvey et al. (2009) generated an estimate of 1,600 to 4,900 adult pallid sturgeon for the middle Mississippi River (i.e., mouth of the Missouri River downstream to the Ohio River confluence). Similarly, Hintz et al. (2016) estimated a population size of 1,516 (95 % CI of 710–3,463) adult pallid sturgeon in the IHMU below the Missouri River confluence (USACE 2017, p. 99). Estimate of total abundance of age 3+ pallid sturgeon in the Middle Mississippi River were at least 2.6 - 8.5 fish per river kms^{-1} (Friedenberg et al. 2017). For additional information including population numbers in this unit see Section 3.1.

CPMU
Limited conservation stocking efforts have occurred in the past in the Mississippi River but due to evidence of natural recruitment, stocking has been discontinued (Service 2014). This unit contains the most intact available habitat for the pallid sturgeon throughout its range. The population contains multiple age cohorts and low mortality rates. Some of the ongoing threats in this unit include entrainment, hybridization, contaminants, and non-native species (Jordan et al. 2016). Land procurement, habitat conservation and restoration, sturgeon surveys, population quantification, modeling and monitoring, and habitat use studies are ongoing conservation efforts in this management unit.

Limited population estimates are available for this management unit. Friedenberg et al. 2017 did determine an estimate of total abundance of age 3+ pallid sturgeon in the Lower Mississippi River for at least 3.0 - 9.8 fish per river kms^{-1}.

2.11 Climate Change
The potential impact of climate change on the sturgeon's environment is very difficult to assess. We reviewed the National Oceanic and Aeronautic Administration's (NOAA), Technical Report Regional Climate Trends and Scenarios for the U.S. National Climate Assessment (NOAA 2013). Specifically, we examined Part 4 of that report which focused on climate of the U.S. Great Plains. The Great Plains region covers the following states: Montana, Wyoming, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas. A large portion of the action area and species range is within that geographic area.

The report makes it clear that the scientific information available and used for the report is **not** predictive. "*The future climate scenarios are intended to provide an internally consistent set of climate condition that can serve as inputs to analysis of potential impact of climate change. The scenarios are not intended as projections as there are no established probabilities for their future realization.*" (NOAA 2013, p. 1). However, the scenarios presented give us our best glimpse at whether models agree in showing a significant change from the past and if they agree in the direction of that change.

For the first period reported by the report (2021 to 2050) more than 50 % of the models show a significant difference in temperature and more than 67 % agree that the change is to a higher temperature in the action area and larger surrounding areas. The difference expressed is 1.5 to 3.5 degrees (NOAA 2013, p. 37).

For the same period changes in average annual precipitation are more mixed with less than 50 % of the models showing a statistically significant change (NOAA 2013, p. 55). As the models are pushed out into periods 2041 to 2070 and 2071 to 2099, they generally show increased annual average precipitation in the northern Great Plains and decrease in the southern part of the region (NOAA 2013, p. 55). The NOAA models didn't produce statistically significant scenarios that would alter the precipitation rate.

Given that the sturgeon lives in river systems influenced by winter precipitation (snow pack), we examined the report's information regarding differences in annual and seasonal precipitation. Less than 50 % of the models showed statistically significant change to annual precipitation in the Great Plains region for 2021 to 2050. For the period 2041 to 2070 as with the annual precipitation change, less than 50 % of the models show a statistically significant change in any of the seasons (NOAA 2013, p. 57). Shafer et al. (2014) noted that rising temperatures in the Great Plains may increase competition for water. They also noted that the projected precipitation increase in the northern areas could increase runoff and flooding and the projected decrease in the southern areas could increase competition for water (See Section 3.2.9 for additional discussion on potential climate change impacts to the Missouri River and the pallid sturgeon within the Action Area).

2.12 Population Dynamics

The Missouri River Pallid Sturgeon Effects Analysis study evaluated how pallid sturgeon population dynamics are linked to management actions in the Missouri River (Jacobson et al. 2016b). The Effects Analysis team was tasked with developing conceptual ecological models that illustrate population dynamics and connect to management actions and drivers; compiling and assessment of available scientific literature, databases, and models; development of predictive, quantitative models; to explore the system dynamics and population responses to management actions; and analysis and assessment of effects of system operations and actions on species' habitats and populations. This report considers the lines of evidence for each working management hypothesis and the degree of uncertainty and risk associated with it.

During the Effects Analysis study (Jacobson et al. 2015), four population models for pallid sturgeon were identified: (Jager and Krentz 2002; Reynolds and Tyre 2011; Wildhaber et al. 2015; Moran et al. 2016). Three published models for shovelnose sturgeon were identified for the Missouri River: population viability model (Bajer and Wildhaber (2007); equilibrium yield models by Koch et al. (2009) and Quist et al. (2002). Wildhaber et al. (2017) and Deslauriers (2016b) also published a bioenergetics model for pallid sturgeon. Deslauriers (2018) developed an individual based model to evaluate growth potential for pallid sturgeon in the Missouri River.

The Collaborative Population Model is currently under development and will be used to evaluate the links between management actions and predicted population responses. Existing sturgeon population models have been evaluated and useful parts are incorporated into the collaborative population model. In future years, the model will be updated with new information and will provide model projections of population-level responses to the management actions and address uncertainties and this information will be incorporated into the Adaptive Management Report (USACE 2018).

3. PALLID STURGEON - ENVIRONMENTAL BASELINE (Action Area)

The Environmental Baseline section presents a review of the past and present human and natural factors leading to the current state of the species, including its habitat and ecosystem within the action area (50 CFR §402.02; Service 1998, p. 4-22). The scale of the Environmental Baseline section is at the scale of the action area, which covers the Missouri River basin and includes Great Plains, Interior Highlands, and Central Lowlands Management Units for pallid sturgeon.

3.1 Status of the Pallid Sturgeon within the Action Area

Here we describe the status of the pallid sturgeon in the action area in terms of its distribution, abundance, and reproduction. The historic and more recent (through 1990s) status of pallid sturgeon in the Missouri River basin was described by the 2000 BiOp for the MRRP (Service 2000, pp. 155-159).

The next section describes the current status of the pallid sturgeon in the Missouri River basin, which includes the Great Plains, Interior Highlands, and Central Lowlands Management Units. The Pallid Sturgeon Recovery Plan states that self-sustaining pallid sturgeon populations in all management units and the achievement of recovery criteria must be achieved before the species will be considered for delisting (Service 2014). Because there is no barrier to movement between the Interior Highlands and Central Lowlands units, and genetic analyses indicate no meaningful distinctions in the individuals, we will discuss the status of the pallid sturgeon in these two units together.

Condition of Pallid Sturgeon within the Great Plains Management Unit

Pallid Sturgeon Distribution (GPMU)

In this reach, pallid sturgeon can be found in the Missouri River: (I) from Fort Benton, Montana to the Fort Peck Reservoir; (2) Downstream of Fort Peck Dam to Lake Sakakawea, including the lower Yellowstone River; (3) Downstream of Garrison Dam to Lake Oahe; and (4) Downstream of Oahe Dam to Lake Sharpe (Service 2014).

Pallid Sturgeon Abundance (GPMU)

A 2016 estimate of 85 to 112 wild adults has been made for the GPMU (Upper Basin Pallid Sturgeon Workgroup 2016, p. 23). See Table 1 and Figure 3 for additional estimates and catch per unit effort numbers.

Missouri River (upstream of Fort Peck Dam) - An estimate in 1995 indicated that about 45 wild pallid sturgeon existed in this area (Gardner 1996), but more recent information indicates far fewer wild fish are present, with only three wild fish collected in recent years (USACE 2017, p. 98; Service 2014). The estimated number of surviving hatchery fish in this area as of September 2013 was 7,935 (95 % CI [6,231 to 9, 630] (Rotella 2015). Rotella (2017) updated those numbers to indicate that approximately 4,109 hatchery fish were still alive as of September 2016 from those released since 1998.

Missouri River (downstream of Fort Peck Dam to Lake Sakakawea including lower Yellowstone River). In 2004, an estimated 158 wild adult pallid sturgeon were reported to remain in the population from Fort Peck Dam to the headwaters of Lake Sakakawea, including the Yellowstone River (USACE 2017 p. 133; Klungle and Baxter 2005). Jaeger et al. (2009) estimated approximately 125 wild adult pallid sturgeon remain within this reach. These remaining wild adults were estimated to be 43–57 years (i.e., fish spawned before Lake Sakakawea was filled in the 1950s; USACE 2017, p. 133; Braaten et al. 2015b).

Predicted numbers of pallid sturgeon still alive that were released from hatcheries from 1998 through September 2013 was 43,012 of the 243,934 fish (USACE 2017, p. 133; Rotella 2015). Most (94 %) of these fish were between 3 and 8 years of age in 2013 (these fish are between 7 and 12 years of age in 2017). Rotella (2017) updated these numbers and the estimated number of surviving hatchery fish in this area is 16,444, 95 % CI [12,138-20759] (Rotella 2017; USACE 2018) of the 245,249 fish released from 1998 through May of 2016. Two things were noted that may explain the difference in the sampling estimates from the time of the Rotella 2015 report to the Rotella 2017 report: two types of sampling gear (mini fyke nets and otter trawl) were dropped in 2016 (Hunziker et al. 2017) that tend to sample smaller fish and pit tag loss may have occurred. Recent information suggests that past stocking rates will result in significantly more pallid sturgeon (numbers and biomass) within this reach than may have existed prior to system modifications (USACE 2017, p. 133; Service 2014).

Pallid Sturgeon Reproduction (GPMU)

Missouri River - Currently there is no known reproduction or recruitment in the riverine reach above Fort Peck Dam. Below Fort Peck Dam, suitable spawning habitat is presumed to be available for pallid sturgeon in the river in areas of coarse substrate. Currently there is no known natural recruitment in either the Yellowstone or Missouri Rivers above Lake Sakakawea despite evidence of successful spawning. One hypothesis explaining the lack of natural pallid sturgeon recruitment within this reach is that insufficient drift distance exists between spawning locations and reservoir headwaters (USACE 2017, p. 134; Guy et al. 2015). However, Marotz and Lorang (2017) indicated that drift distance was not the limiting factor but that other causes such as predation, fragmentation of habitats, altered flow and the hypolimnetic[5] release likely contributed to recruitment failure. In February 2018, Zach Shattuck (Montana Fish Wildlife and Parks) notified the Upper Basin Pallid Sturgeon Workgroup members that on "…8/25/2017, an unmarked 412 mm sturgeon was collected at River Mile 1580.8 of the Missouri River just below the confluence of the Yellowstone River. Genetic results confirmed this individual originated from a family cross that was ONLY used for the drift study…" indicating that recruitment is possible in this reach if pallid spawn near Ft. Peck.

In 2011 to 2013, six Pallid sturgeon drifting free embryos were collected from these areas, one in the upper Missouri basin and five from the Yellowstone River (Eichelberger et al. 2014). One spawning location was documented in 2011 downstream of the Milk River (Delonay et al. 2014). This was the first time pallid sturgeon spawning was documented below Fort Peck Dam and

[5] Hypolimnetic releases – releases from the lower and colder layer of water in a lake

contrasts with most studies indicating the vast majority of telemetered pallid sturgeon typically move from the Missouri River upstream into the Yellowstone River for spawning. Although reported in all management units, evidence of hybridization appears lowest in the GPMU (Schrey et al. 2011).

Yellowstone River - Currently on the Yellowstone River the majority of pallid sturgeon spawning occurs in several locations from River Miles 6 to 20 (Fuller and Braaten 2012; Bramblett and White 2001; Bramblett 1996). However, approximately 12 to 26 % of telemetered fish migrate up to Intake Diversion Dam in any given year and presumably would continue to migrate further upstream if not blocked by the weir (Braaten et al. 2015a).

There is evidence of pallid sturgeon spawning in the Yellowstone and Missouri Rivers, but that spawning has not produced evidence of recruitment into this population. The most likely reasons for this are the effects of both the dams on the Missouri River and diversion structures on the Yellowstone River. These structures segment those rivers into shorter pieces than historical conditions. This segmentation blocks adults from accessing upstream historical spawning and alters drift dynamics. Limited spawning and lack of recruitment have been attributed to impoundments, altered flows, and altered temperature regimes.

In 2011 when a spawning location was documented and a free embryo collected in the Missouri River (Delonay et al. 2014) flows were high in the Missouri River due to the combined high flows from the Milk River and Missouri River from a large snowpack and high spring rainfall. Even though approximately 322 km of the Missouri River were available for drifting pallid sturgeon free embryos during the 2011 season, there is no indication of any recruitment. This could be a result of the large snowpack causing high flow velocities (moving the free embryos faster) and low water temperature (from snow melt) slowing free embryo maturation before reaching anoxic conditions at Lake Sakakawea.

The free-flowing river between Cartersville Dam on the Yellowstone River and Lake Sakakawea provides approximately 400 rkm for drifting free embryos; this is nearly 1.5 times the available distance between Fort Peck Dam and Lake Sakakawea. Further, telemetered pallid sturgeon that either passed (2014) or were translocated (2017) upstream of the Intake Diversion Dam moved a significant distance up the Powder River in what appeared to be a spawning run. The availability of the Powder River provides additional, potential spawning areas and drift distance (USACE 2017, p. 149).

Condition of Pallid Sturgeon within the Central Lowlands Management and Interior Highlands Units (CLMU/IHMU)

Pallid Sturgeon Distribution (CLMU/IHMU)

In this section of the Missouri River basin, pallid sturgeon can be found between Fort Randall and Gavins Point Dams, South Dakota and Nebraska; downstream from Gavins Point Dam to St. Louis, Missouri; in the lower Milk and Yellowstone rivers, Montana and North Dakota; the lower Big Sioux River, South Dakota; the lower Platte River, Nebraska; the lower Niobrara River, Nebraska; and the lower Kansas River, Kansas.

Pallid Sturgeon Abundance (CLMU/IHMU)
A total population estimate is not available for the reach below Fort Randall Dam. Using published survival rates from hatchery-produced pallid sturgeon, it is estimated that approximately 1,986 hatchery-produced pallid sturgeon are currently present in this area (USACE 2017, p. 133; Rotella 2015).

While current abundance estimates are lacking for the entire CLMU, Steffensen et al. (2012) generated annual population estimates for both wild and hatchery-reared pallid sturgeon for the reach of the Missouri River extending from the Platte River confluence downstream 80.5 km. Steffensen et al. (2012) estimated wild pallid sturgeon at 5.4 to 8.9 fish per km and hatchery produced pallid sturgeon at 28.6 to 32.3 fish per km. Population modeling in the lower Missouri River suggests that the wild, adult population may consist of around 6,000 individuals (Steffensen et al. 2012). In contrast, estimates in the segment below Kansas City are 0.6 to 0.9 fish per km for wild pallid sturgeon and 5.5 to 10.2 fish per km for hatchery fish (Winders and Steffensen 2014). Wu and Holan (2017) used a Bayesian approach to estimate that the lower Missouri River (CLMU and a portion of the IHMU) contains 5,655 (95 % CI = 4,253–7,572) hatchery-produced pallid sturgeon and 1,846 (95 % CI = 1,265–2,772) of wild-origin; however, their estimates did not account for the rate of tag loss (USACE 2017, p. 99). Although the inter-reach variability makes it difficult to extrapolate these estimates broadly; the current total population (hatchery and wild fish) in the CLMU/IHMU is between 4,000 and 20,000 fish (USACE 2018). The population trend in these management units has stabilized as a result of the stocking of hatchery-reared individuals through the Pallid Sturgeon Conservation Augmentation Program (PSCAP), the population in this section of the basin remains neither self-sustaining nor viable (Steffensen et al. 2012, Steffensen et al. 2013). See Table 1 for additional estimates and Figure 4 for catch per unit effort numbers.

Pallid Sturgeon Reproduction (CLMU/IHMU)
Pallid sturgeon natural recruitment in the CLMU and Missouri River portion of the basin is minimal (Jordan et al. 2016). Adult wild reproductive pallid sturgeon using the Nebraska reach were found to be in poor condition and fewer reproductively ready fish were being sampled (Steffensen et al. 2014). Average fish condition has declined since 2012, however, in 2016, the trend is no longer downward (Randall et al. 2017) and continued monitoring is necessary to evaluate this issue. The upstream reaches of the CLMU have no evidence of natural recruitment (Pierce et al. 2017; Loecker et al. 2016). In downstream reaches of CLMU and Missouri River portion of the IHMU, there is evidence of low levels of natural recruitment (Steffensen and Huenemann 2016; Wrasse 2016; Herman and Wrasse 2016). For example, two pallid sturgeon larvae collected in 2014 were the first signs of successful reproduction and survival in the lower Missouri River (Herman and Wrasse 2016). The recent capture of "presumed-wild" pallid sturgeon <800 mm (predicted age = 10 to 13 years old based on size) may be a sign of a very low level of natural recruitment (Steffensen and Huenemann (2016; 2017). Hrabik et al. (2007) collected a larval pallid sturgeon in the Mississippi River, verifying that reproduction occurs in these management units.

Spawning has been documented but evidence of recruitment is limited. One likely hypothesis is that pallid sturgeon spawn in the lower Missouri River, drift into, and rear in the Middle Mississippi River. Pallid sturgeon have moved from the Mississippi River into the lower

Missouri River indicating possible spawning migrations (USACE 2017; Koch et al. 2012; Delonay et al. 2009) but at this time it is difficult to determine the extent to which fish are moving back and forth between the Missouri and the Mississippi River. Porreca et al. (2015) examined the natal origin of pallid sturgeon, shovelnose sturgeon, and pallid × shovelnose sturgeon hybrids captured in the middle Mississippi River. Of the five genetically-confirmed pallid sturgeon captured during the study, two individuals were hatchery progeny but the other three originated in the lower Missouri River. Additionally, 80 % of the closely related shovelnose sturgeon and 67 % of hybrid sturgeon originated in the lower Missouri River (USACE 2017, p. 136). Hybridization with shovelnose sturgeon is a continued concern for pallid recovery in this CLMU/IHMU reach. Although reported in all management units, evidence of hybridization appears highest in the southern part of its range (Schrey et al. 2011).

Summary Status in the Upper/Lower Missouri River (GPMU/CLMU/IHMU)

The number of wild fish in the GPMU/CLMU/IHMU units are slowly declining due to age, but thousands of hatchery-reared fish are reaching the age where spawning is likely. Maintenance of the species currently relies on artificial propagation and stocking. Population estimates for wild sturgeon within some inter-reservoir reaches of the Missouri River indicate the extant wild populations are declining or gone. Recruitment of young (from limited natural spawning) into the population in the Lower Yellowstone River and Missouri River below Fort Peck is almost non-existent. However, unmarked, adult wild pallid sturgeon seem to be captured with greater regularity, albeit still in low numbers, in the upper portion of the Lower Missouri River near the Platte River than in river segments downstream. See Table 1 and Figures for a summary of published estimates and catch per unit effort numbers.

Table 1. Recently published estimates of the abundance of Pallid Sturgeon for both the Upper and Lower Basin. [Np, estimated number in population; SE, standard errors; PSPAP, Pallid Sturgeon Population Assessment Program]. Adapted from USACE (2018)

Location	Component	Data				Source	Note
Upper Basin		**Np**	**95 % Confidence Interval**			Rotella (2017)	As of September 2016. Of estimated 245,249 stocked 1998 - 2016.
	Hatchery	16,444	12,138 - 20,759				
	Wild total	125	100 - 150			Jaeger et al. (2009)	As of summer 2008. Mark/recapture from broodstock and PSPAP.
	Wild female	40	28 - 52				
Lower Basin		**Fish/km***	**SE**	**Fish/km****	**SE**	Steffensen et al. (2017b)	Intensive broodstock collection, 2008 - 2016, 80.5 km reach in segment 9. Robust design mark-recapture.
	Wild	4	0.2	7.3	0.3		
	Hatchery	8.4	0.7	18.4	1.4		Fish/km (cells above), extrapolated to Lower Missouri River by regression based on catch per unit effort in segments 7, 8, 9, 10, 13, and 14.
		Np	**-1 SE**	**+1 SE**			
	Total	13,616	6,474	20,758			
		Np	**95 % Confidence Interval**			Wu and Holan (2017)	PSPAP data, 2006 - 2010, Bayesian multistate Jolly-Seber model, segments 7, 8, 9, 10, 13, 14.
	Total	5,655	4,253 - 7,572				
		Fish/km*	**SE**	**Fish/km****	**SE**	Winders and Steffensen (2014)	Intensive broodstock sampling, 2011 - 2013, 43.3 km reach in segment 10. Robust design mark-recapture. Fish per km.
	Wild	0.6	0.002	0.9	0.002		
	Hatchery	5.5	0.03	10.2	0.07		
		Fish/km*	**SE**	**Fish/km****	**SE**	Steffensen, et. al. (2012)	Intensive broodstock collection, 2008 - 2010, 80.5 km reach in segment 9. Robust design mark-recapture.
	Wild	5.4	0.45	8.9	0.85		
	Hatchery	28.6	0.89	.3	0.96		
	* Low estimate based on years sampled; ** High estimate based on years sampled						

The level of uncertainty in these estimates in Table 1 varies by basin. Five of the six estimates use intensive mark-recapture and a variety of statistical techniques that may involve sampling bias. These estimates indicate a population size of 4,000 to 20,000 (juvenile and adult) wild and hatchery –origin fish. The redesigned PSPAP is intended to improve these estimates (USACE 2018).

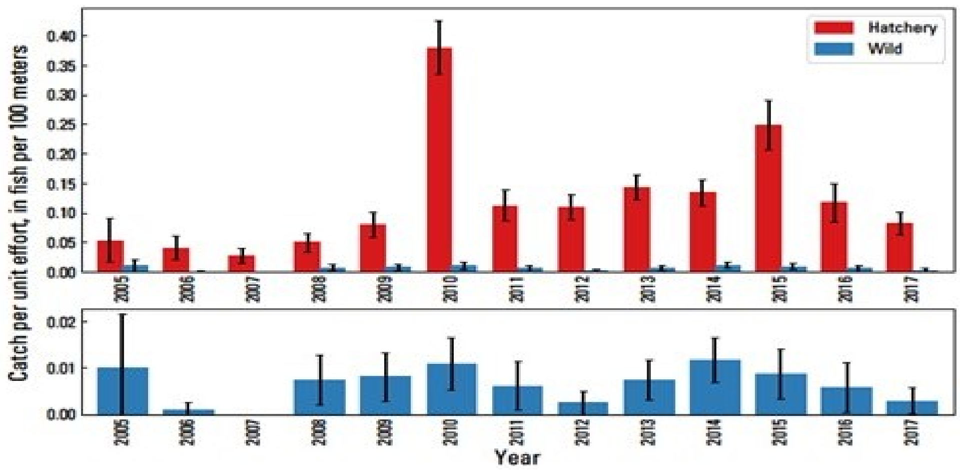

Figure 3. Upper River Catch per unit effort using drifted trammel nets, fish-community season, standard gear, segments 2, 3, and 4. Data source: PSPAP as of November 3, 2017 (USACE 2018)

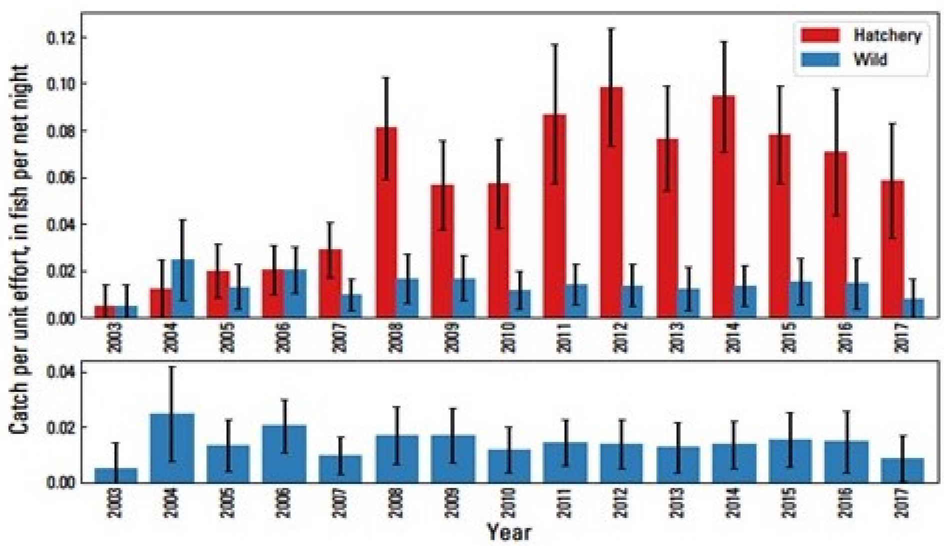

Figure 4. Lower River Catch per unit effort using gill nets, all seasons, standard gears, and combined segments 7, 8, 9, 10, 13, and 14. Note that segments 13 and 14 were not sampled during 2016 and 2017. Data source: PSPAP, as of November 3, 2017 (USACE 2017).

3.2 Factors Affecting Species Environment within the Action Area

This analysis describes factors affecting the environment of the listed species in the action area. In addition to the effects from factors associated with the past operations and maintenance of the Missouri River projects, the environmental baseline includes unrelated Federal actions that have completed formal or informal consultation, as well as Federal actions within the action area that may benefit listed species. The baseline also includes non-Federal (i.e., State, Tribal, local, and private) actions already affecting the species or that will occur contemporaneously with this consultation.

3.2.1 Missouri River Mainstem Reservoir System

The Missouri River has been modified significantly with approximately 28 % of the riverine habitat inundated by reservoirs, 51 % channelized, and the remaining 21 % altered due to dam operations (Jordan et al. 2016). Most of the major tributaries of the Missouri and Mississippi Rivers have also been altered to various degrees by dams, water depletions, channelization and riparian corridor modifications. These alterations affect almost every physical or biological feature of the sturgeon's habitat and life history. Here we discuss the main effects.

Blocked access to habitats

The six large mainstem dams/reservoirs constructed between 1933 and 1963 have transformed much of the formerly turbid, sediment-rich, complex multichannel river into a series of artificially simplified or channelized river reaches and interspersed lake-like habitats with isolated pallid sturgeon populations upstream and downstream of each dam. In many of these situations, the historical spawning habitats and migration corridors were cut off. In addition, mainstem dams may have altered genetic exchange between adjacent populations (Service 2014). Not only do dams block access for the sturgeon, but also affect population viability for its prey species by creating barriers to movement and migration for aquatic and fish species (Kennedy et al. 2016; Albers and Wildhaber 2017). These dams affect larval pallid sturgeon by limiting the amount of riverine (vs. reservoir) habitat available for pallid sturgeon to complete the transition from free embryos to exogenously feeding larvae. In some reaches, insufficient drift distance between spawning sites and downstream impoundments is hypothesized to be the cause of recruitment failure (Braaten et al. 2008; 2012a).

Altered water quality

Reservoir impacts

The level of dissolved oxygen in the water column plays a major role in the health and survival of most fish species, including pallid sturgeon. A study conducted at the upper end of Ft. Peck Reservoir found that the transition zone between the river and reservoir was depleted of dissolved oxygen due to the reduced river velocities and high microbial respiration due to concentrations of organic matter (Guy et al. 2015). Measurements of dissolved oxygen near the substrate surface in the transition zone were 1.32 milligrams per liter (mg/L) in 2012 and 0.00 mg/L in 2013. Laboratory studies indicate that pallid sturgeon free embryos and 40-day old larvae experienced 100 % mortality in about one hour at dissolved oxygen concentrations of 1.5 mg/L or less (Guy et al. 2015). Below Fort Peck Dam, low dissolved oxygen levels just above and within fine sediments in the transition zone and upper end of Lake Sakakawea were also confirmed in 2015 (Bramblett and Scholl 2017). Low levels of dissolved oxygen below Ft. Peck Dam, in Lake Sakakawea, have been hypothesized as a potential key cause of recruitment failure for pallid sturgeon below the Ft. Peck Dam and Intake Diversion Dam because free embryos may not have sufficient drift distance from spawning areas to develop into exogenously feeding larvae and settle to the substrate before they drift into reservoirs and perish (Delonay et al. 2016).

Altered temperature, flow, and sediment regime
A more detailed description of effects from these factors is provided in Section 4.2.1. The damming and flow regulation of the Missouri River began in the 1930s (NRC 2002). The presence and past operations of the dams have altered the water temperature, sediment and hydrology regime. Extreme high and extreme low flows were lost from the natural hydrograph downstream of each mainstem dam (NRC 2002). This dampening effect extends downstream to near Nebraska City, Nebraska and results in less variability in the annual hydrograph (NRC 2002). Hypolimnetic (cold water from the bottom) releases from the dams during operation of the system depress water temperatures for some distance downstream of the dams. The dams have trapped sediment, substantially reducing transport of sediment downstream and reducing turbidity. Discharge and sediment load, together with physiographic setting, are primary factors controlling the morphology of large alluvial rivers (Kellerhals and Church 1989). Seasonally high turbidity levels are a natural component of ecological riverine processes. The trapping and reduction of sediment behind dams affects natural habitat features, like sandbars. Thus from the headwaters to confluence with the Mississippi River, the Missouri River retains only smaller reaches of its historical riverine habitat, with most river miles being impounded in reservoirs or otherwise within the influence of the effects of dams. Yager et al. (2013) documented the historic changes in side channel and backwater habitats in the unchannelized reach below Gavins Point Dam. Significant losses of off-channel habitats have occurred and these declines in habitat have likely decreased productivity in the river (Yager et al. 2013). Based on studies conducted after the 2011 flood, the dams on the Missouri have created an alternate stable state and significant floods are not capable of restoring the river to pre-dam conditions (Skalak et al. 2016).

Restoration of Shallow Water Habitat (SWH)
From 2003 to 2015, USACE has implemented 2,226 construction actions for the purposes of providing SWH. USACE has constructed off-channel projects resulting in an estimated 1,612 acres of SWH and top-width widening projects resulting in 146 acres of SWH. USACE estimated that as of 2014, approximately 11,325 acres of SWH were available from Ponca, NE to the mouth (USACE 2015a; USACE 2017, p. 13). Although the habitat focus in the Proposed Action has changed from shallow water habitat, there is likely much that can be learned from existing SWH projects, and it is expected that many SWH projects may address one or more functional components of IRC habitat. While the proposed criteria for food-producing and foraging habitat components of IRCs are narrower than the previous definition of SWH, significant overlap in the depths and velocities of the three habitat types exist, so existing SWH projects can be modified to provide IRC habitat (USACE 2017, p. 63).

Pallid Sturgeon Propagation and Augmentation
USACE has provided funding annually for pallid sturgeon broodstock collection since 2008. USACE has also funded propagation efforts including facility and infrastructure improvements at six hatcheries. These efforts have resulted in the stocking of over 290,000 yearling equivalent pallid sturgeon since 2001 (USACE 2017, p. 14). This program has successfully reestablished missing size classes, prevented local extirpation and resulted in hatchery fish attaining sexual maturity.

Research/Monitoring Programs

Pallid Sturgeon Population Assessment Program (PSPAP) - USACE has implemented the PSPAP since 2002. The PSPAP is the primary fish monitoring element for the 2003 amended BiOp and the MRRP. Data collected through the PSPAP are used to evaluate the Pallid Sturgeon Propagation and Population Augmentation Management Action (RPA IV) and provide long-term assessment of fish metrics (RPA V; e.g., population trends, survival, movement, distribution, and habitat use by wild and stocked pallid sturgeon). USACE has developed partnerships with state and Federal agencies already active on the Missouri River and has provided the funding, standardized protocols, and quality control oversight necessary to implement the monitoring strategy of the PSPAP (USACE 2017, p. 14). From 2008 to 2017, 12,464 total pallid sturgeon were captured/handled through PSPAP (1,246/year) (T. Gemeinhardt, USACE, personal communication, January 2018).

***Habitat Assessment and Monitoring Program (HAMP)* -** The goal of this program is to provide information on the response of target fish species to the USACE habitat creation on the Lower Missouri River. USACE, Missouri Department of Conservation and Iowa Department of Natural Resources have contributed staff to this effort in the past. From 2008 to 2017, 273 total pallid sturgeon were captured and handled through HAMP (T. Gemeinhardt, USACE, personal communication, January 2018).

***Comprehensive Sturgeon Research Project (CSRP)* –** This is a multi-year, interdisciplinary research study funded by the USACE to determine factors leading to spawning and survival of the endangered pallid sturgeon and the closely related shovelnose sturgeon. Delonay et al. (2016) provides the synthesis of the research completed by this project and its collaborators from 2005 through 2012. Activities associated with the Comprehensive Sturgeon Research Project studies from 2007 to 2017 comprised work with field collected adults, juveniles, and larval pallid sturgeon. In the Lower Missouri River and tributaries 245 wild and hatchery-origin pallid sturgeon were captured and implanted with transmitters by the USGS and its collaborators. Implanted fish were tracked and regularly targeted for recapture to assess reproductive status and spawning success. The 245 fish were recaptured 558 times, and 407 surgical implantations were performed without evidence of direct mortality. During the same time, CSRP studies in the Upper Missouri and Yellowstone River also have used surgical implantation of telemetry devices to track adults and juveniles to monitor habitat use and spawning. The CSRP also has sampled for free embryo and larval sturgeon at fixed stations in the Missouri and Yellowstone rivers, and below known pallid sturgeon spawning aggregations (T. Gemeinhardt, USACE, personal communication, January 2018).

3.2.2 BSNP-Channelization and bank stabilization

A description of the BSNP can be found in this BiOp in Section 1.3 BSNP Operations and Maintenance.

Beginning in the early 1900's, the wide, braided, meandering character of the Missouri River was engineered into a single, narrow navigation channel (Ducey 1985). The hydrologic and sediment transport processes that shaped the pre-development Missouri River ecosystem have been interrupted or modified by Missouri River mainstem dam construction and operation, and other actions which have profoundly altered the river's channel and floodplain morphology through bank stabilization and navigation training structures, tributary channelization, levee development

(Funk and Robinson 1974; Hallberg 1979; Sandheinrich and Atchison 1986). The Missouri River downstream from Sioux City, Iowa has been channelized and the banks stabilized to support navigation resulting in little natural channel habitat diversity (Delonay et al. 2016). Nearly all channelization projects were conducted through the federally authorized BSNP.

Channel modifications reduce access to side channel and overbank habitats and can cause local reductions in juvenile fish that use those habitat (Bowen et al. 2003a). Five species of chubs (sturgeon, sicklefin, flathead, silver, and speckled) were common in the Missouri River before it was channelized (Hesse and Sheets 1993). The decrease in insect abundance after channelization occurred (67 %) is likely the cause of the decrease in fish abundance (Hesse and Sheets 1993). The loss of aquatic habitat and low-lying lands and reduced access to side channel and overbank habitats as a result of the channelization and stabilization that occurred historically continues to impact pallid sturgeon through loss of rearing and foraging habitats for sturgeon and their prey (macroinvertebrates and fish).

3.2.3 BSNP Mitigation Project

USACE develops habitat on lands consistent with the BSNP Fish and Wildlife Mitigation Project authorizations in WRDA 1986, 1999, and 2007 to restore fish and wildlife habitat lost by the construction, operation, and maintenance of the BSNP. Habitat development has included chutes and side channels, shallow water habitat, backwater areas, slack water habitats, wetlands, bottomland forest, and native prairie. To date, USACE has acquired approximately 66,333 acres of the authorized 166,750 acres. Sterner et al. (2009) evaluated several off-channel aquatic habitat sites that were constructed through this program. They found that creating backwater and chute habitats added habitat complexity and these habitats were dominated by juveniles of most fish species. This program can be used to implement pallid sturgeon habitat construction.

3.2.4 Contaminants

Over 70 % of the watershed is listed as impaired for aquatic life due to exceedances of water quality criteria for a large number of chemical and biological constituents. While there is very little direct toxicological sensitivity data available for pallid sturgeon, poor water quality may play a role in the sturgeon's ability to survive and recover in the Missouri River Basin. Jordan et al. (2016) identified contaminants as a concern for pallid sturgeon based on its life history. Contaminants have been identified in the water column and sediments throughout its range. Sources for these contaminants may come from a variety of nonpoint and point sources, including mining, agriculture, grazing, oil and gas development, municipal, industrial, and residential facilities, water diversions, impoundments, and animal feed lots. Studies on other sturgeon species indicate reproductive impacts for a number of similar contaminants as are found in the Missouri River Basin (Blevins 2011). According to an initial review of water quality data, there are widespread exceedances of: benchmarks for trace elements (e.g., arsenic, selenium) in all media and management units; widespread exceedance of benchmarks for nutrients (e.g. nitrogen, phosphorus) in some management units; occasional exceedances of benchmarks for industrial organics (e.g. polychlorinated biphenols) and estrogens in some management units; and vast data gaps for most pesticides, but occasional exceedances of benchmarks where data exist (J. Skorupa, U.S. Fish and Wildlife Service, personal communication, January 2018). A benchmark is a numerical value that represents concentrations of contaminants in sediments, water, soil or tissues of animals which when exceeded are expected to cause harm.

3.2.5 Sand and Gravel Mining

USACE (2017b) has completed a technical study of Missouri River bed degradation focused on the river from St. Joseph, Missouri to Waverly, Missouri. The success of shallow water habitat projects could potentially be affected by future bed degradation and a corresponding drop in water surface elevations. Between 1987 and 2014, the 8.0-km reach from River Mile 369 to 374 degraded approximately 3.1 m. If commercial sand and gravel mining in the channel continues at the currently permitted amounts into the future, model projections indicate that the reach of the river between St. Joseph and the Platte River confluence would continue to degrade. The projected degradation at St. Joseph, Missouri reaches 1.4 m by the end of 50 years. The Kansas City area is expected to continue a recovery trend for the near term. Projections indicate that at the currently permitted commercial sand and gravel mining quantities, degradation in the reach downstream of the Kansas City area will migrate upstream over time and induce a new degradation trend. Reaches between the downstream boundary of the Kansas City metropolitan area and Waverly, Missouri are projected to degrade up to an additional 1.3 m (USACE 2017b, USACE 2017 p. 110). Fischer et al. (2012) evaluated impacts of sand dredging to the fish community in the Kansas River. He did not find alterations for the fish community structure and hypothesized that was due to the fishes in this reach being mobile and adapted to a range of habitat conditions. The ongoing degradation of the channel in the Lower Missouri will continue to affect habitat availability for the pallid sturgeon.

3.2.6 Entrainment

The loss of Pallid Sturgeon associated with cooling intake structures for power facilities, towboat propellers, dredge operations, irrigation diversions, and flood control points of diversion has not been fully quantified, but entrainment has been documented for both Pallid and Shovelnose sturgeon (Service 2014). Towboat entrainment of shovelnose sturgeon in the Upper Mississippi River was estimated at 0.02 per km of navigation (Miranda and Killgore 2013). USACE has conducted studies relative to the potential of pallid sturgeon entrainment by dredging activities. Evidence suggests a low risk of entrainment (dredge intake) for fish during dredging operations (USACE 2017, p. 17). Hoover et al. (2011) found that juvenile sturgeon are vulnerable to entrainment by cutterhead dredges and recommended restricting dredging outside of spawning and rearing season and using smaller pipe diameters for dredging.

3.2.7 Invasive Species

Asian carp (bighead, silver, and grass) are well established in the Missouri River downstream of Gavins Point Dam (Wanner and Klumb 2009). In the Mississippi River, common, grass, silver, and bighead carp have become established and may negatively affect the pallid sturgeon (Jordan et al. 2016). Asian carp eat plankton and although they may not be in direct competition with pallid sturgeon for their food sources, they may diminish the food web which could lead to effects to the pallid sturgeon (Randall et al. 2017). Pendleton et al. (2017) found that silver carp likely suppress native fish that feed on zooplankton and phytoplankton. There is little information on larval pallid food sources but plankton is an important food source for larval fish and if competition for that food source leads to food deprivation, recruitment would be affected (Blevins 2011). In addition, if Asian carp reduce zooplanktivorous fish production, this could contribute to a decline in adult pallid sturgeon growth. Asian carp may also impact pallid sturgeon recruitment by predating on their eggs or drifting free embryos (Jordan et al. 2016).

3.2.8 Hybridization

Hybridization between pallid and shovelnose sturgeon is occurring throughout much of the range for pallid sturgeon, is not a recent event, and has been occurring for several generations (Schrey et al. 2011). It is currently unknown what impact, if any, hybridization has on the recovery of the pallid sturgeon.

3.2.9 Climate change in the action area

The Service discussed various scenarios for climate change in the Status section (2.11). Those scenarios encompassed the Great Plains and included the action area. These models indicated that there would be a significant difference in temperature (increases) in the period from 2021 to 2050. The NOAA models didn't produce statistically significant scenarios that would alter the precipitation rate, however, they generally show increased annual average precipitation in the northern Great Plains and decrease in the southern part of the region (NOAA 2013, p. 55).

USACE (2016) also assessed how climate change could potentially change the effects of actions within the geographic area of the Proposed Action in The Climate Change Assessment – Missouri River Basin report that is available online (www.moriverrecovery.org). This report indicates that future climate trends will likely consist of increased temperatures and precipitation. Increased precipitation will result in higher streamflow, while increased temperatures will likely result in earlier spring snowmelt, decreased snowmelt season duration, and decreased peak snowmelt flows. Increased air temperatures could also have impacts on water temperatures and water quality. Rainfall events will likely become more sporadic for the entire Missouri River basin. Large rain events will likely become more frequent and interspersed by longer relatively dry periods. Extremes in climate will likely magnify periods of wet or dry weather, resulting in longer, more severe droughts, and larger more extensive flooding (USACE 2017, p. 138).

Bureau of Reclamation (Reclamation 2016) identified the following climate challenges within the Missouri River Basin: increases in mean annual temperatures, increase in drought and heat waves, decreases in snowpack, and changes to seasonal and timing of runoff. Precipitation is geographically complex in the Missouri River Basin and predicted to continue to have inter-annual to inter-decadal variations. Water supply, hydropower and reservoir operations are likely to be impacted by these changes (Reclamation 2016).

Potential effects from these environmental changes to pallid sturgeon could be altered spawning habitat (movement and timing), reduced survival of early life stages, reduced habitat due to reduced flows and warmer temperatures, and reduced food items (USFWS 2014). Initial efforts through the development of a modeling framework have been made to evaluate effects of climate change on pallid sturgeon on the Missouri River. In this preliminary study, Wildhaber et al. (2017) found that increased water temperatures and velocity could be expected. Temperature changes can affect timing of spawning cues and increased velocities could affect growth (Wildhaber et al. 2017). Negative effects to the sturgeon will occur if water temperatures rise beyond the optimal range needed for certain life history needs (see Section 4.2 for discussion on optimal temperature ranges). Additional work is necessary to identify the potential consequences of climate change on the Missouri River ecosystem and the species that depend on it.

3.2.10 Commercial/Illegal Harvest

Commercial harvest was identified as one of the threats when the pallid sturgeon was listed in 1990 and illegal harvest remained a threat due to the ongoing commercial harvest of shovelnose sturgeon, a species that is hard to differentiate from pallid sturgeon in the wild (Jordan et al. 2016). To address this threat, the Service listed the shovelnose sturgeon under the ESA due to similarity of appearance which ended the commercial fishery for shovelnose sturgeon (Jordan et al. 2016). Illegal harvest of reproductive females may have had a population effect (Jacobson et al. 2016b)

4. PALLID STURGEON - EFFECTS OF THE ACTION

Effects of the action are defined as the "*...direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action that will be added to the environmental baseline*."(50 CFR §402.02) (emphasis added).

In this section, the Service reviews the action agency's analysis and discussion of how the proposed actions (modifications to land, water, and air) are likely to result in an effect to the species. This analysis is the responsibility of the action agency and is required as part of the materials submitted to the Service when requesting formal consultation (50 CFR §402.14). It describes what modifications to the environment from the proposed action the species will be exposed to, what the species' response will likely be if exposure occurs, and then what biological effect (if any) is likely to result from the response.

Effects of the action are a reasonable prediction of the likely response by individuals of a species to and the resulting biological effects from the environmental changes brought about by implementation of the chosen proposed action. It is not an exploration of alternatives to the proposed action. As with any prediction of an animal's response to environmental impacts, there are many uncertainties associated with it. The prediction must be a reasoned prediction that is informed by science (if available). But because scientific literature reports on the results of controlled experiments and purposefully restricts its findings to the conditions and circumstances of the study, its findings can only be used to inform a predicted result from a future proposed action – they cannot be used to determine the outcome with certainty. Therefore additional information from observations on other species, from other environments, outcomes from similar projects, and professional judgment from biologists familiar with the species also may play a role in arriving at a reasoned prediction.

4.1 Analytic Approach

One of the most effective techniques for arriving at the effects of an action on a listed species is to follow the logic chain of Exposure – Response – Effect. In other words, the first evaluation is whether the species will be exposed to modifications of land, water or air from the proposed action. Then, if exposed, what is the likely physiological and biological response of the species, and then what is the likely population level effect from the combined responses. Following that analysis, the USACE provided a detailed deconstruction of the elements of the Proposed Action and the associated subactivities (USACE 2017, Appendix J). These deconstruction tables were used as an organizing tool to eliminate subactivities that the species would not be likely to be exposed to. For each subactivity, the stressor, the species and life stage that would be present when the activity took place, the potential exposure with associated rationale, and any conservation measures were identified that could minimize or avoid potential exposure.

If a response and effect was unlikely to occur, the effect was considered to be discountable. If the effect was considered to be small enough that its effects to the species could not be meaningfully measured, detected, or evaluated it was considered insignificant. The sub activities that were determined as being not likely to adversely affect the pallid sturgeon were identified in the deconstruction tables along with the rationale. Because these activities were determined to may affect but not be likely to adversely affect the pallid sturgeon they will not be discussed in this section. They include BSNP operation and maintenance, Kansas River operations, interior least tern and piping plover management actions, spawning habitat construction, channel reconfiguration for IRC habitat and structure modifications, and habitat development and land management on MRRP lands.

The remaining activities and their sub activities, where effects or responses were likely and NOT insignificant or discountable, were brought forward to be discussed further in this effects section (Table 2). These are discussed individually below.

Table 2. Summary of activities/subactivities that may affect and are likely to adversely affect the pallid sturgeon (USACE 2017, Appendix J.)

Activity	**Subactivity**	**Circumstance leading to potential exposure**	**Rationale for may affect, likely to adversely affect**	**Pallid Management Unit where activity occurs**
Missouri River Mainstem System Operations	Reservoir Operations to serve flood control	Reservoir operations alter the hydrograph, often resulting in increased base flow and decreased peak flow, decreased turbidity levels, and departure from the natural temperature regime. Reservoir operations alter the hydrograph, significantly reducing seasonal floodplain connectivity and in-channel habitat diversity.	Free Embryo/Larvae and Juvenile –decreased temperatures may slow growth and reduced turbidity may increase rates of predation Adult –hydrologic cues to initiate spawning may be absent All life stages- reduced growth and survival due to loss of habitat, productivity, and reduced system carrying capacity	GPMU, CLMU, IHMU
	Reservoir Operations to serve navigation and other authorized purposes	Reservoir operations alter the hydrograph, often resulting in increased base flow and decreased peak flow, decreased turbidity levels, and departure from the natural temperature regime. Reservoir operations alter the hydrograph, significantly reducing seasonal floodplain connectivity and in-channel habitat diversity.	Egg, Free Embryo/Larvae – decreased temperatures may slow growth and reduced turbidity may increase rates of predation Juvenile –decreased temperatures may slow growth	GPMU, CLMU, IHMU

Activity	Subactivity	Circumstance leading to potential exposure	Rationale for may affect, likely to adversely affect	Pallid Management Unit where activity occurs
			Adult-decreased temperatures may slow growth; hydrologic cues to initiate spawning may be absent All life stages- reduced growth and survival due to loss of habitat, productivity, and reduced system carrying capacity	
Pallid Sturgeon Population Assessment Project and **Propagation and Augmentation**– Sampling to meet fundamental objective 1 (increase pallid sturgeon recruitment to age 1)	Netting for age-0 to age-1 pallid sturgeon	Sampling will occur in the river with benthic trawls.	Free embryo/larvae and Juvenile –harm to fish in nets. Physical stress from netting and handling	GPMU, CLMU, IHMU
	Collection of biological samples from netted larval or juvenile pallid sturgeon – Genetic Tissue and Microchemistry analysis or age determination	Whole fish are removed from the river or fin rays or pieces of fin tissue are taken for assessing the genetic structure of individual sturgeon, or for microchemistry analysis or age determination.	Free embryo/larvae – permanent removal of fish from the river. Juvenile –harm to fish in nets.	GPMU, CLMU, IHMU
Pallid Sturgeon Population Assessment Project and Propagation and Augmentation – Sampling to meet fundamental objective 2 (Maintain or increase numbers of pallid sturgeon until sufficient and sustained natural recruitment occurs	Netting for juvenile and adult pallid sturgeon	Sampling will occur in the river with trotlines, trammel nets, or gill nets.	Juvenile and Adult–harm to fish in nets. Physical stress from netting and handling.	GPMU, CLMU, IHMU
	Collection of biological samples and tagging of netted pallid sturgeon: Genetic Tissue and Microchemistry analysis or age determination, sexual maturity.	Fin rays of pieces of fin tissue are taken for assessing the genetic structure of individual sturgeon. Blood samples are taken from fish for assessing sexual maturity, reproductive readiness, or condition. Fish are captured in the river and marked through scute removal and/or tag injection into body tissue (e.g., Passive Integrated Transponder).	Juvenile and Adult – removal of a small portion of a fin ray, removal of blood sample, small tag injected into fish tissue, and single scute may be removed. Physical stress from netting and handling	GPMU, CLMU, IHMU
Level 1 and 2 Studies – Research and Monitoring to test hypotheses related to Fundamental Sub-objective 1	Netting for age-0 to age-1 pallid sturgeon	Sampling will occur in the river with benthic trawls	Free embryo/larvae and Juvenile–harm to fish in nets. Physical stress from netting and handling	GPMU, CLMU, IHMU
	Collection of biological samples from netted larval or juvenile pallid sturgeon – Microchemistry analysis or age determination	Whole fish samples are taken or pieces of fin rays removed for microchemistry analysis or age determination.	Free embryo/larvae – Likely to adversely affect through permanent removal of fish from the river. Juvenile – Likely to adversely affect through removal of a small portion of a fin ray.	GPMU, CLMU, IHMU

Activity	Subactivity	Circumstance leading to potential exposure	Rationale for may affect, likely to adversely affect	Pallid Management Unit where activity occurs
Level 1 and 2 Studies – Research and Monitoring to test hypotheses related to Fundamental Sub-objective 2	Netting for juvenile and adult pallid sturgeon	Sampling will occur in the river with trotlines, trammel nets, or gill nets.	Juvenile and Adults– harm to fish in nets. Physical stress from netting and handling	GPMU, CLMU, IHMU
	Collection of biological samples from netted pallid sturgeon and tagging for Genetic Tissue and Microchemistry analysis or age determination, sexual maturity.–	Fin rays of pieces of fin tissue are taken for assessing the genetic structure of individual sturgeon. Blood samples are taken from fish for assessing sexual maturity, reproductive readiness, or condition. Fish are captured in the river and marked through scute removal and/or tag injection into body tissue (e.g., Passive Integrated Transponder).	Juvenile and Adult – removal of a small portion of a fin ray, removal of blood sample, small tag injected into fish tissue, and single scute may be removed. Physical stress from netting and handling	GPMU, CLMU, IHMU
Spawning Habitat Construction – Biological Monitoring	Netting for age-0's from spawning habitat restoration locations	Netting takes place in the river channel and is targeting sturgeon	Free embryo/larvae – harm to fish in nets	CLMU, IHMU
	Netting for adults from spawning habitat restoration sites	Netting takes place in the river channel and is targeting sturgeon	Adults – harm to fish in nets	CLMU, IHMU
	Collection of eggs from spawning habitat restoration locations	Collections occurs in the river channel and is targeting sturgeon	Egg – harm by removal	CLMU, IHMU
Channel Reconfiguration for IRCs (Includes modifications to existing SWH sites – Pre and Post Construction Monitoring of IRC's	Sampling to test hypotheses directly related to Fundamental Sub-objective 1	Netting takes place in the river channel and is targeting sturgeon	Free embryo/larvae – permanent removal of fish from the river. Juvenile –capture in nets and handling stress	CLMU, IHMU
Channel Reconfiguration for IRCs (Includes modifications to existing SWH sites – Pre and Post Construction Monitoring of IRC's	Capture of sturgeon for genetic identification		Free embryo/larvae – permanent removal of fish from the river. Juvenile –capture in nets, tissue sample removal and handling stress	IHMU

4.2 Components and elements that are likely to have adverse effects

4.2.1 Missouri River Mainstem Reservoir System Operations

In the BA (USACE 2017, Appendix J and pp. 148-161), the USACE determined that the reservoir management to serve flood control, navigation, and other authorized purposes are likely to adversely affect all life stages of the pallid sturgeon (egg, free embryo/larvae, juvenile and adult). In this section we describe how the ongoing system operations affect the pallid sturgeon. To summarize the effects from the operations we have categorized into 3 main sections: 1) Altered water temperatures, 2) Altered flow regime, and 3) Altered sediment regime and turbidity. However, effects to the pallid sturgeon do occur as a result of a combination of these factors.

1. Altered water temperatures

Hypolimnetic releases from the dams during operation of the system depress water temperatures for some distance downstream of the dams. Five of the six dams release cold water due to summer stratification. Stratification occurs as the summer progresses and the surface water in a reservoir warms while the deeper waters remain cold. Releases from these deeper waters are colder. At the uppermost dam (Fort Peck), between 2001 and 2009, the hypolimnetic releases were an average of 6.4 degrees lower than waters upstream of Fort Peck Dam (Fuller and Braaten 2012). Mean temperatures above Fort Peck were 19.4 °C versus the 13.0 °C below the dam. These temperature effects could be seen 290 km downstream from the dam where temps remained greater than 1.0 degree cooler than upstream of the Fort Peck (Fuller and Braaten 2012). These colder water temperature effects lessen as you move downstream and as warmer tributaries contribute flow into the Missouri River. Below Gavins Point Dam, temperatures are not as depressed since Lewis and Clark Lake is shallower and weakly stratified (Havel et al. 2009). In fact, in the lower Missouri River, high temperatures caused by natural conditions can be an issue and may approach stressful levels for younger life stages of pallid sturgeon during hot summers (Blevins 2011). Because pallid sturgeons rely on their surrounding environment to regulate their body temperature, water temperatures likely affect sexual maturity and development, spawning migrations, growth, and habitat quality (Service 2014).

Temperature studies have documented the optimal temperature ranges needed for various life stages/events for the pallid and other sturgeon species. Sexual maturity may be delayed by cold temperatures. In the hatchery environment, females maintained in the optimal 16 to 20 °C temperatures reached sexual maturity at age 6 compared to females in colder temperatures that did not reach sexual maturity until age 9 (Service 2014). Paragamian and Wakkinen (2002) found that temperature was the most important variable to predict the movement of female Kootenai River white sturgeon to their spawning reach. Photoperiod and temperature were the most important factors to predict reproductive readiness in shovelnose sturgeon (Papoulias et al. 2011). Using thermal tolerances of embryos, Kappenman et al. (2013) predicted that pallid and shovelnose sturgeon spawning occurred when water temperatures were from 12 to 24 °C and mass spawning occurred between 16 and 20 °C. This is consistent with captures of shovelnose sturgeon in spawning condition when temperatures are between 16.9 and 20.5 °C (Keenlyne 1997). Mean water temperatures during the typical spawning period of pallid sturgeon (June and July) do not meet the optimal temperatures in the Missouri River downstream of Fort Peck Dam for 237 to 280 river kms (near Culbertson, MT and near Nohly, MT) (Fuller and Braaten 2012). Recruitment is possible in the Upper River as evidenced by the wild-hatched pallid sturgeon free embryos that were collected near Frazier Rapids, Montana in 2011 (Delonay et al. 2014).

Once spawning is successful, Delonay et al. (2009) noted that egg deposition in the Missouri River typically occurred within the temperature range from 16 to 19 °C. Optimal temperature for embryo survival was determined to be 17 to 18 °C for both pallid and shovelnose sturgeon (Kappenman et al. 2013) and green sturgeon (Van Eenennaam et al. 2005). The duration of optimal water temperatures positively affects growth rate and development of shovelnose sturgeon, and ultimately their reproductive potential (Porter and Schramm 2018). Water temperatures caused by natural conditions in excess of 30 °C in the Lower Missouri River are likely to be stressful to pallid sturgeon (Blevins 2011).

Water temperature also influences feeding and growth of juvenile pallid sturgeon (Chipps et al. 2008). Sechler (2013) hypothesizes that diet trends in sturgeon may be due to a combination of factors such as river stage height, water temperature, water velocity, substrate, macroinvertebrate availability, predation, competition and these factors ultimately affect recruitment into adult, spawning populations. Growth rates in shovelnose sturgeon were greater in a more natural river segment (Yellowstone River) compared to a highly altered segment on the Missouri River near

Bismarck, North Dakota. Cooler temperatures, less flow variation, and greater water clarity in the highly altered segment were thought to be the explanation for this growth rate difference (Everett et al. 2003).

The following river reaches are affected by cold water releases: Fort Peck Dam to Missouri-Yellowstone confluence; Garrison Dam to Oahe Reservoir; Fort Randall Dam to Lewis and Clark Lake (NRC 2002). The Service expects that low water temperatures due to the hypolimnetic dam releases reduce the amount of available habitat for pallid sturgeon and its prey base for breeding, feeding and sheltering. Therefore it is likely that limited spawning occurs in those reaches below the dams where optimal temperatures do not occur. If spawning does occur, we expect incubation and hatching is delayed or inhibited, embryos are maturing to larvae at a slower rate, and more time is required for larval development in drift dispersal. Reaching sexual maturity is also delayed or fecundity is affected. In addition, areas with low water temperatures typically have reduced primary productivity and thus limit food production for juveniles and adults resulting in slower growth rates in juveniles and adults.

2. Altered flow regime

The flow regulation on the Missouri River has altered the hydrograph by increasing base flows and decreasing the peak flows (Galat and Lipkin 2000; Delonay et al. 2016). As with temperature, the significance of the alteration diminishes progressively downstream from the dams. Fort Peck Dam reduces the magnitude, timing, and periodicity of discharge in the Missouri River for nearly 327 river kms between Fort Peck Dam and the upstream extent of Lake Sakakawea (Fuller and Braaten 2012; Brummond 2014). Gavins Point, the most downstream of the System projects, is primarily used for flow re-regulating to smooth out the release fluctuations of the upper projects to better serve downstream purposes, such as navigation and water supply.

Habitat availability

Typically, flow modification due to the management of regulated dams impairs the connection between the channel and the floodplain (Marren et al. 2014; Skalak et al. 2016). The current system management results in stable flows during March to November and therefore the floodplain is inundated infrequently. Decreased peak flows reduce flooding and regular lateral connection to floodplain habitats which in turn may reduce habitat for and production/availability of prey, which may in turn reduce adult growth, survival, and reproduction.

Habitat availability for all life stages of pallid sturgeon is likely affected by flow regime (Delonay et al. 2016). Pallid sturgeon have been documented on and adjacent to inundated floodplains on the Lower Missouri River after record high releases at Gavins Point Dam in 2011 (Delonay et al. 2014). Low lying riparian habitats that are flooded during high flow events increase habitat availability for drifting free embryos and juveniles. Bowen et al. (2003b) compared the unregulated Yellowstone River to the regulated Missouri River and found that flow regulation and its effects to channel morphology resulted in fewer areas of inundated floodplains.

Food availability
Food availability for sturgeon species is likely critical as the free embryo transforms into exogenously feeding larvae. Several hypotheses addressed in the Effects Analysis study (Jacobson et al. 2016b) discuss how management changes could affect food availability. For example, Hypothesis 1 asserts that naturalizing flows from Fort Peck Dam will increase food availability by connecting the river with low-lying lands. Another hypothesis asserts that reconfiguration of the channel to create more food producing habitats will benefit growth and survival of pallid sturgeon exogenously feeding larvae to age-1. Hydraulic conditions on the Missouri River may be inhibiting growth and survival of larval pallid sturgeon (Erwin et al. 2017). To evaluate this, Erwin et al. (2017) conducted a quantitative analysis of habitat availability in the Missouri River. The result indicated that the availability of food-producing habitat in the Lower Missouri River is low and found that the construction of side-channel chutes and providing access to the floodplain increased foraging habitats (Erwin et al. 2017). Future restoration projects, such as levee setbacks, could allow for more frequent and short-term inundation (less than a month) of the floodplain which could benefit the production of chironomid larvae and zooplankton. This in turn could benefit native fish including the pallid sturgeon (Gosch et al. 2014).

Kennedy et al. (2016) found that mayflies, a known prey base for larval stages of pallid sturgeon, are negatively impacted from fluctuating flows because they lay their eggs on the river-edge which results in desiccation and mortality of their eggs. Macroinvertebrates at a regulated river site responded significantly to flow changes, particularly to the timing of extreme flow events (White et al. 2017). This suggests that daily fluctuations associated with hydropower production may affect the diversity and abundance of Missouri River macroinvertebrates. Poff and Zimmerman (2010) found varying responses to macroinvertebrates due to changes in flow magnitude. Elevated and reduced flows both increased and decreased macroinvertebrate abundance and diversity (Poff and Zimmerman 2017).

Steffensen and Mestl (2016) documented the significant decline in relative condition of pallid sturgeon in the Lower Missouri River in the spring of 2015. Perhaps related to the poor condition, fecundity in female pallid sturgeon was lower in the Lower Missouri River, near Gavins Point Dam and atresia (reabsorb eggs in lieu of release) was more common (Delonay et al. (2016). Randall et al. (2017) acknowledged that the average condition of pallid sturgeon had declined in the Lower Missouri from 2011 to 2015 but failed to determine the specific cause. Data from 2016 suggest that the decline has levelled off but Randall et al. (2017) recommended increased and enhanced fish condition monitoring. Several hypotheses were considered in this report, three of which were related to food availability: overstocking of fish has depleted prey base, interspecific competition has altered local food webs, and changes in channel morphology provide less favorable habitat for the pallid sturgeon and their prey base.

Steffensen et al. (2017a) conducted a rangewide assessment of pallid sturgeon relative condition. They found that the pallid sturgeon in the Middle Mississippi River were in the best condition. Possible reasons that condition is better in the Middle Mississippi River is that it is free-flowing and a lower energy environment. Also, preferred food items of the pallid sturgeon such as benthic chubs (sturgeon and sicklefin) are abundant in this section of the river (Steffensen et al. 2017a). In a literature review of ecological responses to flow regime, Poff and Zimmerman

(2010) found that fish were the only taxonomic groups that consistently responded negatively to flow magnitude changes. Fish abundance, diversity, and demographic rates declined with elevated and reduced flow magnitude (Poff and Zimmerman 2010). The sicklefin chub relies on habitats where food is concentrated and predation is low (potentially shallow water habitat) for the successful development during early life stages (Albers and Wildhaber 2017). The sicklefin chub is a riverine broadcast spawner where the eggs and larvae have a drifting phase and juveniles are found in inshore shallow habitats (Albers and Wildhaber 2017). Increased feeding success and food intake of fish have been reported during flooding events when fish were able to access the floodplain (Barko et al. 2006; Sommer et al. 2001; Van de Wolfshaar et al. 2011; Sechler et al. 2013). Studies after the 2011 Missouri River flood noted that the increased available food resources may have been the reason for the substantial weight gain documented in adult native fishes, especially pallid sturgeon (Steffensen et al. 2014).

Spawning

Galat and Lipkin (2000) reported that the median magnitude and duration of maxima annual discharge extremes at the Wolf Point, MT gage declined by 27, 28, and 21 % for the 1-day, 7-day, and 30-day average, respectively, from pre-flow regulation to post-flow regulation. The mean rise rate and fall rate for hydrograph changes at the Wolf Point, MT gage declined by 39 % and 27 % post-flow regulation (Galat and Lipkin 2000). Discharges from Fort Peck Dam have shifted annual peak flows from late spring to late summer (Brummond 2014); subsequently inhibiting upstream spawning migrations of adult Pallid Sturgeon and further complicating downstream drift of any larvae. Flow pulses are thought to cue spawning in sturgeon but uncertainties still exist (Doyle et al. 2011). In a regulated tributary to the Missouri River in Montana, Goodman et al. (2013) found that a certain flow threshold and suitable water temperatures needed to be met to provide a spawning cue for shovelnose sturgeon. Shovelnose sturgeon are also known to move from the Yellowstone River into the Tongue and Powder Rivers to spawn with increasing flows and temperature (Delonay et al. 2016).

In the Missouri River directly downstream of the Fort Peck Dam, reproductively active pallid sturgeon seemed to respond to flow pulses by forming aggregations and spawning in two higher-flow years (i.e., 2011, 2013) in an area typically not used in lower flow years (Fuller and Braaten 2012). This event resulted in a pallid sturgeon free embryo being captured in 2011 (Delonay et al. 2016). While it seems to indicate that the response was due to the higher flows, other factors or a combination of factors could have influenced this response such as water temperature and turbidity (Delonay et al. 2016).

However, at Gavins Point Dam, pallid sturgeon have been spawning without pulsed flow releases (Delonay et al. 2009) and Doyle et al. (2011) stated that there was no evidence to support the hypothesis that managed spring pulses were necessary to induce pallid sturgeon spawning. In other sturgeon studies, female Kootenai River white sturgeon movement during spawning was not affected by changes in discharge (Paragamian and Wakkinen 2002) and shovelnose sturgeon spawned above Ft. Peck under varied hydrographs (Richards et al. 2013).

As with spawning, flow regime is also likely to affect where eggs are deposited, the drifting of free embryos, and the substrate conditions of spawning and foraging sites (Delonay et al. 2016). Flow regime is known to affect the movement of developing larvae from their hatching to nursery habitat in many other fish species (Lagarde et al. 2017). Sturgeon recruitment increased on the Mississippi River during high water years possibly due to increased larval habitat from the flooding of riparian and island areas (Phelps et al. 2010). Altered hydrograph and channel morphology may also prevent the formation of in-channel suitable nursery/rearing habitat and increase embryo/larvae drift downstream in thalweg to similarly unsuitable habitats downstream (Jacobson et al. 2016b).

In the Upper Missouri River below Fort Peck, studies have been ongoing to try to determine if there is adequate drift distance for the survival of free embryos before they reach the hypoxic conditions of Lake Sakakawea. Guy et al. (2015) found that the bottom sediments in the headwaters of Lake Sakakawea are anoxic and are likely lethal to pallid sturgeon free embryos. Braaten et al. (2012a) indicated that the drift distance required below Fort Peck likely exceeds the amount of river habitat and is the probable cause of the lack of recruitment. However, Marotz and Lorang (2017) indicated that drift distance was not the limiting factor but that other causes such as predation, fragmentation of habitats, altered flow and the hypolimnetic release likely contributed to recruitment failure. On the Lower Missouri River, spawning does not appear to be linked consistently to discharge conditions, but it may influence overall spawning success (Delonay et al. 2016).

The following river reaches are affected by the alteration of flows/hydrograph: Fort Peck Dam to the confluence of Missouri –Yellowstone Rivers; Fort Randall Dam to Lewis and Clark Lake; Yankton, South Dakota to Ponca State Park in Nebraska; Ponca State Park to the confluence of Missouri and Big Sioux Rivers (NRC 2002). The impact is felt throughout the entire lower river to the mouth. However as one moves downstream the impact is lessened as tributaries gradually begin to normalize the hydrograph. We expect that the altered flow regime from the continued management of the six dams for the authorized purposes negatively affects feeding, breeding and sheltering of all life stages of the pallid sturgeon, specifically spawning, drift distance, habitat availability, and growth and development for pallid sturgeon and their prey base.

3. Altered sediment regime and turbidity

There are many confounding factors contributing to the sediment imbalance on the Missouri River: sediment mining and land use changes, floods and droughts, increased water use, the creation of the navigation channel, and the development and operation of the reservoirs. The USACE has been studying this issue for many years (for example, Lewis and Clark Lake Sediment Management Study). The operation of the reservoirs is the component of the proposed action that we are evaluating in this BiOp. Decreases in suspended sediment and turbidity have occurred in the Lower Missouri River due to the operation of the dams (Blevins 2006). The native flora and fauna, including pallid sturgeon, evolved and adapted to a high turbidity and high sediment load environment (NRC 2011). Sediment regimes in a river system influence water quality, thermal regime, habitat and aquatic communities and river stability (Wohl et al. 2015). Many aquatic organisms depend on and are sensitive to the size, distribution, and movement of sediment for various life stage needs, such as appropriate substrate for spawning and juvenile rearing (Wohl et al. 2015).

Little information is available on how the decrease in turbidity affects pallid sturgeon (Blevins 2011), whether turbidity is important to early life stage development or how it affects feeding processes (Delonay et al. 2016). However, turbidity was a factor in determining the presence or absence of sicklefin and sturgeon chubs (Everett et al. 2004), known prey species for pallid sturgeon. Blevins (2006) hypothesized that the increased water clarity due to decreased sediment in the system may be a disadvantage to native fish such as pallid sturgeon. Higher pre-impoundment turbidity levels may have afforded improved foraging effectiveness for pallid sturgeons by providing older juveniles and adults some level of concealment. In addition, the clearer water may increase the production of plankton thus providing a new food source for nonnative fish that eat plankton such as Asian Carp or providing an advantage to sight feeding fish at the expense of species that need little light such as pallid sturgeon. Another hypothesis was that turbidity may protect young pallid sturgeon from predation. French et al. (2014) found that Age-0 pallid sturgeon were easily captured by predators but rarely consumed and that turbidity did not affect vulnerability. In laboratory studies, increased predation on White Sturgeon yolk-sac larvae was observed at low turbidity levels, suggesting that high turbidity levels associated with a natural hydrograph and natural sediment transport regimes may offer concealment for free-drifting sturgeon embryos and larvae (Gadomski and Parsley 2005).

The following river reaches are affected by sediment transport imbalance: Fort Peck Dam to the confluence of the Missouri-Yellowstone Rivers; Garrison Dam to Oahe Reservoir; Fort Randall Dam to Lewis and Clark Lake; Yankton, South Dakota to Ponca State Park in Nebraska; Ponca State Park to the confluence of Missouri and Big Sioux Rivers (NRC 2002) to the mouth. We expect that reduced sediment transport and the associated decrease in turbidity affects feeding, breeding, and sheltering for all life stages of pallid sturgeon by affecting habitat availability/suitability, predator/prey relationships, and feeding efficiency.

4.3 Components and elements that are likely to have beneficial effects

4.3.1 Pallid Sturgeon Management Actions

Propagation and Augmentation - USACE provides financial support for the Pallid Sturgeon Propagation and Augmentation program but does not have any decision-making authority regarding the implementation of the program. This beneficial program was implemented initially to prevent extinction and is viewed as a short-term solution to maintain numbers and ensure genetic variability until a self-sustaining population is achieved. The Service and state agencies are responsible for stocking decisions and the program follows a Range-wide Pallid Sturgeon Stocking Plan that is currently being updated and revised. This plan addresses genetic issues that can occur in the hatchery environment. This program is a critical management action to support the recovery of the pallid sturgeon and provides an overall beneficial effect on the pallid sturgeon population. Absent the USACE continued support the effectiveness of the Propagation and Augmentation program would be significantly impaired.

Pallid Sturgeon Population Assessment Project – This ongoing program provides important, long-term data on metrics, including population trends, survival, movement, distribution, and habitat use by pallid sturgeon and other target fishes. PSPAP collects population-level data (size, growth, survival, and distribution) that is used to parameterize stage-based population models for pallid sturgeon. PSPAP requires capturing, collecting, and tagging adult and juvenile pallid sturgeon. This sometimes results in mortality and injury to individuals. Effects are expected to all life stages except eggs (not sampled or collected). However, similar research and monitoring has been on-going for many years to better understand the physical and biological requirements of pallid sturgeon and these effects have been minor, therefore future effects are expected to be minor. Further, all monitoring will occur in compliance with scientific collection permits or other appropriate instruments and reporting of injuries and mortality will occur continuously. PSPAP is a critical management action to support adaptive management of pallid sturgeon and represents a long-term, indirect beneficial impact on the pallid sturgeon population (USACE 2017, p. 173).

Jacobson et al. (2016b) notes that PSPAP data have been used to generate the first survival estimates for the upper (Hadley and Rotella 2009) and for the lower (Steffensen et al. 2010) Missouri River basin. In addition, PSPAP data have been used to study demographics such as gender ratio, age at sexual maturity, fecundity, and reproductive readiness (Jacobson et al. 2016b).

From 2008 to 2017, a total of 12,464 pallid sturgeons were captured/handled through PSPAP (1,246/year). Mortality in that same timeframe from PSPAP was 46 individuals (includes one from the 2018 data year). The average is 4.5 per year with a high of 11 and a low of 2. We anticipate that future numbers will be similar to data from the past (T. Gemeinhardt, USACE, personal communication, January 2018).

4.3.2 Level 1 and 2 Studies Including Spawning Cue Test Release -Level 1 and Level 2 studies are described in Appendix I of the Science and Adaptive Management Plan and will directly or indirectly test hypotheses to better understand factors limiting pallid sturgeon populations. These studies will be short-term in nature relative to PSPAP. These studies will result in mortality and injury to individuals and effects are expected to all life stages. However, similar research and monitoring has been on-going for many years to better understand the physical and biological requirements of pallid sturgeon and these effects, from a population level, have been minor, therefore future effects are expected to be minor. Further, all monitoring will occur in compliance with scientific collection permits or other appropriate instruments and reporting of injuries and mortality will occur continuously (USACE 2017, p. 174). In the past these focused monitoring studies were handled through HAMP and CSRP and we use that past information to evaluate the effects of those programs. These programs are also critical management actions to support adaptive management of pallid sturgeon and represent long-term, indirect beneficial impact on the pallid sturgeon population. Future monitoring needs as determined through the Science and Adaptive Management Plan will be similar to those programs although they may be carried out by other entities.

From 2008 to 2017, 273 total pallid sturgeon were captured/handled through HAMP and other focused monitoring and mortality was 3 age-0 individuals. The estimated future mortality rate is expected to be similar to the past (T. Gemeinhardt, USACE, personal communication, January 2018).

For activities associated with the Comprehensive Sturgeon Research Project studies, no adult mortalities were recorded as a result of capture, evaluation, or surgical implantation of telemetry transmitters. The only mortalities, two recently stocked juveniles, were recorded during trotline collection efforts early in the project (2007). Modifications to the gear (larger hooks, shorter gangion lines, and additional swivels) eliminated mortality and injuries, and reduced apparent stress to sturgeon. In the Lower Missouri River and tributaries, 245 wild and hatchery-origin pallid sturgeon were captured and implanted with transmitters by the USGS and its collaborators. Implanted fish were tracked and regularly targeted for recapture to assess reproductive status and spawning success. The 245 fish were recaptured 558 times, and 407 surgical implantations were performed without evidence of direct mortality. Eleven fish were retired from the study for various reasons, but only one was for health concerns associated with telemetry implantation. During the same time, CSRP studies in the Upper Missouri and Yellowstone River also have used surgical implantation of telemetry devices to track adults and juveniles to monitor habitat use and spawning. Similarly, no instances of adult mortalities or health concerns of implanted sturgeon have been recorded in CSRP studies in this study segment. Proposed CSRP studies will expand the use of telemetry using demonstrated capture, evaluation and implantation techniques. Mortality expected in proposed studies is not anticipated to increase (T. Gemeinhardt, USACE, personal communication, January 2018).

The CSRP also has sampled for free embryo and larval sturgeon at fixed stations in the Missouri and Yellowstone rivers, and below known pallid sturgeon spawning aggregations. From 2007 to 2017, this sampling has resulted in the collection and preservation of 10 confirmed pallid sturgeon free-embryos. Sampling for these life stages is anticipated to increase focused sampling at known or suspected spawning sites. It is necessary for collected specimens to be sacrificed and preserved in ethanol for genetic confirmation of species identity. While more focused sampling is expected to increase the numbers of early stage pallid sturgeon collected, the actual annual numbers are anticipated to remain relatively low (<100) and will constitute a very small fraction of any progeny from any known spawning event (T. Gemeinhardt, USACE, personal communication, January 2018).

4.3.3 Adaptive management

Adaptive management as a principle of developing future actions

The USACE has included in their Proposed Action an extensive and detailed Science and Adaptive Management Plan (Fischenich et al. 2016). The intent of this plan is to create a rigorous process for assessing and evaluating management actions in relation to achieving the purpose of the MRRP. That purpose is to enable the USACE to operate the Missouri River System in accordance with the Missouri River Mainstem Reservoir System Master Water Control Manual, to meet its authorized purposes without jeopardizing the continued existence of the piping plover, interior least tern, and pallid sturgeon.

An adaptive management framework was recommended by the Service in the 2003 BiOp, the ISAP in 2011, and NRC (2011). In 2012 the MRRIC recommended by consensus that the USACE move forward and develop such a plan. An adaptive management plan for the MRRP serves at least two important purposes. One is to systematically and experimentally reduce the uncertainty regarding actions and the probable response by the pallid sturgeon, with the clear intent to improve the likelihood of survival and recovery of the sturgeon. The second is to provide a mechanism and process for evaluating new information as it arises in the future. In the case of the Proposed Action, the Science and Adaptive Management Plan acts to monitor habitat improvement projects that will begin immediately and serves as a framework to examine known hypotheses regarding species conservation needs, and propose new areas of experimentation and changes to management in the future as information on species response becomes clearer.

Though the phrase adaptive management is often used casually, adaptive management is a specific management approach that must meet several criteria – it is not just "trial and error." The National Research Council describes it this way. "Adaptive management [is a decision process that] promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process. Adaptive management also recognizes the importance of natural variability in contributing to ecological resilience and productivity. It is not a 'trial and error' process, but rather emphasizes learning while doing. Adaptive management does not represent an end in itself, but rather a means to more effective decisions and enhanced benefits. Its true measure is in how well it helps meet environmental, social, and economic goals, increases scientific knowledge, and reduces tensions among stakeholders"(NRC 2004).

The Department of Interior produced a technical guide on Adaptive Management in 2009 (Williams et al. 2009). That guide outlines nine questions to determine if an adaptive management approach would be the appropriate approach to decision making:

1. Is some kind of management decision to be made?
2. Can stakeholders be engaged?
3. Can management objective(s) be stated explicitly?
4. Is decision making confounded by uncertainty about potential management impacts?
5. Can resource relationships and management impacts be represented in models?
6. Can monitoring be designed to inform decision making?
7. Can progress be measured in achieving management objectives?
8. Can management actions be adjusted in response to what has been learned?
9. Does the whole process fit within the appropriate legal framework?

Based on the affirmative answers to those questions, the MRRP is well suited for an adaptive management approach.

It is well established that the long-term management actions most likely to produce a positive population response in the pallid sturgeon are uncertain. This uncertainty is the exact circumstance that a science-based adaptive management plan is well suited to address. As mentioned earlier in the discussion about uncertainty, Congress recognized that because consultations had to be completed in a timely fashion, those consultations might be based on incomplete information regarding effects to the species. Because action agencies had a continuing duty to not violate 7(a)(2) (even after a no Jeopardy opinion was made for a proposed action) and this might include continuing to develop information to fill gaps, Congress believed that the 7(a)(2) requirement "continues to give the benefit of the doubt to the species." H. Conf. Rep. No. 96–697, 96th Cong., 1st. Sess. 12, reprinted in [1979] U.S. Code Cong. & Ad. News, 2572, 2576.

The Science and Adaptive Management Plan, as a central part of the Proposed Action, is a science based process that helps insure that Congress' assumption of a "continuing benefit of the doubt to the species" is being actively supported throughout the life of this project. In addition to the commitments that the USACE has outlined in the governance structure in the Science and Adaptive Management Plan, the Service has developed an organizational structure that more specifically outlines roles and responsibilities for our agency to support its implementation (Appendix A). This structure lays out our commitment to this process and provides for our effective and efficient participation. It also provides an outreach tool to help participants and other interested entities understand what role the Service plays in this process. The draft structure is found in Appendix A of this BiOp.

The key components of the plan (below) describe the process in detail and outline the commitment of the agencies to this process:

- Governance Process – defines role and responsibilities, describes the decision processes and workflows, protocols and procedures.
- Plover and Terns – defines objectives, targets, and uncertainties, management actions
- Pallid sturgeon – defines objectives, recommends strategy, provides overview of level 1 and 2 components, implementation plan and monitoring
- Human Considerations – defines objectives, decision, monitoring
- Data acquisition, Management, Reporting, and Communications – describes principles and practices

4.3.4 Section 7(a)(1) Conservation Plan

The USACE has developed and committed to implement this conservation plan (USACE 2017, Appendix D). The conservation plan lays out ways for the USACE to continually look at opportunities to evaluate their program to avoid and minimize impacts to the listed species and their habitats and will result in a net conservation benefit for those species that it addresses. This plan also provides a mechanism to have a continuing dialogue with the Service on avoidance and minimization to listed species and their habitats. This plan in concert with the Science and Adaptive Management Plan will provide a proactive basin-wide conservation strategy.

4.4 Effects of Interrelated or Interdependent Actions

The implementing regulations for section 7 consultations define interrelated actions as *"…those [actions] that are a part of a larger action and depend on the larger action for their justification."* (50 CFR §402.02) (emphasis added). Interdependent actions "*…are those [actions] that have no independent utility apart from the action under consideration."* (50 CFR §402.02) (emphasis added). Water depletions are considered an inter-related and interdependent action because operations of the System allow for these depletions to occur in order to serve authorized purposes of the System. The HEC-ResSim model used for assessment of effects of the Proposed Action accounts for forecasted depletions. The runoff conditions for the period of record (POR) were adjusted to account for the current level of depletions. Depletions and evaporation from large reservoirs reduce runoff from the basin. Depletions are likely to increase in the future, further reducing average annual basin runoff (USACE 2015b). The effects from water depletions are included in the species Effects Analysis study because these depletions are accounted for in the HEC-ResSim model (USACE 2017, Chapter 6 and p. 182).

5. PALLID STURGEON - CUMULATIVE EFFECTS

The implementing regulations for section 7 define cumulative effects as "*...those effects of future State, or private activities, not involving Federal activities that are reasonably certain to occur within the action area of the Federal action subject to consultation.*" (50 CFR §402.02) (emphasis added). The purpose of identifying and assessing cumulative effects is to examine whether there are additional actions in the action area that while not part of the proposed action under consultation, might need to be considered in assessing the impact of the effects of the action to the listed entity. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation.

The Service's consultation handbook (Service 1998) recommends review of the action agency's NEPA document as a method for identifying potential cumulative effects. The Handbook cautions however, that NEPA cumulative impacts are not identical to the narrower definition of cumulative effects for consultation under 7(a)(2). The difference arises from the degree of likelihood of the impact occurring. The standard for NEPA is "reasonably foreseeable" whereas the consultation standard is a much more narrow "reasonably certain to occur".

The Service reviewed the cumulative impact section in the MRRMP-DEIS and the BA. We find that the foreseeable impacts described are largely the impacts that the Service has already noted in the BiOp's status and environmental baseline section. In addition to those impacts, the Service has identified the role of degraded water quality that exists in the baseline and the possible effects that has had (and will continue to have) on the pallid sturgeon. We also described the risks to pallid sturgeon from sand and gravel mining, entrainment, invasive species, and hybridization. We have characterized the general effect those impacts will have on the species and that the effects will continue in similar fashion into the future in the action area.

As described in the environmental baseline, the dominant effects leading to the condition of the pallid sturgeon have come through large changes to the river from past federal agency manipulation and management of the Missouri river to support the Congressionally-authorized purposes of flood control, navigation, hydropower, irrigation, water supply, water quality control, recreation, and fish and wildlife and the lingering effects of the dams constructed in the river over the last 100 years and the Bank Stabilization and Navigation Project. These dominant, overarching effects make it impossible to clearly discern, for categorization, the exact non-federal actions and their corresponding effects that contributed and will continue to contribute to a degraded condition for the pallid sturgeon.

NioCorp' Elk Creek project near Elk Creek, Nebraska involves the construction of an underground mine, a surface plant, and appurtenances required to manufacture the United States' first localized sources of niobium (Nb_2O_5), scandium (Sc), and titanium (TiO_2). These ores are contained in a single carbonatite and encapsulated by groundwater. Wells would be installed to pump the saline groundwater above ground in order for workers to access the carbonatite via underground mine. Wells would pump the saline groundwater into a holding pond located at the mine site for approximately five days to allow groundwater to equilibrate before transmitting the groundwater through an approximately 40 mile underground pipeline that would discharge into the Missouri River. The pallid sturgeon is known to occur in the vicinity of the discharge site and therefore, may be affected by the proposed mine discharges.

6. PALLID STURGEON - JEOPARDY DISCUSSION AND CONCLUSION

In section 7 of the ESA, Congress required that every federal agency must insure that any action "*…authorized, funded, or carried out…is not likely to jeopardize the continued existence of any endangered or threatened species…*" (emphasis added). To meet this requirement, Congress required that the action agencies request assistance from the United States Fish and Wildlife Service (Service) and seek their biological opinion regarding whether the proposed action is likely to jeopardize the continued existence of a listed species.

The definition of "Jeopardize the continued existence of" is "…*to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species.*" 50 CFR §402.02 (emphasis added).

6.1 Summary of Effects from the Action

While the propagation and augmentation program (a program recommended as part of the pallid sturgeon recovery plan) insures the probable long term survival of the pallid sturgeon, recovery is dependent upon recruitment success. As a result of project-related impacts from Missouri River Mainstem Reservoir System Operations that cause alterations to water temperature, flow regime, and sediment regime within the Action Area, we anticipate that all pallid sturgeon life stages will be adversely affected by the Proposed Action by the following: 1) inhibit spawning, 2) delay or inhibit incubation and hatching, 3) inhibit growth in all life stages of sturgeon and its prey base, 4) delay sexual maturity, 5) reduce primary production which affects all life stages and prey base, 6) reduce habitat availability for feeding, breeding, and sheltering for pallid sturgeon and its prey base.

However, the USACE has committed to an initial suite of prioritized actions that will have overall beneficial effects to the pallid sturgeon (Level 1 and 2 studies that will determine future management actions, spawning habitat construction and monitoring, channel reconfiguration for interception and rearing habitats, and habitat development and land management on MRRP lands). In addition, the USACE will continue to provide funding for propagation and augmentation and the pallid sturgeon population assessment program and has committed to implementing conservation measures that avoid or minimize some of the adverse effects described. Given the acknowledged uncertainty regarding the actions necessary to provide for recruitment, the USACE is embarking on the implementation of a rigorous Science and Adaptive Management Plan in collaboration with the Service. The pallid sturgeon is likely to not only maintain, but improve its status in the Action Area based on the goals of the adaptive management plan which are to develop and implement actions to benefit the pallid sturgeon.

6.2 Conclusion

In 2003, we made a determination that the action proposed at that time would likely jeopardize the pallid sturgeon with a Reasonable and Prudent Alternative that was developed and accepted. Since the issuance of that BiOp, habitat improvements have been implemented and artificial propagation and stocking has successfully increased the extant population to thousands of fish in the Missouri River. Hundreds of these fish are reaching the age of sexual maturity and represent a strong biological potential for recovery. However, recruitment failure continues to be a problem in the Great Plains Management Unit with only limited evidence of recruitment in other management units (Service 2014).

The Service has analyzed and described the likely adverse effects to the pallid sturgeon from the Proposed Action, which are in addition to legacy negative effects existing in the environmental baseline. The effects of the Proposed Action include ongoing changes in river hydrology and geomorphology, water quality (temperature), sediment regime, and effects associated with monitoring. The probability of long-term survival of the species is better supported today than at any time in the recent past. That is a necessary first step to recovery, however to recover the species, successful spawning and recruitment is necessary. Although many of the ecological conditions and ongoing actions are similar to 2003, there have been some improvements. In addition, the initial suite of management actions along with the implementation of the Science and Adaptive Management Plan will lead to a range of management actions with the objectives to increase pallid sturgeon recruitment to age 1 and to maintain or increase numbers of pallid sturgeon as an interim measure until sufficient and sustained natural recruitment occurs. The USACE has also amended the previous Proposed Action in the 2017 BA and updated the Science and Adaptive Management Plan to 1) address new information related to pallid sturgeon condition in the upper Lower River and 2) prioritize hypotheses related to flows out of Fort Peck Dam to benefit the pallid sturgeon in the upper Missouri River. The Proposed Action will stabilize or improve the population abundance, and increase survival of the pallid sturgeon through implementation of the Science and Adaptive Management Plan, conservation measures, and Section 7(a)(1) plan.

The definition of "likely to jeopardize" hinges on a change to the reproduction, abundance and distribution of a species such that it appreciably reduces the likelihood of survival and recovery. Therefore, the impacts of the Proposed Action were analyzed to determine the probable effects on reproduction, abundance, and distribution of pallid sturgeon in the Action Area. The Proposed Action is not likely to reduce the current reproduction, abundance or distribution of the pallid sturgeon. In fact, the overall effect of the Proposed Action including the emphasis on the 7(a)(1) program, and Science and Adaptive Management Plan are likely to lead to an improvement in each of those factors. It follows then that they are not likely to reduce appreciably the likelihood of both survival and recovery of the pallid sturgeon. Based on that rationale, and after reviewing the current status of pallid sturgeon, the environmental baseline for the action area, the effects of the Proposed Action, and the cumulative effects, it is the Service's biological opinion that implementation of the Proposed Action is not likely to jeopardize the pallid sturgeon.

7. PIPING PLOVER – STATUS OF THE SPECIES AND CRITICAL HABITAT RANGEWIDE

7.1 Status of the Species

The piping plover was listed on January 10, 1986, under provisions of the ESA of 1973, as amended (Service 1985). Piping plovers breed in three geographic regions of North America: beaches of the Atlantic Coast from North Carolina to Newfoundland; shorelines of the Great Lakes; and, along alkaline wetlands and major rivers and reservoirs of the Northern Great Plains (NGP, Figure 5; Service 2017). The three breeding populations are recognized and treated separately in the final rule listing the piping plover across its range: the Atlantic and Northern

Great Plains (NGP) piping plover are each classified as threatened and the Great Lakes piping plover as endangered (Service 1985).

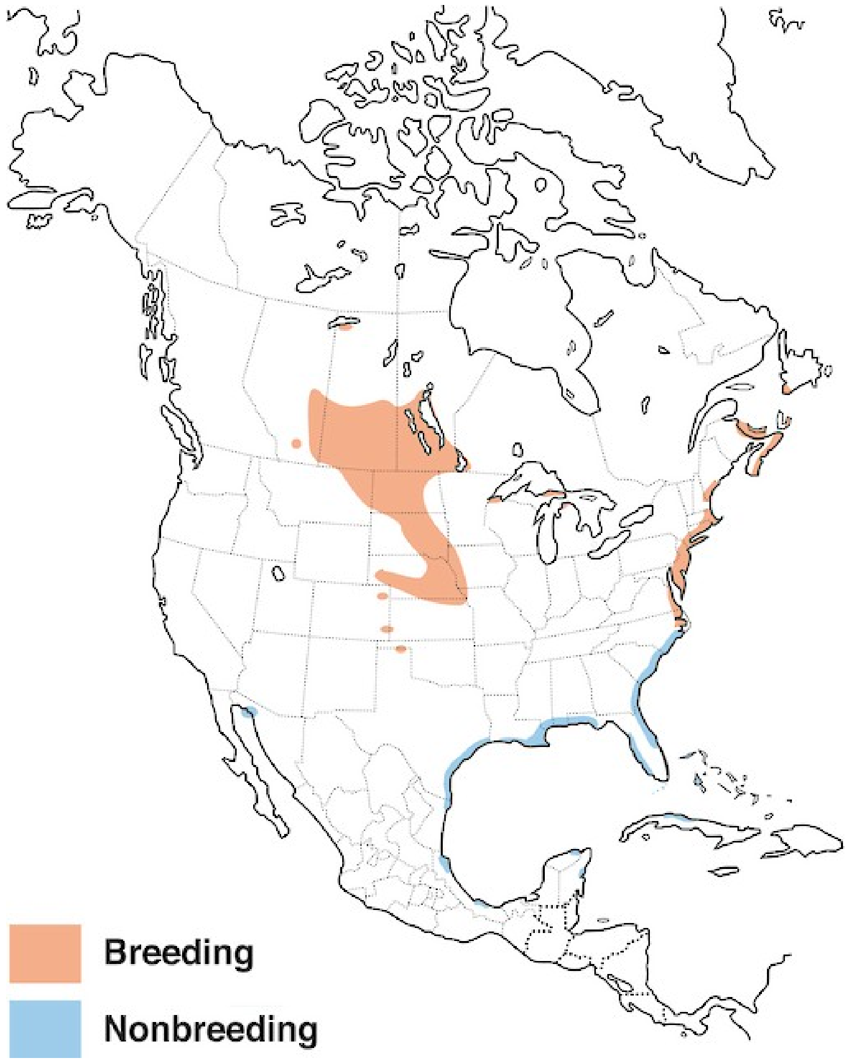

Figure 5. Piping plover range map. Source: Birds of North America Online http://bna.birds.cornell.edu/bna maintained by the Cornell Lab of Ornithology.

Populations on all three portions of the range have increased since listing. The Atlantic Coast population has increased from approximately 790 pairs in 1986 to 1,941 in 2016 (Service 2017). Likewise, the Great Lakes population has increased from an estimated 12 pairs in 1984 to 76 unique nesting pairs in 2017 (Cuthbert and Saunders 2017, p. 36). Unlike on the Great Lakes and Atlantic Coast where breeding piping plovers are censused annually, counts of NGP piping plovers occur only once every five years during the International Piping Plover census. The results of this census indicate that NGP piping plovers are the most numerous among the three, with an estimated 2,953 individuals in 1991 (1,981 in the U.S. excluding Canada) and an estimated 4,662 individuals in 2006 (2,959 in the U.S. excluding Canada, Ferland and Haig 2002; Elliott-Smith et al. 2009). The breeding census fell to 2,249 on the NGP in 2011 due to extreme flooding on the Missouri River and high water levels elsewhere in this geographic area (Elliott-Smith et al. 2015). Results from the 2016 census are not yet available.

The criteria of the Service's *Draft Revised Recovery Plan for the Northern Great Plains Piping Plover* (Service 2016) call for stable or increasing numbers of nesting birds and sufficient habitats spread throughout the range of the population. This includes the following regions (Figure 6):

- Southern Rivers (Missouri River system from Fort Randall Dam, South Dakota to Ponca, Nebraska, the Niobrara River, the Loup River system and the Platte River system),
- Northern Rivers (Missouri River system from Fort Peck Lake, Montana to Pierre, South Dakota),
- U.S. Alkaline Lakes,
- Prairie Canada.

The action area for this biological opinion contains the Northern Rivers Recovery Region, which encompasses the Missouri River system on Fort Peck Lake, Montana to Pierre, South Dakota and part of the Southern Rivers Recovery Region, which encompasses the Missouri River system from Fort Randall Dam, South Dakota to Ponca, Nebraska. This recovery region also includes breeding grounds outside of the action area along the Niobrara River, the Loup River system and the Platte River system (Service 2016, p. 23). There is historical evidence that the Missouri River was inhabited and important to the piping plover before the dams were constructed. Lewis and Clark observed the plover on sandbars in the Missouri River between Iowa and Missouri in 1804 (Swenk 1935). The final listing rule (Service 1985, p. 50729) cites references that contain further evidence of the presence of the species on the upper Missouri River system prior to extensive European settlement and regulation of these rivers.

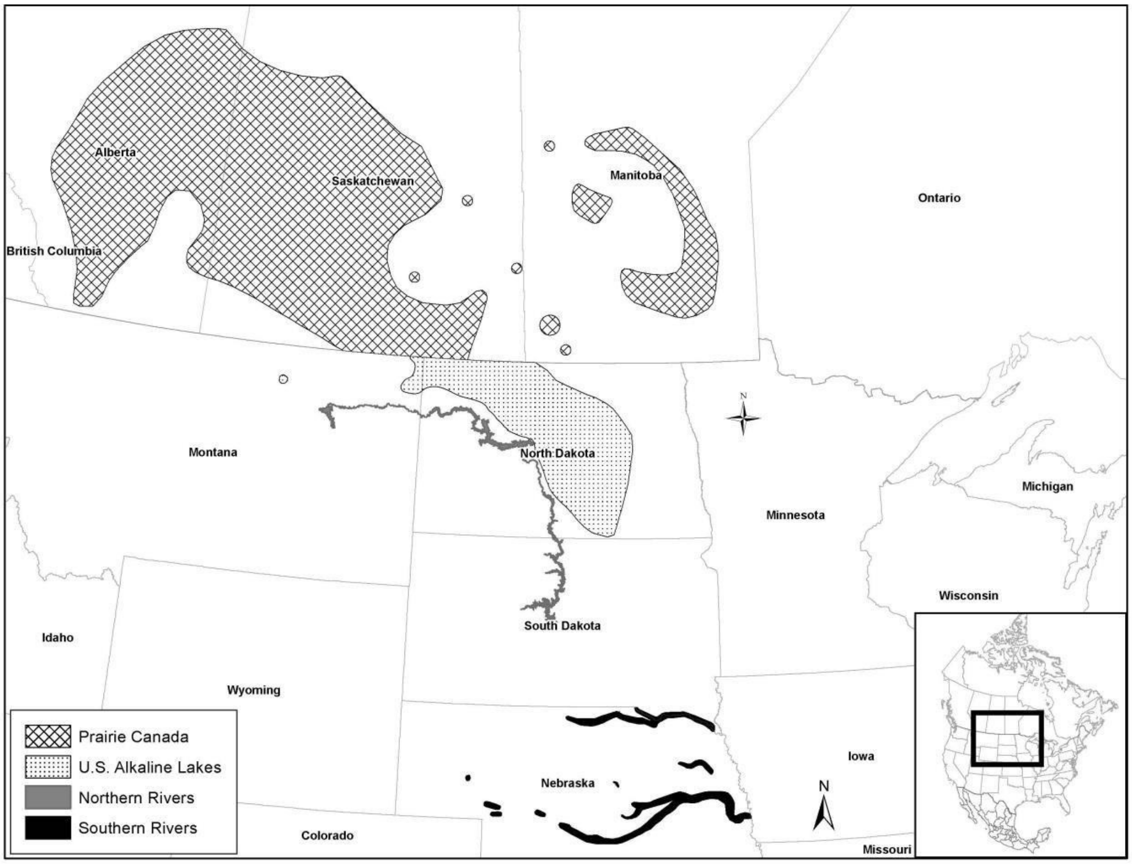

Figure 6. Four recovery regions for the Northern Great Plains piping plover population breeding range. Adapted from Service 2016, p. 24).

The U.S. Alkaline Lakes Recovery Region includes areas where piping plovers nest on alkaline (naturally salty) lakes in North Dakota, and Montana. Small numbers – 33 birds reported in the 2006 International Census – breed in Colorado, Iowa, Kansas, and Minnesota (Elliott-Smith et al. 2009). The Prairie Canada Recovery Region includes alkaline and freshwater lakes and reservoirs in Alberta, Saskatchewan, Manitoba, and Ontario (Environment Canada 2006; Service 2016, p. 23).

Some breeding areas in the U.S. Alkaline Lakes Recovery Region that are near the Missouri River support relatively stable numbers of piping plovers and are typically exposed to environmental influences that are distinct from those that affect birds nesting on the Missouri River (Figure 6). This helps to buffer the numbers of piping plovers nesting on the Missouri River in the Northern Rivers Recovery Region. The greater stability of populations in the U.S. Alkaline Lakes Region is due in part to asynchrony among the factors that influence the numbers of piping plovers that nest across this region. Populations on the Missouri River are typically "highly synchronous" (Roche et al. 2016, p. 568). Piping plovers move among alkaline lake habitats and between alkaline lakes and the Missouri River, especially around Lake Sakakawea, further contributing the persistence of the Missouri River population (Roche et al. 2016, p. 567). Although atypical, in some years important environmental drivers are in sync between the two habitat types as occurred in 2011 when water levels were high and nesting was low in both habitat types (Roche et al. 2016, p. 568).

The role that Missouri River plays towards recovery of the NGP piping plover is also well articulated in the Science and Adaptive Management Plan: "…to meet the range-wide goal of conserving piping plovers across as much of their historical distribution as possible and in the full breadth of its known habitats, the MRRP should focus on providing in-channel habitat in an extent and condition sufficient to support stable demographic units that can persist in the face of dynamic environmental conditions." On the Missouri River, pre-dam development flows declined over the summer as tributary flows decreased. Today, these flows generally increase during the breeding season to provide for downstream human needs. This means that less sandbar habitat is available over the course of the summer, rather than more, as would have been the case prior to dam construction.

As with the U.S. Alkaline Lakes Region in the north, in the Southern Rivers Region, the Platte River subpopulation appears to act "as a stabilizing buffer regardless of the high-flow return interval" on the Missouri River. This population relies on human created off-channel habitats for its persistence due to the "limited potential for consistent" nesting success at on-channel sites (Farnsworth et al. 2017, p. 10; Catlin et al. 2016, p. 13; Zeigler et al. 2017, p. 12-13). Moreover, the number of piping plovers that nest in the vicinity of the Platte River is small with 43 breeding pairs counted in 2016 (Keldsen and Baasch 2016). At nine managed sites along the central Platte River, the species has maintained high levels of productivity with the assistance of habitat management but additional measures, such as woody vegetation removal or the use of root plows (U.S. Forest Service 2010), could further increase productivity and the amount of suitable habitat (Baasch et al. 2017, p. 247).

The productivity of piping plovers in parts of the U.S. Alkaline Lakes Recovery Region affects positively the numbers that nest in the Northern Rivers Recovery Region, but the ability of habitats on the alkali lakes to function as nesting habitat is vulnerable to certain threats. Consolidation drainage of wetlands and climate change may reduce habitat availability on alkali lakes (McCauley et al. 2016, p. 9). Consolidation drainage removes water from some wetlands and concentrates it in undrained wetland basins, resulting in higher water levels in the latter that reduce or eliminate nesting and foraging habitat for piping plovers. Climate change, if it results in warmer and wetter conditions in the range of the NGP piping plover, could also raise water levels in wetlands and reduce habitat availability on alkali lakes (McCauley et al. 2016, p. 9). These threats emphasize the importance of maintaining viable subpopulations among all regions currently inhabited by NGP piping plovers, including Missouri River habitats.

7.2 Critical Habitat Description

Critical habitat was designated for the Northern Great Plains piping plover on September 11, 2002 (Service 2002). Nineteen critical habitat units originally contained approximately 183,422 acres of prairie alkaline wetlands, inland and reservoir lakes, and portions of four rivers totaling approximately 1,943 river km in Montana, Nebraska (excluding the portion of the Missouri River adjacent to Nebraska counties; Loup; Niobrara, Elkhorn, and Platte Rivers), South Dakota, North Dakota, and Minnesota. Estimates reflect the total area or river miles within critical habitat unit boundaries, without regard to the presence of primary constituent elements.[6] Lands designated as critical habitat are under private, Federal, Tribal, and State ownership.

To assess the effects of actions on critical habitat it is necessary to understand how the action is likely to affect the primary constituent elements. The Service described different primary constituent elements for the various types of habitat used by NGP piping plovers in the final rule (Service 2002, p. 57643).

On *prairie alkali lakes and wetlands*, the physical primary constituent elements include—(1) Shallow, seasonally to permanently flooded, mixosaline to hypersaline wetlands with sandy to gravelly, sparsely vegetated beaches, salt-encrusted mudflats, and/or gravelly salt flats; (2) springs and fens along edges of alkali lakes and wetlands; and (3) adjacent uplands 61 m above the highwater mark of the alkali lake or wetland.

On *rivers* the physical primary constituent elements include – sparsely vegetated channel sandbars, sand and gravel beaches on islands, temporary pools on sandbars and islands, and the interface with the river.

On *reservoirs* the physical primary constituent elements include – sparsely vegetated shoreline beaches, peninsulas, islands composed of sand, gravel, or shale, and their interface with the waterbodies.

On *inland lakes (Lake of the Woods)* the physical primary constituent elements include—sparsely vegetated and windswept sandy to gravelly islands, beaches, and peninsulas, and their interface with the water body.

On the Northern Great Plains, the suitability of beaches, sandbars, shoreline, and flats as piping plover habitat types is dependent on dynamic hydrological system of wet-to-dry cycles. Habitat area, abundance and availability of insect foods, brood and nesting cover, and lack of vegetation are linked to these water cycles. On rivers, one site becomes flooded and erodes away as another is created. More importantly the high flows on rivers create a complex of habitats for feeding, nesting, and brooding (Vander Lee et al. 2002). This dynamic nature of rivers, as well as flow regulation, is important to long-term habitat creation and maintenance for piping plovers. On alkali lakes, the complex of different wetland types is especially important for providing areas for plovers feeding, nesting, and brooding in all years, due to fluctuations in precipitation that alter local habitat suitability.

7.2.1 Relationship of Critical Habitat to Habitat Needed for Recovery

The USACE plans to monitor the extent of emergent sandbar islands in the action area. This will serve appropriately as an index to the extent of critical habitat in the action area that contains the

[6] Primary constituent elements is a term used in Endangered Species Act critical habitat rules to describe features that are essential to the conservation of a species and upon which its designated or proposed critical habitat is based. This term has recently been replaced by the term, "physical and biological features," but here we use the terminology from the Service's 2002 final rule that designated critical habitat for the piping plover. Removing the phrase "primary constituent elements" did not substantively alter anything about the designation of critical habitat, but was intended to eliminate redundancy in how the Service describes the physical or biological features. 81 Fed. Reg. 7414-01 (2016).

primary constituent elements. The Service designated critical habitat in the Ft. Peck Reservoir as acres [77,370.0 acre (31,310.6 ha)], but elsewhere on the Missouri River as river miles or shoreline miles. The monitoring of the extent of emergent sandbar islands along the riverine reaches of the Missouri River that is carried out by the USACE and that is supported by the draft recovery plan (Service 2016) serves as an indication as to the extent of the critical habitat area on the Missouri River that contain the primary constituent elements. The USACE plans to maintain and monitor suitable habitat for the piping plover as analyzed immediately below and in the Piping Plover – **Effects of the Action** section, below. With the exception of the Missouri River, the extent of the critical habitat area that contains the primary constituent elements has not been mapped comprehensively (Service 2016, p. 60).

7.2.2 Analysis of the Effects to Piping Plover Critical Habitat in this Biological Opinion

The analysis of effects contained in the USACE BA and in this biological opinion is largely based on effects to the quantity and qualities of piping plover habitats on the Missouri River. The elements considered in the analysis of effects to the species repeatedly address the primary constituent elements of piping plover critical habitat for both rivers and reservoirs, which are described in section 7.2, above. Therefore, the basis for our conclusion of the action's effect on piping plover critical habitat is supported primarily by the information contained in section **8.3 Factors Affecting Species Environment within the Action Area and section 9.2 Analysis for Effects of the Action and Species' Response to the Action – especially the sub-section, Creation or Modification of Habitat**.

7.3 Life History and Ecology

Piping plovers begin to arrive on the breeding grounds in the first half of April, with courtship, followed by nesting, beginning in mid-to-late April (Catlin and Fraser 2006; Catlin and Fraser 2007; Felio et al. 2009; Felio et al. 2010a; Felio et al. 2010b; Shaffer et al. 2013). The male creates a shallow depression on the ground which both adults line with small pebbles and both sexes share incubation duties.

Hatching begins in late May to early June, generally peaking in June and early July (Catlin 2009). The young leave the nest within hours of hatching and begin to forage almost immediately (Wilcox 1959, Haig 1992). Chicks may be brooded by adults for up to 21 days post-hatch (Haig and Oring 1988; Haig 1992; Maxson 2000) and become independent 25 to 35 days after hatching; they are capable of sustained flight soon after fledging (Knetter et al. 2001; Catlin et al. 2013). Piping plovers readily renest if earlier nests fail (Whyte 1985; Haig 1987). They generally only raise one brood a season, although they have been documented to raise two broods on rare occasions (Bottitta et al. 1997). Piping plovers begin to leave the breeding grounds as early as mid-July, with adults leaving first and juveniles last (Elliott-Smith and Haig 2004).

Piping plovers forage on various macroinvertebrates at the soil surface and may consume prey species based on availability (Shaffer and Laporte 1994), although one study of fecal material on the Northern Great Plains suggests that birds selected for beetles (Coleoptera) over flies (Diptera) (Le Fer 2006). A study comparing prey base on the alkaline lakes, a reservoir (Lake Sakakawea, North Dakota) with sandbars below Garrison Dam, North Dakota (a cold water release dam), and Gavins Point Dam, South Dakota (a warm water release dam) determined that the prey biomass was lowest below the cold water release dam (Le Fer 2006).

Plovers on the alkaline lakes fledge at a younger age than those on the Missouri River system (Murphy et al. 1999; Catlin 2009). This may be a result of greater food availability on the alkaline lakes than on the Missouri River (Le Fer 2006).

8. PIPING PLOVER - ENVIRONMENTAL BASELINE

8.1 Status of the Species within the Action Area

Buenau (2015, p. 3) describes succinctly the distribution of the piping plover in the action area as the Missouri River Mainstem from the upper bounds of Lake Sakakawea (River Mile 1,568) through Ponca, Nebraska (River Mile 753) (Figure 7). The absence of habitat on Lake Sharpe and Lake Francis Case, between Oahe and Fort Randall Dams (River Miles 1,072 to 880) creates a dispersal barrier between the Northern and Southern Regions of the piping plovers' breeding range on the river and therefore the range has been divided into two demographic units. The Northern Region consists of riverine habitat on Garrison Reach and shoreline habitat on Lake Sakakawea and Lake Oahe. The Southern Region consists of riverine habitat on Fort Randall and Gavins Point Reaches, as well as the sandbars in the delta of Lewis and Clark Lake, which does not provide reservoir shoreline habitat. The Niobrara River, the Loup River system, the Platte River system, U.S. Alkali Lakes and the Prairie Canada Recovery Regions are not located within the Action Area.

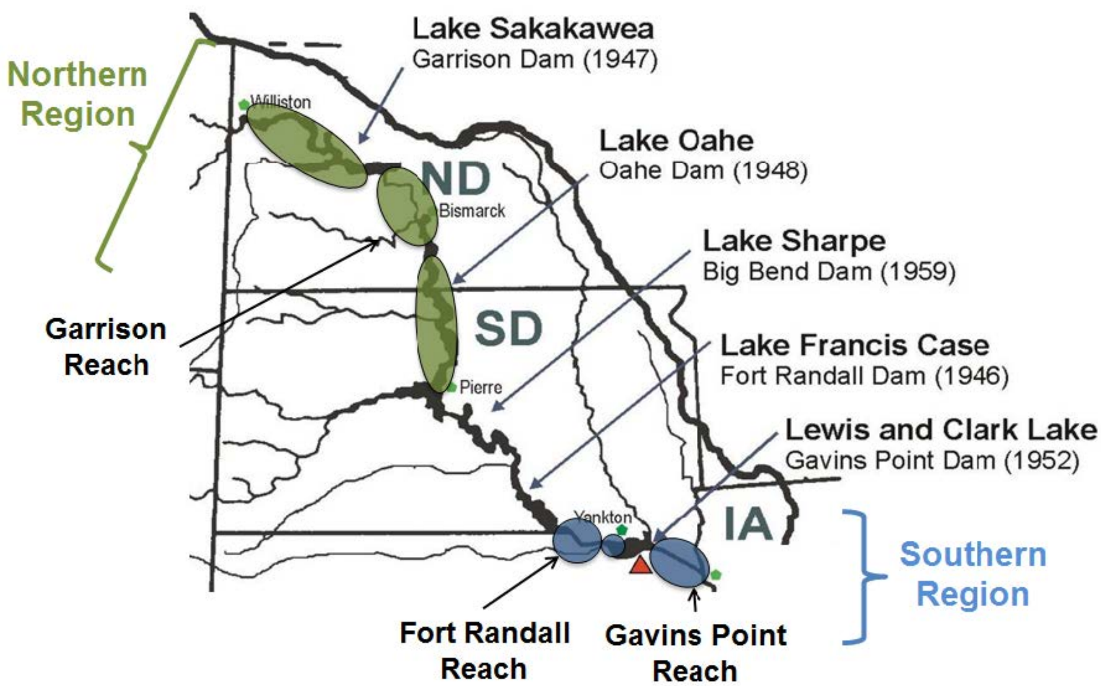

Figure 7. Breeding areas for the piping plover on the Missouri River. Adapted from USACE 2016, p. 164.

Since monitoring began in 1986, piping plover adult numbers on the Missouri River have ranged "from a low of 82 in 1997 to a high of 1,832 in 2016" (USACE 2017, p. 123). Abundance increased after floods in 1996 and 1997 created new and productive habitat and then began to decline until after the 2011 flood (Figure 8). Low runoff for several years led to a multi-year drawdown in reservoir levels that provided large amounts of breeding habitat and slowed the pre-

2011 decline (USACE 2017, p. 124). Mechanical habitat creation by the USACE also began in 2004 (Service 2016, p. 30).

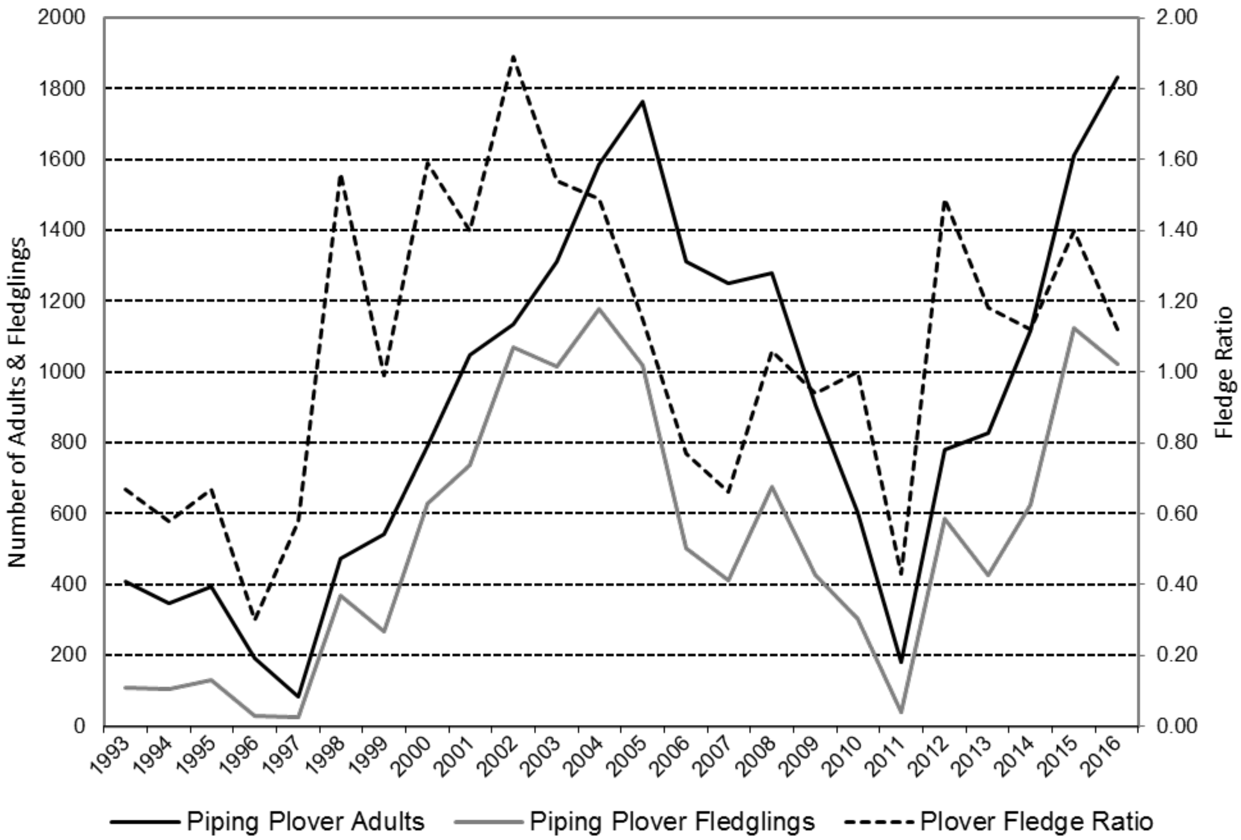

Figure 8. Piping Plover Adult Census and Fledge Ratios for Missouri River (1993–2016). Adapted from USACE 2017, p. 124.

8.2 Status of the Critical Habitat within the Action Area

The extent of the critical habitat that supports the primary constituent elements on the Missouri River fluctuates and is now higher than it was at the time of the final critical habitat designation in 2002. The USACE does not monitor the status of the primary constituent elements, per se, but does monitor the amount of emergent sandbar habitat in the riverine reaches. This area is approximately equivalent to the extent of the riverine reaches where primary constituent elements are present. After 2002, the extent of ESH in the Northern Rivers Region declined from 768 to 593 acres (Service 2016, p. 138); the amount of ESH then increased after 2006. It peaked in 2012, reaching levels markedly higher than were present at the time of critical habitat designation in 2002. In 2017, available ESH on the Missouri River was 3,173 and 6,608 acres in the Northern Region and Southern Region, respectively – well above the amounts in 2002 (USACE 2018; Service 2016, p. 138).

8.3 Factors Affecting Species Environment within the Action Area

Buenau et al. (2016) describe the primary and secondary physical factors that drive the "ecosystem structure and function" that affects interior least terns and piping plovers in the action area. They define primary physical factors as the "environmental conditions that drive ecosystem structure and function" and secondary physical factors as "the hydrological and geomorphological responses to primary physical factors, which create the conditions that are directly experienced by terns and plovers on the Missouri River" (Buenau et al. 2016, p. 3). These secondary physical factors are described by Buenau et al. (2016, p. 7-8):

- Nesting season reservoir levels (water elevation);
- Nesting season river stage;
- Sediment transport;
- Channel width;
- Sandbar morphology and complexity; and
- Shallow water.

Each of these secondary physical factors is relevant to both terns and plovers, except for shallow water habitat, which provides foraging habitat for terns, but is not relevant to piping plovers (Buenau et al. 2016, p. 8). The primary physical factors to which the secondary physical factors respond are: basin runoff, dam releases from May through August; dam releases from September through April; tributary discharge; channel form; and sediment supply.

The BA (USACE 2017) provides a review of the increases and decreases in available piping plover habitat along the river and reservoirs since about 1996 that were due primarily to high flow events in 1996, 1997, and 2011 and the subsequent erosion and vegetation of sandbars, respectively (USACE 2017, p. 110-111). In addition, the USACE has constructed 872 acres of Emergent Sandbar Habitat from 2004 to 2011, and treated over 5,900 acres of sandbars through vegetation management practices since 2004 (USACE 2017, p. 13).

Piping Plovers – Key Factors

The following are the key factors that directly affect the discrete life stages and life stage transitions of the piping plover with special relevance to the action area. They are adapted from Buenau et al. (2016, p. 3-5; 8-10). Each is discussed here briefly and in more detail below, under Factors to be Considered.

- *Nesting and brooding habitat* – Piping plovers locate their nests in sparsely vegetated dry sand, gravel, and cobble. The quantity of nesting and brooding habitat is determined by (1) river stage and reservoir level; (2) the magnitude of previous flows that were capable of building habitat and scouring vegetation from sandbars and shorelines and the time since those flows occurred; the extent of habitat creation; and, possibly, habitat management (vegetation removal). Piping plover habitat is created naturally on the Missouri River by high-flow events and declines quickly due to erosion and vegetation growth (Buenau et al. 2014, p. 973; Zeigler et al. 2017, p. 9). "Extensive nesting habitat was created in the action area, particularly in the segment between Gavins Point Dam and Ponca State Park, by high flows during 1996, 1997, and 2011" (USACE 2017, p. 110).
- *Foraging habitat* for piping plovers consists of sparsely vegetated wet sand along sandbars and reservoirs. Key determinants of foraging habitat quantity include sandbar complexity, river stage or reservoir level, and the effects of prior habitat-forming flows and engineered habitat creation.

- *Nest elevation and location* – breeding adult piping plovers locate nests near foraging habitat to ensure a food supply for themselves and their offspring. Nest elevation is also determined by the slope between nesting habitat and foraging habitat and distance to trees or other vegetation that may provide perches or cover for predators.
- *Nest density* is a function of the extent of nesting habitat and population size. Nest density increases as nesting habitat is reduced in extent due to low levels of habitat creation, resulting in increased nest predation and agonistic interactions among plovers.
- *Predation on eggs, chicks, fledglings, or adults* – The incidence of predation increases with density of nests, chicks, and fledglings and when distances between predator perches or cover and nests are reduced. The placement of cages around nests can decrease predation of nests, but marginally increases the likelihood of adult predation and nest abandonment.
- *Agonistic behavior* – aggressive behavior by adults towards unrelated chicks increases as density of chicks increases. It sometimes results in death of affected chicks. Sublethal effects to chicks may include worsened body condition that can lead to reduced survival (Buenau et al. 2016, p. 9).
- *Immigration and emigration* – piping plovers have high site fidelity and dispersal is limited to relatively short distances.

Additional factors that affect piping plover survival and abundance in the action area include trampling or other disturbances caused by human activity (including livestock, pets, vehicle use) (Buenau et al. 2016, p. 11); weather – e.g., intense storms; and, breeding habitat availability elsewhere in the range of the Northern Great Plains piping plover – e.g., on alkali lakes and on other rivers. The degree to which immigration between alkali lakes and piping plover habitats in the Northern Region of the action area (Figures 6 and 7) occurs is not yet understood with the level of precision needed to inform habitat targets for the Missouri River habitats, including reservoir habitats. Buenau et al. (2016, p. 11) summarize the ways in which human activity could adversely affect piping plovers, but state that effects are difficult to estimate. They are more likely to occur in proximity to roads, boat launches, and other access points.

9. PIPING PLOVER- EFFECTS OF THE ACTION

9.1 Factors to be Considered

Science and Adaptive Management Plan, Piping Plovers, and Critical Habitat

USACE will implement the Science and Adaptive Management Plan as a central and essential component of the Proposed Action. For the piping plover and interior least tern this means that the USACE will use predictive models as part of a plan to manage risks to the species, address key uncertainties, and identify the scope and scale of actions required to achieve the MRRP objectives (USACE 2017, p. 17). Implementation of the Science and Adaptive Management Plan will rely on an empirical process for “assessing and communicating the current habitat and species status and recommended overall pathway of management” to be followed.

Collaborative implementation of the plan between the USACE and the Service will help to ensure that management decisions are initiated based on the trends in the numbers of piping plovers nesting in the action area, their productivity, and the extent of suitable habitat. The habitat that is a focus of the process – typically referred to as emergent sandbar habitat (ESH) –

represents the amount of the riverine critical habitat in the action area that contains the primary constituent elements. The USACE will base management decisions under the Science and Adaptive Management Plan on whether populations are growing, stable, or declining; population productivity, as measured by fledge ratio; and, whether habitat is above or below ESH targets that are designed to be predictive of the viability of piping plover persistence in the action area (USACE 2016, p. 246-247). In response to an anticipated 25 % probability that ESH levels will fall below targets in 2018 and 2019, for example, the USACE plans to construct ESH in those two years (USACE 2018, p. 24).

The USACE objectives for the piping plover are fully described in the BA and summarized below. USACE will assess and refine the sub-objectives, means objectives, performance metrics, and targets through the AM process as dictated by new scientific information.

Sub-Objective 1 (Distribution): Maintain a geographic distribution of plovers in the river and reservoirs in which they currently occur in both the Northern Region (Missouri River from Fort Peck Lake, Montana, to Fort Randall Dam, South Dakota, including reservoir shorelines) and Southern Region (Missouri River from Fort Randall Dam, South Dakota to Ponca, Nebraska).

Means Objective: Meet sub-objectives 2, 3, and 4 in both the Northern and Southern Regions.

Sub-Objective 2 (Population): Maintain a population of Missouri River piping plovers with a modeled 95 % probability that at least 50 individuals will persist for at least 50 years in both the Northern and Southern Regions.

Means Objective (ESH): Provide sufficient ESH (in-channel riverine habitat) on the Missouri River to meet the persistence target.

Metric: Number of standardized and available ESH acres measured annually.

Target: Targets are shown Table 3. Note that it is anticipated the upper percentile of modeled habitat may only be met following natural flows high enough to create habitat.

Timeframe: Median standardized ESH targets (450 acres in the Northern Region; 1,180 acres in the Southern Region) must be met for 3 out of 4 years. Median available acres must be met or exceeded for the specified percent of years over a running 12-year interval.

Table 3. Piping Plover Targets for Sub-Objective 2. Adapted from USACE 2017, p. 70. Note that these targets will change as models and inputs are refined and updated.

		Acres of Emergent Sandbar Habitat					
		Northern Region			Southern Region		
		2.5 percentile	Median	97.5 percentile	2.5 percentile	Median	97.5 percentile
Standardized ESH Acres		190	450	2,160	330	1,180	4,720
Available ESH Acres Exceeded for Percentage of Years	75%	170	270	555	300	430	720
	50%	420	680	1,295	500	740	1,550
	25%	960	1,920	2,670	750	1,410	3,075
	10%	1,965	3,000	5,165	1,125	2,240	4,945

Sub-Objective 3 (Population Dynamics): Maintain a stable or increasing long-term trend in population size in both regions.

Metric: Population growth rate (lambda; λ): the ratio of population size N between the current year and previous year (Nt/Nt-1); calculated annually.

Target: $\lambda \geq 1$ (a growth rate greater than or equal to 1).

Timeframe: The growth rate target must be met as a 3-year running geometric mean calculated as the cube root of the product of the growth rates for each of the three years (i.e., $(\lambda 1 * \lambda 2 * \lambda 3)^{1/3}$).

Sub-Objective 4 (Reproduction): Maintain fledgling production by breeding pairs sufficient to meet the population growth rate objectives within both the Northern and Southern Regions on the Missouri River.

Metric: Fledge Ratio: Number of fledglings observed/(number of breeding adults/2), calculated annually.

Target: ≥ 1.14 chicks fledged per breeding pair

Timeframe: The fledge ratio target must be met as a 3-year running arithmetic mean.

The ESH targets in the Science and Adaptive Management Plan (Table 3) differ from those contained in the draft recovery plan (Service 2016, p. 57) due to difference in modeling approaches (Buenau et al. 2015, p. 12). The model in the draft recovery plan does not "include habitat dynamics or density dependence and thus cannot reflect the findings of" the Buenau et al. (2015) study. The draft recovery plan is currently undergoing review.

In the recent past, the Sub-Objective 4 has been met only in some years and more frequently in the southern than in the northern piping plover demographic unit. The fledge ratio target was met from 2000 through 2007 in the Southern Region (Figure 9) and from 2000 through 2005 in the Northern Region (Figure 10) (USACE 2017, pp. 125-126). In the Southern Region, except for an anomalous year in 2010, fledge ratios remained below the target from 2008 through

2013. After exceeding the target each year from 2014 through 2016, they again dipped below the target in 2017 when the 3-year arithmetic mean fell to 1.08 (USACE 2018; USACE 2017, p. 125). Fledge ratios have failed to meet the target more frequently in the Northern Region and in 2017 the 3-year arithmetic mean fell to 0.83 (USACE 2018; USACE 2017, p. 126).

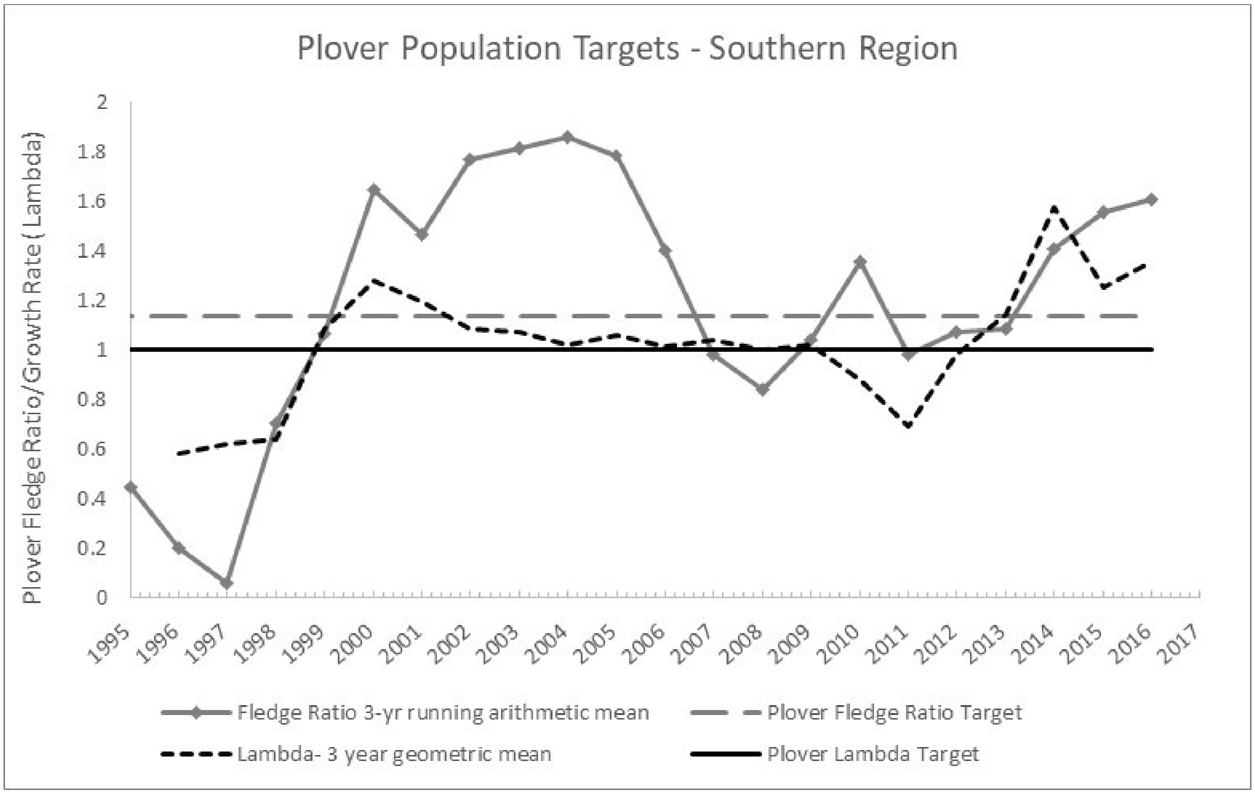

Figure 9. Population Growth Rate, Fledge Ratio, and Targets from 1993 to 2016 for the Southern Region. Adapted from USACE (2017, p. 125). See Figure 12 in the section Natural High Flow Events**, below, for the addition of population growth rate for 2018.**

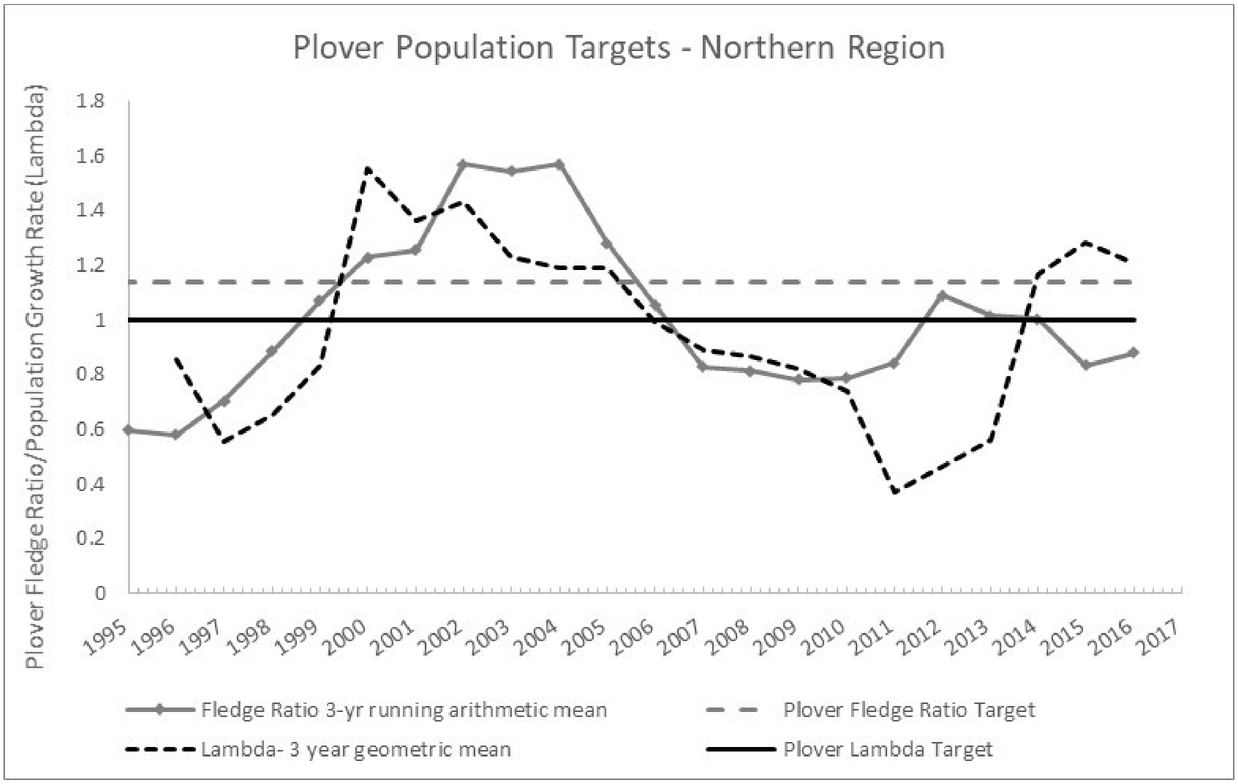

Figure 10. Population Growth Rate, Fledge Ratio, and Targets from 1993 to 2016 for the Northern Region. Adapted from USACE 2017, p. 126. See Figure 13 in the section Natural High Flow Events, below, for the addition of population growth rate for 2018.

Nesting and Brooding Habitat

Piping plover abundance and population dynamics are strongly tied to the extent of nesting habitat, which is dependent on repeated habitat building events over time (Anteau et al. 2014a, p. 1041). Density-dependent factors, including territoriality and competition, limit carrying capacity of available nesting habitat (Baasch et al. 2017, p. 247). As piping plover density increases, several factors begin to limit the productivity of habitats. Piping plovers have adapted to fluctuations in the extent of nesting habitat by increasing reproduction in years after high-flow events to offset low reproduction in years of high water levels (Zeigler et al. 2017, pp. 9-10). Increased dispersal rates and distances are also adaptations to fluctuations in nesting habitat (Zeigler et al. 2017, p. 10), although Buenau et al. (2016, p. 8) suggest that "immigration and emigration to and from the river and among river reaches and reservoir shorelines" is affected by changes in habitat area only "to a relatively small degree."

Re-nesting is another piping plover adaptation to the historical disturbance regime on the Missouri River and elsewhere in the Great Plains (Zeigler et al. 2017, pp. 9-10), but the associated delay in nesting may be costly. Catlin et al. (2014, p. 204) found that fledgling mass and hatch year survival "was higher for chicks that hatched earlier in the season" and "[P]lover chicks that hatch later grow more slowly, are smaller at fledging, and have lower first year survival." Moreover, low fledgling mass reduced juvenile survival following independence and also appeared to affect survival into adulthood.

The composition and structure of potential nesting habitats are also important for piping plovers. Anteau et al. (2012a, p. 3) found that plovers preferred patches that were relatively flat, gravelly, and devoid of vegetation." They "selected sites that had lower relative elevation than random sites" and "for gravel but not pebbles at nest sites," likely due to the camouflaging effect of gravel (Anteau et al. 2012a, p. 4). In their study, piping plovers also selected for at least one cobble at their nest site (Anteau et al. 2012a, p. 4); the authors cited similar findings for other habitats used by the species and suggested that cobbles may hinder the ability of visual predators to easily detect adult plovers on nests (Anteau et al. 2012a, p. 4). First year piping plovers appear to prefer habitats with relatively low densities of adults (Catlin et al. 2015, p. 29).

Increased chick densities have been associated with declines in the growth rates and survival of piping plovers (Catlin et al. 2014, p. 204). Anteau et al. (2014c, p. 201) suggested that fledging rates – survival from chick to fledging – no longer increased with increasing hatchling density greater than about 4-6 hatchlings per acre.

Piping plovers exhibit high site fidelity, but are also adapted to dynamic habitat conditions and can disperse to find habitats with sufficiently low density of conspecifics as long as they are within the species' dispersal capacity (Catlin et al. 2015, p. 30, 34; Catlin et al. 2016, p. 12). If sites used in prior years are gone or too crowded, piping plovers may use other habitats within a limited distance (Catlin et al. 2016, p. 12-13). Loss of habitat may result in decreased connectivity among sites on the Missouri River, which may greatly reduce their ability to avoid local extirpation (Zeigler et al. 2017 p. 11).

Foraging

In addition to the extent of nesting habitat, the quality and extent of habitats for foraging must also be taken into account. Piping plovers forage on sparsely vegetated wet sand along sandbars and reservoirs that is adjacent to nesting areas. Piping plovers may discriminate among potential nesting sites based on food availability in adjacent foraging habitats. Davis et al. (2017, p. 100) found that second year breeders nested preferentially on forage rich sandbars. A decline in prey abundance and corresponding effects on chick body condition and growth rates occurred as soon as two years after the large 2010-2011 flood (Hunt 2016; Hunt et al. 2017, p. 760). On the Missouri River piping plovers selected protected shorelines over exposed shoreline and prey indices were higher in the former (Le Fer et al. 2008, p. 590). On Lake Sakakawea, "fledging rates were lower in areas that were more exposed to wind and waves than in areas that were more protected" (Anteau et al. 2014c, p. 202). Le Fer et al. (2008, p. 591) documented the prey production capabilities of "moist and saturated shoreline habitats" and suggested that flows may be managed to maintain their availability "throughout the piping plover breeding season."

Predation

Predation is typically responsible for most mortality during the egg to chick and chick to fledging stages for piping plovers and reduced predation plays a major role in the increased reproductive output that occurs after major habitat-forming flow events (Figures 10-11; Baasch et al. 2017, p. 246; Hunt et al. 2017, p. 762; USACE 2017, p. 127). Piping plovers appear to select nesting sites with features that minimize the likelihood of predation. The Missouri River corridor is largely forested, which increases risk of predation of nests and adults (Catlin et al. 2015, p. 31). Since 1892, however, the forest has changed from patches of forest surrounded by wetlands and prairie to a thin line of gallery forest between the river and agricultural fields (Catlin et al. 2015, p. 31). Reductions in sandbar habitat area that occur in the absence of habitat-forming flows also concentrate piping plover nesting habitat and may increase the vulnerability of piping plovers to avian predators that hunt from perches, such as the great horned owl (*Bubo virginianus*, Catlin et al. 2015, p. 31). In addition, Hunt et al. (2017, p. 762) found that chick body condition was unchanged after the 2011 flood, but that the improvement in piping plover demography after the floods appeared "to be driven by an increase in habitat and a decrease in predation." Despite the decline in body condition of chicks as the post-flood habitat aged, survival to fledging remained high.

The predominant predators of piping plover nests vary among sites in the action area and may change within sites as habitat conditions change. Predation may also be locally high on islands where nesting gulls (*Larus* spp.) are present. Predation of chicks was higher on islands where gulls nested than on reservoir shorelines on Lake Sakakawea and it may have been a major cause of the 4.3 times higher fledging success among mainland broods (Anteau et al. 2014c, p. 195, 202). Catlin et al. (2015, p. 31) found higher reproductive success in a stretch of the Missouri River where the distance between piping plover nesting habitat and the tree line was relatively large and where there were fewer great horned owls.

Nest Elevation and Location

Nest elevation and location are determined by preferences of piping plovers for locations near foraging habitat; for gravel substrates that help to camouflage nests; and, to minimize predation. Plovers are likely to nest where gravel is abundant and "at elevations near the shoreline (Anteau et al. 2014b, p. 24). Piping plovers have adapted to historic flow regimes by laying eggs immediately following the peak of spring runoff and by the ability to renest up to four times during the breeding season in response to nest loss (Zeigler et al. 2017, p. 10). Piping plovers generally avoid nesting near bluffs, perches for avian predators, and wooded areas that may also provide cover for other predators (Anteau et al. 2014a, p. 1040; Baasch et al. 2017, p. 246).

Agonistic Behavior

Increased density may result in decreased chick survival as a result of an increase in aggressive interactions among piping plovers. There is evidence that adult piping plovers attack and kill young plovers from other broods (Catlin 2009, p. 43).

9.2 Analysis for Effects of the Action and Species' Response to the Action

The variability of the Missouri River system and the need to balance multiple and often competing objectives "support a toolbox approach to managing for plovers and terns" (USACE 2016, p. 177). Buenau et al. (2016, p. 33) placed the contents of this toolbox into the following general categories – flow modification and management; creation or modification of habitat; biotic interventions. The USACE reflected this categorization in its Science and Adaptive Management Plan. We group our analysis of effects into similar categories below and conclude with a focus on the adaptive management approach that has been adopted by the USACE and modeling that is done to inform that approach.

Flow Modification & Management

Management of intra-annual flows during the breeding period has the potential to affect piping plovers in both positive and negative ways. The USACE may manage flows specifically to benefit the species by minimizing inundation of nesting and foraging areas during the breeding season (early May through mid-August) and by the use of high flows when the species is not present to create and restore habitats. USACE dam operations, however, including storage and releases, flood control operations, and releases to meet downstream navigation target flow levels, inundate nests regularly or cause nests to be washed out by wave action (USACE 2017, p. 129). In addition, cold water releases from Garrison Dam may also affect piping plovers by limiting prey biomass compared to areas that receive warm water releases (Le Fer 2006).

Inundation of Nesting Habitat and Foraging Habitat

Losses of eggs due to inundation can be substantial and has been recorded mostly in reservoirs (Figure 11). It may be “the greatest threat to nest success for plovers” at Lake Sakakawea (Anteau et al. 2012b, p. 1176). Plovers’ preference to nest in relatively low locations at Lake Sakakawea, for example lead to nest failures when water levels were increased in the reservoir (Anteau et al. 2012b, p. 1175). In this case, the species’ adaptive preferences for nesting sites are foiled when increases in water levels occur in opposition to historical patterns. USACE sometimes attempts to save at-risk nests by moving them to elevations that may be safe from inundation (USACE 2017, p. 129).

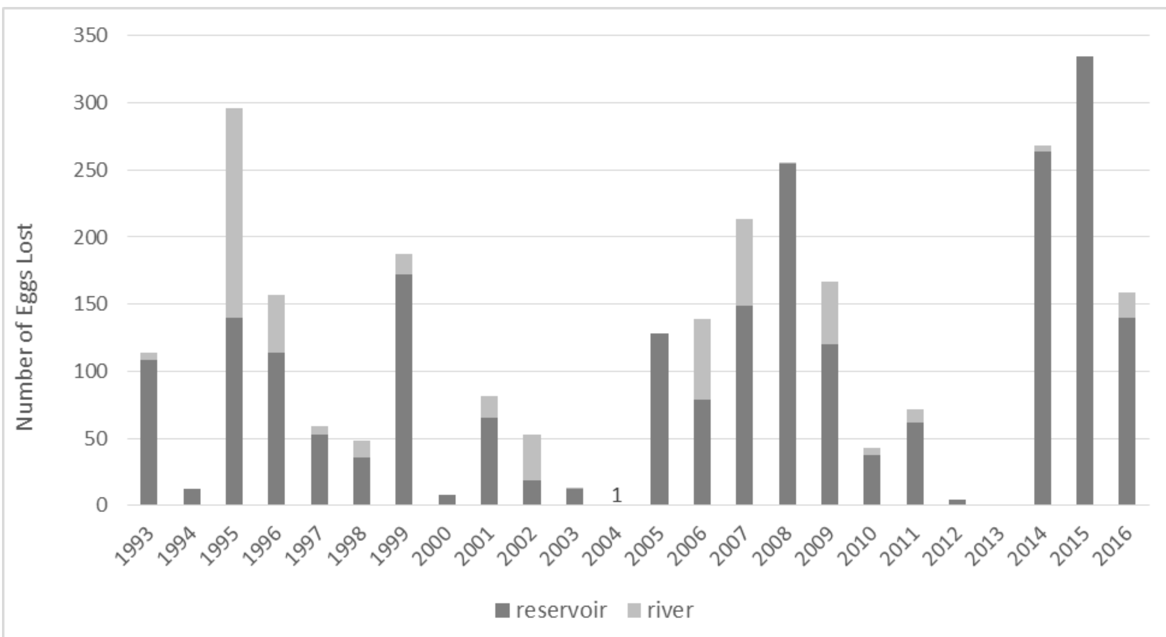

Figure 11. Total Observed Piping Plover Incidental Take on the Reservoirs and River Segments due to USACE Operations on the Missouri River, 1993–2016. Adapted from USACE 2017, p. 130.

The USACE, in cooperation with the Service, has adopted a variety of flow scenarios in an attempt to minimize the adverse effects of flow changes on piping plovers and interior least terns on the river (Table 4).

Table 4. Flow scenarios

Flow Scenario	Description (USACE 2017, p. 50)	Effects to Plovers
Steady Release	When the birds begin to initiate nesting activities in early to mid-May, the release from Gavins Point is set to the level expected to meet downstream flow targets for navigation on the lower Missouri River through August and maintained at that level until the end of the nesting season.	Reduced nesting and foraging habitat (USACE 2017, p. 143); releases exceed the amount necessary to meet downstream flow targets during the early portion of the nesting season.
Flow-to-Target	Releases under the flow-to-target scenario are adjusted as needed throughout the nesting season to meet downstream flow targets and would typically result in increasing releases as the nesting season progresses. "…used in rare occasions during drought years and when nesting habitat is abundant."	Relatively high likelihood of nest inundation on low-lying habitat.
Steady release, and flow-to-target	Sets Gavins Point releases at an initial steady rate and then allows releases to be adjusted upward or downward during the nesting season to meet downstream flow targets, if necessary.	Relatively high amounts of habitat available downstream of Gavins Point early in the season. Lower likelihood of nest inundation compared to flow-to-target. Encourages plovers to nest at higher elevations due to increased flows at the beginning of the nesting season.

Under each of these scenarios, the USACE may increase releases from Gavins Point every third day to encourage terns and plovers to build their nests on higher habitat to minimize nest inundation ("cycling flows"; USACE 2017, p. 51). After hatching, cycling is suspended and replaced with one of the three primary scenarios "to reduce the risk of stranding chicks on low-lying sandbars" (USACE 2017, p. 51). Cycling of Gavins Point has also been used to reduce the likelihood of nest inundation when the USACE keeps early flows low to mitigate the effects of downstream flooding and anticipates increased releases when downstream flooding has subsided.

In July and part of August the USACE typically sets releases from Garrison Dam lower "to increase rearing and foraging habitat", which could also minimize the likelihood of inundation for any remaining nests (USACE 2017, p. 51). The USACE may adjust or reduce peaking pattern at Garrison and Fort Randall Dams depending on hydrologic conditions during the nesting season to minimize take (USACE 2017, p. 51).

Although a reduction in nest inundation is beneficial, higher releases from Gavins Point Dam were associated with slowed growth, delayed fledging, and lower daily survival of piping plovers (Catlin et al. 2013, 532). High releases from Gavins Point Dam occur in either of the steady release scenarios, but also as a result of "cycling" flows, which may be used under any of the three primary scenarios (Table 4; USACE 2017, p. 50-51). High outflows cover wet sand habitats used by plovers for foraging. Moreover, when natural habitat was exposed in years due to relatively low releases from the Gavins Point Dam, site fidelity of plovers hatched from study sites increased (Catlin et al. 2015, p. 35).

To ensure nest success in areas subject to water level rises, shoreline areas of reservoirs with features that attract nesting plovers must be higher than the areas that are likely to be inundated. In their study along Lake Sakakawea, for example, Anteau et al. (2014b, p. 24) found that plovers were likely to experience ecological trap conditions when water levels at the beginning of the nesting season are between 554 and 563 m mean sea level, and rise >2 m during the nesting period. In years when a large amount of habitat is available for nesting plovers on the reservoir, inundation of the habitats after nest initiation could have substantial negative impacts on reproduction (Anteau et al. 2014b, p. 25).

Nest and Chick Relocation

The USACE in collaboration with the Service and others developed the *Contingency Plan for Protection of Least Tern and Piping Plover Nests and Chicks* (USACE 2017, App. E) that includes guidelines for protecting piping plover and interior least tern "nests and chicks threatened with termination due to natural events, inundation due to poor nest selection under normal system operation, or flood control operations." These guidelines will likely result in the movement and elevation of interior least tern and piping plover nests; and, the capture and relocation of piping plover chicks and adults.

Creation of Habitat through Flows

The USACE is not currently proposing the use of habitat-forming flows, but they are discussed as a potential tool to meet ESH targets in the Science and Adaptive Management Plan. Therefore, we will discuss this potential tool in this biological opinion.

Increased flows engineered during the fall and spring when piping plovers are not present may be used to increase nesting and foraging habitat, but their impact is likely in direct proportion to their magnitude. Fall flow releases "increase the area and complexity of existing sandbars" without affecting nesting plovers directly because they are not present (Buenau et al. 2016, p. 36). The piping plover population on the Missouri River is typically habitat-limited. Increases in nesting habitat and foraging habitat would decrease nest densities and chick densities in subsequent years. This would likely increase survival from egg to chick and from chick to fledging and contribute to increases in adult numbers in subsequent years.

Spring rises may be employed to scour vegetation and deposit new sand on existing sandbars. Buenau et al. (2016, p. 38) assumed that "spring habitat conditioning flows", however, "are not of sufficient magnitude and duration to create new sandbars." In addition, they result in nest failure when nests are inundated and have been removed from the USACE suite of actions (USACE 2017, p. 139).

The USACE may increase flows when plovers are selecting nesting sites to limit the number of nests that will be inundated by later rises – this may occur as a result of either of the steady release flow scenarios or with the use of "cycling" flows under any of the scenarios (Table 4; Buenau et al. 2016, p. 37; USACE 2017, pp. 50-51). This may have the effect of reducing the extent of foraging habitat, nesting habitat, or both. A reduction in foraging habitat would increase chick density and affect chick body condition negatively (Catlin et al. 2014, p. 202). Depending on the release levels, however, early releases to control the locations of plover nesting could increase the amount of foraging habitat if flows are decreased to expose additional wet sand when chicks are present. In such cases, chick density would be reduced although nest density could increase due to reductions in the extent of exposed nesting habitat. This would likely have the effect of decreasing survival from egg to chick while increasing survival from chick to fledging due to the inverse density dependence of each stage.

Natural High Flow Events

In some cases, flows are greater than those that may be controlled by the dams and piping plover numbers increase in the subsequent years due to a large expansion in available habitat. This occurred most recently in 2011. When this occurs reproduction of piping plovers is low because much of the suitable nesting and brooding habitat is flooded. These years are followed, however, by several years of low mortality and high reproduction until the newly created nesting habitats erode and become vegetated (Catlin et al. 2016, p. 12). Based on a population viability model and data collected in 2008 to 2013, Zeigler et al. (2017, p. 11) concluded that in the riverine reach of the Missouri River downstream of the Gavins Point Dam, population growth rates may peak with the recurrence of high flow events at about a 4 year interval and may remain above zero until about 16 years post-event. Data collected by the USACE (2018) shows, however, that population growth rates in the Southern Region of the river, which includes the Gavins Point reach, are already approaching 1.0 just six years after the 2011 event (Figure 12).

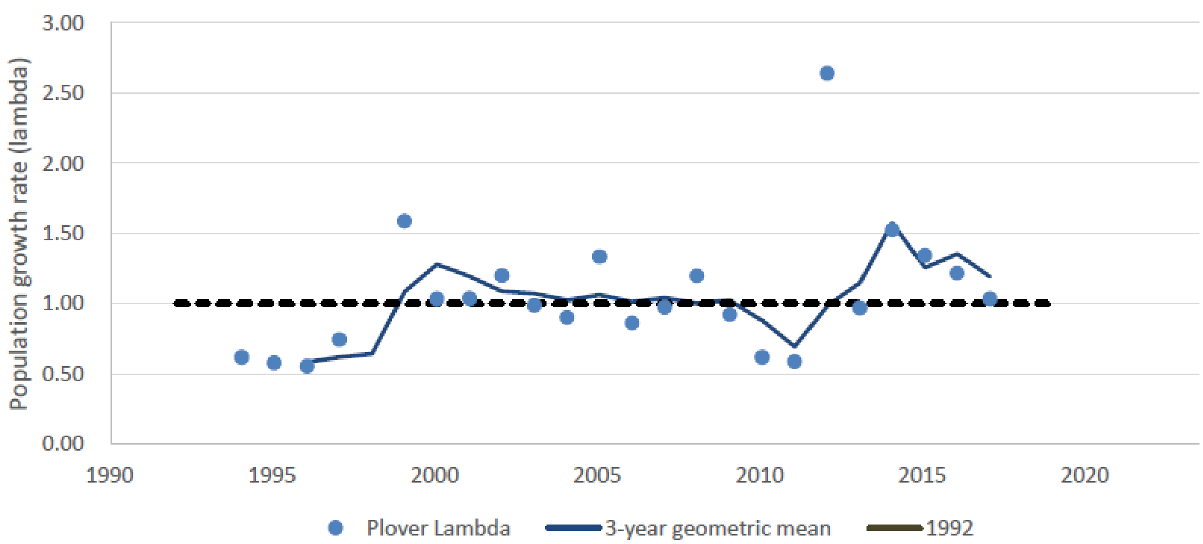

Figure 12. Annual (points) and running geometric mean (line) of the plover population growth rate for the Southern Region. The dashed line indicates the target of λ = 1. Adapted from USACE (2018, p. 22).

In the Northern Region they have already fallen below 1.0 (Figure 13). This may indicate that although population growth rates and productivity (Figures 9 and 10) increase after habitat-forming high flow events, other factors may hasten the post-flood declines in each. Egg loss due to inundation, for example, was high in the Northern Region in 2015 and 2016 (Figure 11). In the section, **Flow Management and its Effects on Piping Plover Habitat Dynamics**, below, we address the effects of river regulation and the reduction in the frequency of high, habitat-forming flows in combination with USACE attempts to ameliorate the resulting habitat loss.

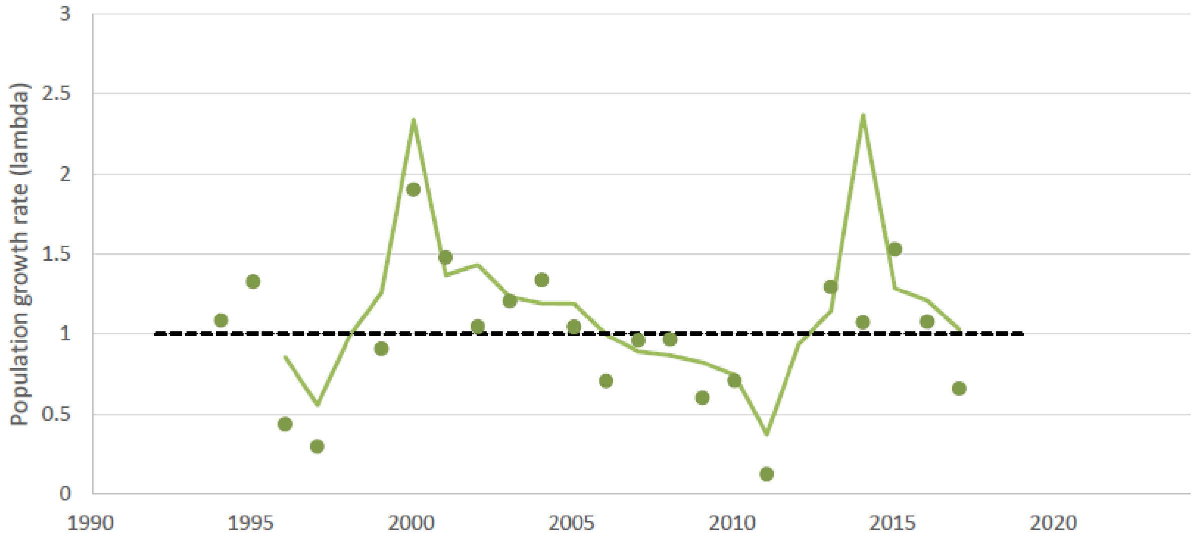

Figure 13. Annual (points) and running geometric mean (line) of the plover population growth rate for the Northern Region. The dashed line indicates the target of λ = 1. Adapted from USACE (2018, p. 22).

Hypolimnetic Releases

Cold water releases from Gavins Point Dam may affect piping plover population growth negatively by limiting prey biomass in the affected reach. The condition of piping plover chicks in the reach below Gavins Point Dam was related to prey abundance (Hunt et al. 2017, p. 760). A reduction in prey abundance is likely to negatively affect the condition of piping plover chicks and to reduce annual survival of hatch year (0-1 year post-hatch) and adult piping plovers (Catlin et al. 2014, p. 204).

Creation or Modification of Habitat

Construction of Emergent Sandbar Habitat

Mechanical habitat creation can contribute positively to population growth of piping plovers in the action area. Due to the infrequency of high flow events, the persistence of piping plovers in the action area is tied to continued human interventions, especially habitat creation and management (Caitlin et al. 2016, p. 13). Engineered sandbars become productive for piping plovers on the Missouri River soon after their creation, but there is typically a one-year lag between their creation and their use by nesting plovers (Catlin et al. 2015, p. 29). After their adoption by nesting plovers, the local population in the area studied by Catlin et al. (2015, p. 33-34) quickly grew to carrying capacity and had higher nesting success than piping plovers on older sandbars. In addition, piping plovers whose first brood failed and that dispersed to new engineered habitats had higher renesting success rates than birds that remained on old natural habitats (Catlin et al. 2015, p. 30).

The manner in which mechanically created habitats are built, especially their size, may have significant effects on their ability to support piping plover productivity. Engineered habitats may be more likely to attract dispersing adults when they are large, new, and have "proportionally more dry sand and less vegetation than the sandbars from which they dispersed (Catlin et al. 2015, p. 30). For at least 3 to 4 years after their creation, engineered habitats were "similar to natural habitats used by piping plovers, viz., open dry sand and pebbles with sparse vegetation…" (Catlin 2009, p. 12). Adults that dispersed to engineered habitats selected larger, younger, less vegetated sandbars with more dry sand – all characteristics of newly created habitat" and predictors of decreased predation risk (Catlin et al. 2015, p. 30). In a comparison of engineered habitats versus those created by the 2011 flood, however, nest success, pre-fledging chick survival, and hatch-year survival were "consistently higher on the flood-created habitat than on the engineered" habitat (Hunt et al. 2018, p. 149). The authors contend that the engineered habitats may be have been too small in comparison to naturally formed sandbar islands and that "building more habitat at one time may provide a better outcome than smaller projects (Hunt et al. 2018, p. 159).

The positive effects of sandbar creation on piping plover population growth are likely to be greater when new sandbars are near existing populations with high fledging rates and constructed to minimize predator efficiency. Greater than 90 % of plovers that nest on the Missouri River "return to the same area for nesting each year (Catlin et al. 2015)", and in successive breeding seasons 50 % of piping plovers moved <153 m between nests (Friedrich et al. 2015). Due to the relatively short distances that adult piping plovers moved between sandbar habitats Catlin et al. (2015, p. 35) stated that "new sandbars will be populated most rapidly if they are constructed within 12 km of existing sandbars with reproductive output >1.25 fledged chicks per pair." Habitats with lower reproductive success may not produce high numbers of immigrants to populate the new habitats and newly created habitats that are not near productive habitats may never reach carrying capacity. Habitat creation increased "hatch-year fidelity" (Catlin et al. 2015, p. 35) and returning birds may be more likely to use nearby newly created habitats as densities increase on their natal habitats.

Adjustments to the shape and exposure of created habitats may also enhance piping plover productivity on mechanically created habitats. Baasch et al. (2017, p. 247) stated that an effective site design for piping plovers would be relatively linear, "maximizing the area of nesting habitat near the waterline" and that to balance benefits for interior least tern, an efficient design "would be lobate, incorporating centralized nesting habitat for terns and "increased access to foraging areas for nesting and brood-rearing" piping plovers. Le Fer et al. (2008, p. 591) noted that "protected shorelines, which include backwater areas, inlets, inter-sandbar channels and ephemeral pools, are important foraging sites" for piping plovers and suggested that engineered sandbars include these elements and slope "gently into the water." In their study on the Missouri River, piping plovers selected protected shorelines over exposed shoreline on the Missouri River and prey indices were higher in the former (Le Fer et al. 2008, p. 590). On Lake Sakakawea, "fledging rates were lower in areas that were more exposed to wind and waves than in areas that were more protected" (Anteau et al. 2014c, p. 202). Catlin et al. (2015, p. 35) recommend that sandbars that are relatively small (25-50 acres) and discontinuous may reduce the likelihood that one or a few predators will 'trap line' large numbers of eggs and chicks.

The decline in quality of mechanically created habitats is typical also of naturally formed habitats. Nest survival declined with age of engineered habitats (Catlin et al. 2011a, p. 309). Nest density increased in the first years after construction, decreased after 2–4 years and then remained similar to densities found on natural sandbars (Catlin et al. 2015, p. 35).

Vegetation Management

Vegetation management on existing sandbars "is intended to improve the habitat quality of existing sandbars and prolong" their useful life " by removing vegetation that deters birds from nesting and provides cover for predators" (Buenau et al. 2016, p. 37). This activity may not succeed in attracting piping plovers to the managed habitats, however, and those that do use them may not experience increased nesting success relative to unmanaged natural sandbars (Catlin 2009, p. 13; Catlin et al. 2011a, p. 309). In fact, piping plovers "selected against modified natural habitat" (Catlin 2009, p. 12). Catlin (2009, p. 13) posited that more complete vegetation removal may result in increased nest success, but this hypothesis apparently remains untested.

Species Protective Measures

Biotic Interactions – Predation Management

Nest Exclosures

The Predation Management Plan includes the use of exclusion cages and fencing to protect nests (USACE 2017, p. 127). Nest exclosures can reduce the likelihood of nest predation, but only if they are used in a way that minimizes nest abandonment and predation of adults. Increased rates of adult abandonment at caged nests are likely driven by an increased risk of adult predation (Catlin et al. 2015, p. 31; Darrah et al. 2018, p. 33; Isaksson et al. 2007, p. 140). Darrah et al. 2018, p. 33) found the rates of nest abandonment to be site-specific and likely related to exclosure construction materials and methods, raptor perch availability and proximity, "and the presence of predators that have learned to target exclosures." For these reasons, nest exclosures should be tailored to local habitat conditions and predator communities (Darrah et al. 2018, p. 33; Murphy et al. 2003, p. 153). In one study on the Missouri River, the use of exclosures increased nest success of piping plovers, likely because the exclosures used were appropriate to the size and species of the common predators in the study area – coyotes, raccoons, mink, and crows – that can be effectively deterred by the exclosures (Catlin et al. 2015, p. 31).

Murphy et al. (2003, p. 153) also found that adult mortality was greatest at small cages, in general, but that no adult mortality occurred among 393 small cages at one site where trees were absent. They found that predation was mostly caused by raptors and the lack of trees would have prevented perching by "tree-associated raptors" (Murphy et al. 2003, p. 153). Where raptors were present, predation was lower at larger cages and even lower when cages had netting on top (Murphy et al. 2003b, p. 153).

For nest caging to have an overall positive effect on the viability of piping plover populations, the structure and placement of nests must be implemented to maximize production of fledglings and minimize loss of adults. Murphy et al. (2003, p. 154) calculated the amount that production – expressed as fledglings/pair – would have to increase due to caging to offset their observed loss of adults at five percent of caged nests. The increase in production needed to offset adverse effects to adults at caged nests is dependent on (1) overall rates of adult survival; (2) mean production level (fledglings/pair) among caged nests; and, (3) the mean number of adults killed per predation incident at caged nests. Adult survival is dependent on myriad factors unrelated to caging practices, but the latter two factors are highly dependent on the methods of caging and the nature of the predation threat at the sites where caging is applied.

Murphy et al. (2003, p. 154) provide several recommendations to minimize adult loss at cages, including close monitoring of the cages for signs of predation or other problems. They specifically recommended the following (Murphy et al. 2003, p. 154):

- Check cages "at least every two to three days in areas of moderate to high nesting density (>4 breeding pairs/km^2);"
- Remove any cages within 3 km "at the first signs of predation to protect the remaining adults;" and,
- Assess baseline productivity of local piping plover populations and predator communities "to help determine whether and what type of predator exclusion is warranted."

The second recommendation – to promptly remove cages – is reflected by the recommendation of Pauliny et al. (2008, p. 1582), based on their study of dunlins (*Calidris alpina schinzii*) in Sweden – "that nest exclosures be accompanied by close monitoring of potential predators on adults to enable early detection of even a tendency of exclosures becoming associated with prey."

Predator Removal

Predator removal will likely contribute to meeting population and reproduction objectives in some years, but when habitat is plentiful after floods it is likely unnecessary. Management actions described in the USACE Predation Management Plan include the use of hazing of predators with audio or visual frightening devices to deter them from nesting sites and lethal and non-lethal removal of individual predators. Catlin et al. (2011b, pp. 460-461) found that removal of great horned owls improved prefledge survival of piping plovers in at least one of two study years during their 2008-2009 study, but that the positive effect decreased with increasing age of chicks. Habitat creation by floods decreases the effects of nest predation to the degree that predator management may be unnecessary to maintain high growth rates for a period thereafter (USACE 2017, p. 127). The USACE found that predator control was not needed in 2012 and 2013 due to the "abundant habitat and new nesting areas" created by the 2011 flood (USACE 2017, p. 119). Two coyotes were removed from Lake Oahe in 2014, but again no predators removed in 2015 and 2016 (USACE 2017, p. 127). In response to an increase in predation in 2016, control resumed in 2017 with the removal of 32 predators – 20 mammals and 12 birds (M. McPherron, USACE, pers. comm. 2018).

Use of sandbars and reservoir shorelines for recreation on the Missouri River is increasing the likelihood of impacts to piping plovers, especially to eggs and chicks, and impacts may be exacerbated by declines in habitat availability (USACE 2017, p. 128). Effects are likely to occur due to both foot and vehicle traffic and may also be exacerbated by the presence of pet dogs (Service 2016, p. 40; USACE 2017, p. 128). In areas with high human disturbance, plovers spend less time foraging and brooding, and more time in alert behaviors (Cairns 1982; Flemming et al. 1988; Burger 1994; Gratto-Trevor and Abbott 2011). Evidence suggests that chicks that grow more slowly and fledge later and that unfledged chicks are at a greater risk of predation (Catlin et al. 2014, p. 202). Piping plovers may avoid areas with high human activity, instead using less optimal habitat (Cohen et al. 2008). Human restriction measures include public education about endangered and threatened species habitat and access restrictions, posting of signs at nesting areas, and installing fencing to deter humans from entering areas used for nesting (Buenau et al. 2016, p. 37; USACE 2017, p. 16).

Human Disturbance

The USACE has recorded nest loss due to human disturbance since 2003. Although typically caused by the general public, it sometimes occurs as a result of research and monitoring activities (USACE 2017, p. 129). The USACE attempts to minimize nest loss caused by the general public by placing signs in areas of frequent nesting – and at any area where five or more nests are present – and "occasionally" ropes-off or barricade areas to stop vehicle access (USACE 2017, p. 129). Although signing may reduce human entry into nesting areas, violations are common (USACE 2018, p. 27). Barricades are typically placed near recreation areas where off-road vehicle use may be most common. Although data on nest loss due to human disturbance are collected by the USACE, it represents only the minimum amount that occurs due to the incidents that are not detected. Nest loss that occurs due to nest abandonment caused by human disturbance is especially difficult to detect (USACE 2017, p. 128).

Flow Management and its Effects on Piping Plover Habitat Dynamics

The USACE actions described above in this section include actions intended primarily to benefit piping plovers and interior least terns, but USACE management of flows in the action area on the mainstem Missouri River dams take multiple other objectives into account, including flood control and water supply. Suppression of the natural disturbance regime on the Missouri River to meet these objectives results in a loss of habitat for piping plovers, fewer adults, and increased likelihood of extirpation unless other factors are successful in creating habitats similar in quality and extent (Zeigler et al. 2017, pp. 9-10).

To help assess the combined effects of dam regulation and artificial habitat creation on the Missouri River on piping plovers, the USACE developed "a model of the change in ESH due to vegetation growth and the deposition and erosion of sandbars as a function of flow and ESH area" (USACE 2016, p. 170; Buenau 2015). The model is "based on a mechanistic understanding of sandbar dynamics" and is quantified for the three riverine reaches (USACE 2016, p. 170). Buenau (2015, p. 5) combined the ESH model with a piping plover population viability model to examine the effects of flow and management scenarios on population viability of piping plovers on the Missouri River.

For the purposes of this analysis and modeling approach, the Service agreed to use the risk of quasi-extinction of the piping plover on the Missouri River and reservoirs as the model output. The likelihood of quasi-extinction is defined here as the probability of there being less than 50 adults nesting in either region of the Missouri River in 50 years. A probability of less than five percent of quasi-extinction would meet the primary population objective for the piping plover on the Missouri River – that is, a 95 % probability of maintaining more than 50 adults on each section of the river over the next 50 years (USACE 2016, p. 67-70).

Buenau (2015, p. 4) modeled the probability of quasi-extinction of the piping plover under four different management scenarios and separately for the northern and southern demographic units in the action area (Buenau 2015, p. 4). The model uses two metrics of ESH for riverine reaches and water elevation for reservoir habitat in combination with the most current demographic rates available to estimate population growth. The modeling framework used to calculate habitat targets was originally developed for the Missouri River Effects Analysis study and is referred to briefly as the predictive ESH model in the BA (Buenau et al. 2014; Fischenich et al. 2014; USACE 2017, p. 47). Estimates of the relationships between habitat availability, piping plover population density, and fledgling production "were derived using data from 2005−2014 for riverine habitat and from 1993−2014 for reservoir shoreline habitat" (Buenau 2015, p. 11). Buenau (2015, p. 11-12) describes a number of caveats that should be considered when interpreting its predictions, including the lack of information about the interactions between piping plovers using the Missouri River and other areas inhabited by Northern Great Plains piping plovers.

The four modeled scenarios (Buenau 2015, pp. 6-10, Table 5) were:

- an Existing Conditions scenario – "reflected the current operations and spatial configuration of the Missouri River system";
- a No-Operations scenario that modeled flows that would occur with the dams in place but not operated;
- an Unregulated scenario that modeled flows without dams or reservoirs; and,
- a Calibrated Target scenario constructed to provide just enough habitat through mechanical creation to lower the extinction risk with the Existing Conditions scenario below five percent.

Buenau et al. (2015, p. 7) describes how "ResSim includes an option to run the modeled system as "unregulated," i.e., routing runoff through the system without the presence of dams or reservoirs. This unregulated scenario was intended to represent the effects of a natural hydrograph on ESH dynamics. Because the unregulated model was based on the absence of reservoirs, all segments of the river from the upper bounds of the contemporary Lake Sakakawea to Ponca were modeled as riverine, using the ESH models developed for the most similar river reaches . . . This included Lake Sharpe and Lake Francis Case, modeled using the Fort Randall ESH model. As with the No-Operations scenario, the ESH models were parameterized using data reflecting current conditions and thus do not reflect actual historic conditions. The associated estimation error is unknown."

The Calibrated Target scenario was included to determine the amount of engineered ESH needed to achieve specific population viability criteria.

Table 5. The management scenarios modeled by Buenau et al. (2015) and the resulting probabilities of quasi-extinction for both the northern and southern demographic units of the piping plover on the Missouri River.

Scenario	Probability of Quasi-Extinction	Predicted Median ESH Area (acres)
Existing Conditions	0.082	768
No-Operations	0.001	12,477
Calibrated Target	0.012	1,433

The relative probabilities of quasi-extinction indicate clearly that operation of the dams, as modeled, has a marked effect on the viability of piping plovers on the Missouri River due to the varying amounts of habitat produced under the scenarios (Table 5; Buenau 2015, p. 8). Under current operating rules, "flows of sufficient magnitude and duration to create habitat are relatively uncommon" (Buenau 2015, p. 9). The Existing Conditions Scenario included 10-15 year stretches when little to no habitat was available and its 95 % confidence interval went as low as 3 acres (Buenau et al. 2015, p. 8). The Calibrated Target scenario included the creation of engineered habitat and led to a substantial predicted likelihood of quasi-extinction (Table 5; Buenau 2015, p. 8).

The Calibrated Target scenario most closely resembles the Proposed Action and addresses the key management issue faced by the USACE as it strives to meet its objectives for the piping plover – "…a lack of habitat requires more intensive population protection…" (USACE 2016, p. 171). This scenario "was constructed to provide just enough habitat through mechanical creation to lower the extinction risk with the Existing Conditions scenario below five percent" (Buenau 2015, p. 10). Under this scenario, the amount of habitat creation needed in the Southern Region was greater due to the relatively stable shoreline habitats on Lake Sakakawea and Lake Oahe in the Northern Region. In addition, the amount of habitat needed on the riverine Garrison Reach was sensitive to assumptions about productivity on the two reservoirs. The viability of the species in the Northern Region was also sensitive to changes in reservoir management.

The authors clarify that the ESH model used in their analysis (Fischenich et al. 2014) "remains in early stages of development" and that it contains "unknown biases...especially under extreme conditions" (Buenau et al. 2015, p. 11). In addition, "it is based upon the presence and operation of dams and reservoirs and contemporary channel morphology and sediment supply" and not on a pre-dam, natural hydrograph. The ESH model could be improved in the future by expanding the range of hydrologic variability upon which it is based. In addition, the plover population was based on data from 1993 and later and its use to approximate historical conditions "should be done with caution" (Buenau et al. 2015, p. 11). The model includes additional uncertainties with regard to plover reproductive success on reservoirs and plover fledgling production on ESH and assumes balanced migration between Missouri River and nearby habitats.

Other authors provide additional perspectives and approaches to the relationship between management of the Missouri River and the viability of the piping plover in the Northern and Southern demographic units. Zeigler et al. (2017, p. 12) provided another perspective on the relationship between flows on the Missouri River and predicted that a metapopulation of piping plovers comprised of three subpopulations – Lewis and Clark Lake; the riverine reach below Gavins Point Dam; and, birds nesting along the Platte River in Nebraska, would persist with the recurrence of high flow events at a 15-year frequency, with the highest abundance at a 4-year frequency. The metapopulation addressed by Zeigler et al. (2017) represents a variation on the Southern demographic unit addressed in this biological opinion (Figure 7). Catlin et al. (2015, p. 35) found that to achieve "stationarity" of piping plovers in this metapopulation minus the Platte River birds, 1.25 fledged chicks would have to be produced per pair. They cautioned that criteria for amounts of suitable habitat necessary to sustain piping plovers on the Missouri River must account for the facts that "sandbars begin to erode and vegetate as soon as they are constructed" that "plover populations will take a number of years to reach carrying capacity on any sandbar" (Catlin et al. 2015, p. 33-34). Buenau et al. (2014, p. 972) found that "(F)low and habitat availability largely determined observed and modeled plover population size and variability because of the territorial nature of piping plovers and the dependence of chicks upon suitable foraging habitat near the nest."

If the effects of the USACE actions are to be assessed and managed with respect to the amount of suitable nesting habitat, it will be important to avoid overestimating nesting habitat. To address this issue, the Service made a conservation recommendation in this BiOp and we will raise this issue through the Science and Adaptive Management Process. Anteau et al. (2014b, p. 25) stated that they had not "yet developed a method for estimating the spatially explicit distribution of gravel, an important component of plover habitat." Remotely-sensed classifications that ignore substrate may classify some areas as habitat, but those areas might be poor habitat because of non-optimal substrate conditions."

9.3 Effects of Interrelated and Interdependent Actions

There are a variety of actions that would not occur but for the USACE operations, including the Science and Adaptive Management Plan and activities focused specifically on species conservation, but we do not anticipate that they would add effects in addition to those considered above. Activities carried out by non-federal entities in the action area are numerous, but any effects to piping plovers are highly integrated with the effects of the USACE actions and we do not anticipate that these actions would affect the species in a manner or to an extent not already considered above. One example is human disturbance, whose effects appear to largely be not caused by the USACE actions, but in some cases are facilitated by them. For example, placement of engineered habitats near recreation areas may facilitate an increased exposure to human disturbance, but we address the effects of human disturbance above.

10. PIPING PLOVER – CUMULATIVE EFFECTS

Most, if not all, effects to piping plovers relevant to this consultation occur as a result of the federal action. As discussed above in the immediately preceding section, human disturbance of piping plovers is likely to occur as a result of some activities that would occur regardless of the federal action. Humans would likely use sandbar areas for recreation regardless of the activities. We do not anticipate that there would be additional effects in the action area to piping plovers that we have not already considered above.

11. PIPING PLOVER – CONCLUSION

11.1 Northern Great Plains Population of the Piping Plover

For piping plovers, the focus of this biological opinion is to determine whether the Proposed Action would jeopardize the continued existence of the threatened piping plovers that nest on the Northern Great Plains. We conclude that the Proposed Action is not likely to jeopardize the continued existence of the Northern Great Plains Piping Plover for the following reasons:

- USACE will implement the Science and Adaptive Management Plan in collaboration with Service and MRRIC. The Science and Adaptive Management Plan includes science-based objectives for ESH and for population growth and productivity of the piping plover that will help to ensure the conservation of the piping plover on the Missouri River consistent with proposed Service recovery objectives. This will help to ensure that piping plovers are capable of maintaining a level of reproduction in the action area that is sufficient to support numbers of breeding adults at levels similar to the period, 1993-2017. The means objectives, targets, and timeframes associated with these objectives will help to ensure that the management actions that are necessary to meet the conservation objectives for the species will be carried out. Each of the primary objectives must be met for both the northern and southern portions of the action area, which will help to ensure that the species' current distribution will be maintained.

- Piping plovers that comprise the Northern River demographic unit in the action area do not typically share a common environmental driver with piping plovers that nest in the alkaline lakes component of the NGP, reducing the likelihood that numbers of nesting birds will act synchronously. Moreover, populations on alkali lakes in the U.S. are more stable than on the Missouri River and piping plovers move between alkaline lakes and Missouri River, especially around Lake Sakakawea (Roche et al. 2016, p. 567-568).
- The action area contains a substantial proportion of the Southern Rivers component of the NGP breeding population, but this component also includes manmade habitats along the central portion of the Platte River. Habitats used by piping plovers there are highly productive and act as a stabilizing buffer in this component "regardless of the high-flow return interval" on the Missouri River (Zeigler et al. 2017, pp. 12-13).

11.2 Piping Plover Critical Habitat
We conclude that the Proposed Action is not likely to destroy or adversely modify the critical habitat designated for the Northern Great Plains Population of the piping plover. To make this determination, Service must determine whether the action results in an alteration of the quantity or quality of the essential physical or biological features of designated critical habitat, or that precludes or significantly delays the capacity of that habitat to develop those features over time, and if that effect appreciably diminishes the value of critical habitat for the conservation of the species.

Suppression of the natural disturbance regime has a marked effect on the extent of the critical habitat in the action area that contains the primary constituent elements, but the USACE plans to restore primary constituent elements by building habitats to counter the effects of its operations. The extent of the area that now contains the primary constituent elements exceeds what was present at the time of critical habitat designation in 2002, but that is due primarily to the habitat created by the 2011 flood. The USACE has committed to a process in its AM plan that is intended to ensure that the extent of habitat needed to meet explicit population viability goals for the piping plover is maintained. This aim and intention of the program is likely to facilitate maintenance of the primary constituent elements in a substantial proportion of the action area to the degree that it will facilitate the species conservation.

The status of critical habitat for the Northern Great Plains Piping Plover will also be buffered by the status of extensive areas outside of the Missouri River. The action will only affect the critical habitat in the action area and will not affect the large extent of critical habitat on alkaline lakes in North Dakota and Montana.

In light of (a) the heavy reliance of the Proposed Action on the Science and Adaptive Management Plan and its inclusion of objectives and measures to maintain the nature and extent of critical habitat that is in a condition needed to conserve the species in the action area and (b) the extent of critical habitat that will not be affected by the Proposed Action, we conclude that it will not destroy or adversely modify critical habitat for the Northern Great Plains Breeding Population of the Piping Plover.

12. INTERIOR LEAST TERN – STATUS OF THE SPECIES AND CRITICAL HABITAT RANGEWIDE

12.1 Species Description

Least terns within the Interior Basin of North America were described as *Sterna antillarum athalassos* (Burleigh and Lowery 1942, pp. 173-177). In 2006, the American Ornithologist's Union recognized least terns under a previously published genus (*Sternula*) based on mitochondrial DNA phylogeny (Bridge et al. 2005, p. 461). Interior least tern was one of three subspecies of New World least terns previously recognized by the American Ornithologists' Union (1957, p. 239), including the eastern least tern (*S. antillarum antillarum*), and the California least tern (*S. antillarum brownii*). Least terns are distinguished from all other North American terns by their small size. Interior least terns can only be separated from Eastern and California least terns by the geographic area of nesting.

12.2 Life History

Interior least terns are potentially long-lived, with records of recapture more than 20 years following banding (Thompson et al. 1997, p. 15); however, the average life span is probably less. They begin breeding in their second or third year and breed annually throughout their lives (Thompson et al. 1997, p. 15).

Interior least terns generally nest on the ground, in open areas, and near appropriate feeding habitat (Lott and Wiley 2012, pp. 9-11). Nests are simple scrapes in the sand, and nesting sites are characterized by coarser and larger substrate materials, more debris, and shorter and less vegetation compared to surrounding areas (Smith and Renken 1993, p. 501; Stucker 2012, p. 49). Typical least tern clutch size is reported as 2 to 3 eggs (Thompson et al. 1997, p. 15); however, clutch size may vary by location and year (e.g., Szell and Woodrey 2003, p. 37; Jones 2012, p. 3).

Natural nesting habitat features are maintained and influenced by magnitude and timing of riverine flood events (Sidle et al. 1992, p. 134; Renken and Smith 1995, pp. 194-195). Vegetation-free sand or gravel islands are preferred for nesting, although sand banks, point bars, and beaches may also be utilized. Interior least terns prefer areas remote from trees or other vegetation that may hide or support predators (Lott and Wiley 2012, pp. 9-11). Least terns also nest on anthropogenic sites (Jackson and Jackson 1985, p. 57; Lott 2006, p. 10) near water bodies with appropriate fish species and abundance, including industrial sites (Ciuzio et al. 2005, p 102; Mills 2012, p. 2), dredge disposal sites (Ciuzio et al. 2005, p. 102); sand pits (Smith 2008, p. 2), constructed habitats (Stucker 2012, pp. 59-66), and rooftops (Boylan 2008, entire; Watterson 2009, entire).

Lott and Wiley (2012, pp. 9-11) described five physical and biological conditions that are necessary for interior least tern nest initiation and successful reproduction:

1) nest sites that are not inundated during egg laying and incubation;
2) nesting sites that are not inundated until chicks can fly;
3) nesting sites with less than 30 % plant cover;
4) nesting sites that are more than 76.2 m from large trees; and
5) availability of prey fishes to support chick growth until fledging.

Interior least terns are colonial nesters. Colony size may vary from a few breeding birds to over 1,200 (Jones 2012, p. 3). Some drainage populations may be limited by annual availability of nesting habitat (e.g., Missouri River; Stucker 2012, p. 104), while potential nesting habitat is generally abundant and underutilized in others (e.g., Mississippi River; USACE 2008, pp. 10-13). Nesting site conditions (e.g., habitat suitability, flood cycles, forage fish abundance, predation pressure) can vary significantly year to year in all drainages, resulting in wide fluctuations in bird numbers (Jones 2012, p. 14) and/or nesting success (Smith and Renken 1993, p. 41; Lott and Wiley 2012, p. 15). However, interior least terns may re-nest, or relocate and re-nest if nests or chicks are destroyed early in the season (Massey and Fancher 1989, pp. 353-354; Thompson *et al*. 1997, p 15). Interior least tern chicks leave their nests within a few days of hatching (semi-precocial), but remain near the nests and are fed by their parents until fledging (Thompson et al. 1997, pp. 14-15).

Interior least terns are primarily opportunistic piscivores, feeding on small fish species or fingerlings of larger species (less than 52 millimeters (mm) total length for adults, and less than 34 mm total length for young chicks) (Stucker 2012, p. 6). Least tern will also occasionally feed on aquatic or marine invertebrates (Thompson et al. 1997, pp. 6-7). In the Missouri River drainage, interior least terns have been documented foraging for fish in shallow water habitats and within 12 km from colony sites (Stucker 2012, p. 24). On the Missouri River, prey species include emerald shiner (*Notropis atherinoides*), sand shiner (*Notropis stramineus*), spotfin shiner (*Cyprinella spiloptera*), and bigmouth buffalo (*Ictiobus cyprinellus*) of appropriate size and declines in fish prey have been noted (Stucker 2012, pp. 6, 21).

Breeding-site fidelity for least terns appears to vary in different populations and breeding areas. Thompson et al. (1997, p. 16) summarized reports of return rates of banded adults to sites where banded as 36 to 86 % in California colonies, 42 % on the Mississippi River, 28 % on the central Platte River, Nebraska, and 81 % at Quivira National Wildlife Refuge in Kansas and on the Cimarron River in Oklahoma. Fidelity to natal site is also difficult to estimate because re-sightings or recaptures of terns banded as chicks have been limited. Estimates of natal site fidelity have varied from five percent on the Mississippi River, to 82 % in Kansas and Oklahoma (Thompson et al. 1997, p. 16).

Site fidelity in least terns may be affected by physical habitat variables or the extent and type of predation (Atwood and Massey 1988, p. 394). As noted above, least terns are strong fliers and can re-locate if conditions on natal or previous year nesting grounds become unfavorable. In a study of eastern least terns, Burger (1984, p. 66) found an average 22 % turnover rate in nesting colony sites, primarily due to changes in habitat condition or disturbance.

Lott et al. (2013, pp. 3617-3618) used data from published mark/recapture studies and a large number of unpublished band recovery records to assess least tern dispersal and site fidelity. Their analysis found that 50 to 90 % of reported recaptures occurred less than 26 km from the original banding sites, while over 90 % dispersed less than 96 km. These data seem to suggest that most birds show a high degree of adult site fidelity and natal site philopatry (remaining near their point of origin), rarely dispersing far from nesting areas. However, most banding study designs focus recapture or re-sighting efforts at or near banding locations, and have a low probability of documenting long distance dispersal.

12.3 Predation

Interior least tern eggs, chicks and adults are prey for a variety of mammal and bird predators. Cryptic coloration of eggs and chicks, and secretive behavior of chicks, and mobbing behavior of adult birds protect eggs and chicks from predators (Thompson et al. 1997, p. 11). Location and size of nesting colonies also has a significant influence on degree of predation. In several studies, interior least tern reproductive success has been higher on island colonies as compared to connected sandbar colonies, and when water levels maintained isolation of islands and nesting bars from mammal predators (e.g., Smith and Renken 1993, p 42; Szell and Woodrey 2003, p. 41). Large colonies may also experience greater predation than comparatively small colonies (Burger 1984, p. 65).

12.4 Population Status

12.4.1 Current Distribution and Abundance

The current documented east to west distribution of summer nesting interior least tern encompasses more than18 degrees of longitude (1,440 kms) from the Ohio River, Indiana and Kentucky, west to the Upper Missouri River, Montana. The north to south distribution encompasses over 21 degrees of latitude (more than 2,300 kms) from Montana to southern Texas. Interior least terns currently nest along more than 4,600 km of river channels across the Great Plains and the Lower Mississippi Valley (Lott et al. 2013, p. 3623), with nesting colonies documented from the States of Montana, North Dakota, South Dakota, Nebraska, Colorado, Iowa, Kansas, Missouri, Illinois, Indiana, Kentucky, New Mexico, Oklahoma, Arkansas, Tennessee, Texas, Louisiana, and Mississippi.

In 2005, Lott (2006, pp. 3-5) coordinated the only simultaneous survey to date of the geographic range of interior least tern during a 2-week window of the breeding season. Summarized counts from this survey indicated an approximate minimum adult population size of 17,500, with nesting occurring in more than 480 colonies spread across 18 states (Lott 2006, pp. 10-21). Lott (2006, pp. 13-15) also provided counts for 21 populations or population segments that were unknown at the time of listing, which collectively supported over 2,000 terns. Further, Lott (2006, p. 50) considered that both total population size and the distribution and number of colonies from this survey were biased low, since counts lacked methods to account for imperfect detection of adults, and many areas potentially supporting interior least tern colonies were not surveyed.

12.4.2 Population Trends

The interior least tern has demonstrated a positive population trend, increasing by almost an order of magnitude since listing. As both the geographical extent and effort of interior least tern surveys increased after listing, sufficient interior least tern count data became available to analyze population trends for several river reaches supporting persistent interior least tern breeding colonies. Kirsch and Sidle (1999, p. 473) reported a range-wide population increase to over 8,800 adults in 1995 and found that 29 of 31 interior least tern locations with multi-year monitoring data were either increasing or stable. Lott (2006, p. 50) reported an increase to over 17,500 adult birds in 2005, forming 489 colonies in 68 distinct geographic sites.

Lott (2006, p. 92) conceptualized the interior least tern functioning as a large metapopulation (a regional group of connected populations of a species), which might also include least terns on the

Gulf Coast. Using available information on dispersal of least tern, Lott et al. (2013, pp. 3616-3617) defined 16 discrete breeding populations of interior least tern, with four major geographical breeding populations (population complexes) accounting for more than 95 % of all adult birds and nesting sites throughout the range. Portions of these four population complexes have experienced multi-year monitoring to different degrees. While some local (colony, subpopulation) declines have been documented, interior least tern have experienced a dramatic increase in range and numbers since listing and development of the recovery plan (e.g., Kirsch and Sidle 1999, p 473; Lott 2006, pp. 10-49). There has been no reported extirpation of any population or subpopulation since the species was listed in 1985.

The Missouri River population of the interior least tern may be habitat limited and is unlikely to meet the recovery goals of the 1990 recovery plan (Service 1990) – i.e., a stable population of at least 2,100 for 10 years (Figure 14). However, the inability to meet this and other sub-drainage targets established in the 1990 recovery plan have been offset by large increases in the interior least tern populations along the Arkansas, Red, and Lower Mississippi Rivers, and by the discovery of numerous subpopulation segments throughout the Interior Basin. The latter were either unrecognized or not occupied at the time of listing and recovery plan development (see Service 2013, pp. 31-33).

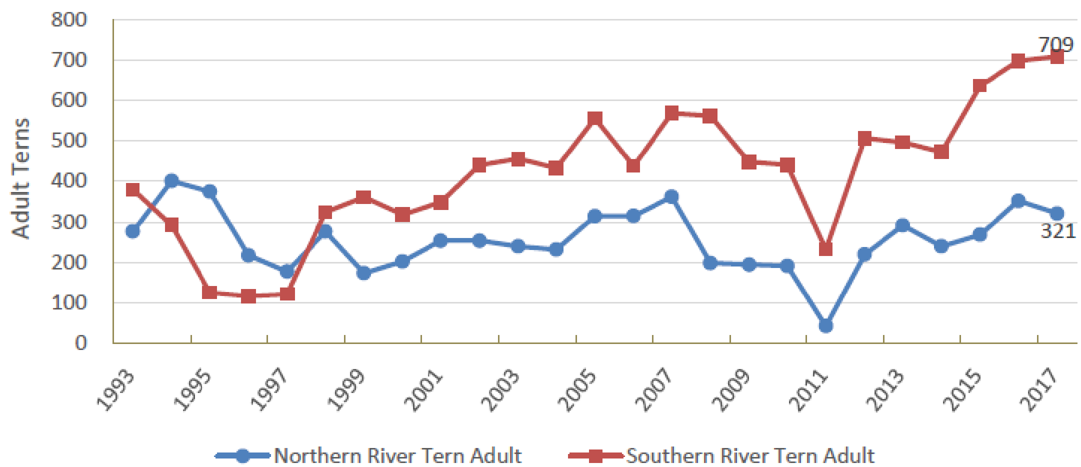

Figure 14. Adult least tern counts by region. Adapted from USACE (2018).

13. INTERIOR LEAST TERN – ENVIRONMENTAL BASELINE

13.1 Status of the Species within the Action Area

Along the Missouri River drainage, the interior least tern population was relatively stable during the period from 1993 to 2016, but since recovery criteria were identified neither the drainage population target (2,100) or many of the targets identified for Missouri River drainage segments have been consistently met. The birds that nest on the Missouri River currently comprise less than five percent of the range-wide interior least tern population (Service 2013, p. 70). Whereas the Upper Missouri River North population tern counts appear to have experienced a declining trend over the period of record, it is offset by an apparent increasing trend in the Upper Missouri River South reach (Service 2013, p. 15). Dispersal between interior least tern populations has been poorly documented, but it appears to be an important factor in maintenance of the upper Missouri River (Lott et al. 2013).

Since the tern was listed, the Missouri River system has received a significant commitment of conservation attention and resources, particularly in comparison to other drainages that have experienced increases in tern populations, suggesting that this portion of the ecosystem is likely at the carrying capacity of the available habitat (Service 2013, pp. 14-21, at *http://www.regulations.gov*). Monitoring data indicate that periodic downward trends observed in a few Missouri drainage subpopulations have been reversed by habitat improvement following major floods (Pavelka 2012, p. 2), or offset by upward trends in other subpopulations (Pavelka 2012, pp. 7-8; Lott and Sheppard 2017, pp. 49-53).

13.2 Factors Affecting Species Environment within the Action Area

Interior Least Terns – Key Factors

The following key factors that directly affect discrete life stages and life stage transitions of the interior least tern in the action area are adapted from Buenau et al. (2016, p. 10).

- Suitable nesting and brooding habitat for terns consists of sparsely vegetated dry sand, primarily on ESH in river reaches. Terns prefer less vegetation than plovers tolerate and use reservoir shoreline less than plovers. Their use of reservoirs is often limited to ESH or similar habitat exposed in upper portions of reservoirs when reservoir levels are low. The amount of suitable ESH available depends on prior habitat forming flows, the river stage during the nesting season and sandbar morphology. Terns prefer to nest in areas that have greater channel widths. Habitat area determines nest density for a given population size and may affect immigration and emigration to and from the river and within areas of the river.
- Foraging habitat for terns consists of shallow water, in which they dive for small fish. Terns travel longer distances to forage than piping plovers. Therefore, the local availability of foraging habitat does not have a strong effect on nest density, but if it is limiting at the landscape scale it may affect tern chick survival. Proximity to foraging habitat is not important for least terns and so they can nest on sites at higher elevations than piping plovers, reducing their vulnerability to inundation when water levels rise. Nevertheless, if the only available habitat is near the water level, inundation can affect survival from egg to chick.
- Nest density is determined by the area of nesting habitat available and the size of the population. High nest densities may increase predation, but food limitation does not typically affect survival of tern chicks because adults forage away from nesting sites and bring food to chicks.
- Predation affects survival from egg to chick and from chick to fledgling and, to a lesser degree, survival of adults. Predation is more significant when nest densities are high and is also affected by nest location, such as, if nests are on habitats connected to the floodplain or within the channel, or whether they are close to trees or other vegetation that may provide perches or cover for predators. During the 25-year monitoring period on the Missouri River (25 years), the greatest cause of egg loss has been predation (three percent) (Aron *in litt.* 2012). Except for a sharp increase during the flood year of 2011 when nests were concentrated, the proportion of interior least terns predated in the action area has remained relatively constant (USACE 2017, p. 120).
- Immigration and emigration rates are driven by habitat availability and quality, both on the Missouri River and in other rivers that have nesting habitat. Terns disperse longer

distances than piping plovers to find suitable habitat. This dispersal affects the number of adults breeding on the Missouri River and their distribution among reaches.

Factors to be Considered
Managing for sufficient nesting habitat to sustain a NGP piping plover population in the Missouri River will also provide sufficient nesting habitat for the interior least tern in the Missouri River. Piping plovers and least terns are sympatric nesters, often using the same breeding sites throughout the Missouri River basin. This is reflected in the Science and Adaptive Management Plan.

The increases in habitat availability that follow “habitat-forming flows” result in substantial increases in piping plover populations, but only small increases in habitat for interior least terns (Buenau et al. 2014, p. 973). In other words, the viability of the interior least tern population on the Missouri River is unlikely to be as dependent on habitat-forming flows as are piping plovers.

In addition to the key factors, contaminants may also affect interior least terns on the Missouri River and, as with piping plover, human disturbance is a factor. Sampling for contaminants in interior least terns in the Missouri River drainage have documented sub-lethal amounts of arsenic, mercury, chlorinated hydrocarbon, selenium, and PCBs in the species (Fannin and Esmoil 1993, pp. 153-157; Ruelle 1993, pp. 162-170; Allen et al. 1998, pp. 358-364). Human disturbance may increase due to increases in recreation on the river and may be especially important when habitat is low and birds are concentrated (USACE 2017, p. 120). Outdoor Recreational Vehicle impacts have been documented on the Missouri River, but may typically be limited to situations where low flow conditions allow such access.

14. INTERIOR LEAST TERN - EFFECTS OF THE ACTION

Because so many aspects of the USACE approach to conservation management and the effects of operations, in general, are similar between piping plovers and interior least terns we will largely limit our discussion of effects to those aspects that are somehow different for the terns.

14.1 Analysis for Effects of the Action

As with piping plover, management actions for the interior least tern in the Missouri River include habitat management, habitat creation, flow modification, population and habitat monitoring, predator and vegetation control, applied scientific studies, and public education (Service 2003).

Biotic Interactions

Predation Management
The USACE addresses predation of interior least terns with the Predation Management Plan that was described above for piping plover (USACE 2017, p. 119). As with piping plovers, the USACE proposes to implement a variety of measures to control mammalian and avian predators where predation is evidently affecting bird survival and reproduction. For interior least terns, predation is likely to increase on habitats connected to the mainland and where nest colonies are especially dense.

Human Use Restrictions
As with piping plover, human access to the river for recreation sometimes results in intentional or inadvertent harm, harassment, killing, and nest abandonment among interior least terns on the river. Similar measures are used by the USACE to limit these effects, including barricades, signs, and public education.

Flow Modification & Management
Inundation of Nesting Habitat
As with piping plovers, USACE actions are likely to inundate interior least tern nests as a result of flow management at the system dams. The factors that determine how flows and dam operations may cause inundation of interior least tern nests are essentially identical to those that affect piping plovers, although the number of nests affected is markedly lower than for piping plovers because terns nest at higher elevations. The total number of tern eggs lost has not exceeded about 75 since 1996 (USACE 2017, pp. 122-123). As with plovers, most nest loss (85 %) occurs on the reservoirs as opposed to the riverine sections and this is likely to continue. Effects to foraging habitat are less clear because interior least terns forage predominantly on fish in shallow water.

The Role of Flow in the Creation of and Modification of Habitats
The transport and deposition of sediment and scouring of vegetation from sandbars creates habitat for interior least terns, in a manner similar to that for the piping plover (see above). Although interior least terns nest at higher elevations than piping plovers, they nest in generally similar habitats and the underlying physical factors that form these habitats are similar and discussed in detail above for the piping plover.

Much of the count fluctuation in both the Northern and Southern Regions of the Missouri River appears to be directly influenced by discharge (Service 2013, p. 15). Interior least tern numbers decrease during high water years when nesting habitats are flooded, and increase during low water years with greater exposure of the river bottom (Pavelka *in litt*. 2012). Over time, however, suitable nesting habitat is lost to vegetation and erosion. In recent years, declining habitat trends have been reversed by rare major flow events (a 100-year flood event in 1995-1996 and a 200-year flood event in 2011) which have reset both the nesting habitat and the forage base.

Dams have interrupted coarse sediment transport in the Missouri River. The sediment that does get transported through the dams is often finer and not suitable for interior least tern nesting habitat (USACE 2013b). A USACE modeling exercise evaluating the potential for moving sediment through Gavins Point dam (the lowest dam on the system) determined that a single flushing event without infrastructure changes to the dam would be unlikely to transport coarse sediment through the dam (USACE 2013a, USACE 2013b). This modeling suggests that repeated flushing events, especially in conjunction with dredging to mobilize sediment and infrastructure changes to the spillway, may result in better sediment transport (USACE 2013b).

Construction of Emergent Sandbar Habitat
The USACE has attempted to provide additional nesting and brood-rearing habitat on the Missouri River by constructing sandbars and managing vegetation both in channel and on

reservoirs (Pavelka *in litt*. 2012). Between 2004 and 2011, the amount of habitat lost to erosion was greater than the approximately 870 acres of habitat constructed during the same period (USACE 2012a, USACE 2012b). River habitat losses may be offset to some degree by lower reservoir levels exposing suitable nesting habitat along the shorelines; however, reservoir nesting areas are subject to flooding as the reservoirs capture spring runoff (Service 2003, USACE 2006). Reservoirs support about 15 % of the habitat within the Missouri River system (Pavelka *in litt*. 2012). As noted above, declining habitat trends are periodically reversed by major flow events; the 2011 flood event created greater than 14,000 acres of sandbar habitat on the Missouri River (USACE 2013c). Overall, the available information suggests that interior least tern habitat availability and quality in the Missouri River is primarily affected by periodic events of large habitat forming floods and intervening years of comparatively low flows. The combined data for the Upper and Lower reaches of the Missouri River indicate a stable, possibly increasing interior least tern population in the Missouri River over the period of record (Figure 14) relative to the 1988 population estimate cited in the recovery plan (556 birds). Interior least tern populations have persisted with relative population stability for more than two decades under this management system, given periodic major flood events.

14.2 Effects of Interrelated and Interdependent Actions

There are a variety of actions that would not occur but for the USACE operations, including the Science and Adaptive Management Plan and activities focused specifically on species conservation, but we do not anticipate effects in addition to those considered above. Activities carried out by non-federal entities in the action area are numerous, but any effects to interior least terns are highly integrated with the effects of the USACE actions and we do not anticipate that these actions would affect the species in a manner or to an extent not already considered above. As with the piping plover, one example is human disturbance, whose effects do not appear to be caused by the USACE actions, but in some cases are facilitated by them. For example, placement of engineered habitats near recreation areas may facilitate an increased exposure to human disturbance.

15. INTERIOR LEAST TERN – CUMULATIVE EFFECTS

As with the piping plover, the effects to interior least terns of non-federal actions in the action area are not easily distinguished from the effects of the USACE actions or additive to those effects. The factors that are driving the biotic responses of interior least terns in the action area are dominated by the actions of the USACE – operation of the system and actions implemented to benefit the species addressed in this biological opinion.

16. INTERIOR LEAST TERN – CONCLUSION

We conclude that the Proposed Action is not likely to jeopardize the continued existence of the interior least tern, for the following reasons.

- Implementation of the Science and Adaptive Management Plan by the USACE, in collaboration with Service and MRRIC, will focus primarily on maintaining the amount and distribution of ESH sufficient to ensure viability of the piping plover on the Missouri River. This will help to ensure that interior least terns are capable of maintaining a level of reproduction in the action area that is sufficient to support numbers of breeding adults at levels similar to the period, 1993-2017. Over this time, the population trend was approximately stable. Moreover, in support of the Science and Adaptive Management Plan, the USACE will ensure that these levels of reproduction and abundance will be maintained in both the northern and southern regions of the action area to avoid any reduction in the species' current distribution.

- Since development of the recovery plan in 1990, interior least terns have experienced large increases in the populations along the Arkansas, Red, and Lower Mississippi Rivers and numerous subpopulation segments have been discovered throughout the Interior Basin.

17. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to Section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is defined by regulation as "an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering." Harass is defined by regulation as "… an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding or sheltering." Incidental take is defined as "takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the federal agency or applicant." Under the terms of Section 7(b)(4) and Section 7(o)(2), such taking is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement (ITS).

When a biological opinion concludes the effects of a proposed action is not likely to jeopardize a listed species, but there are effects described in that opinion that meet the definition of take in the Act, an ITS is required in addition to the BO. This ITS exempts the action agency (and any applicant) from the prohibitions of take in section 9 of the Act. Exceeding the described level of such take acts as one of the triggers for reinitiation (there are 3 other triggers) (50 CFR 402.16).

The reasonable and prudent measures described below, along with their implementing terms and conditions, are nondiscretionary, and must be undertaken by the USACE so that they become binding conditions of any grant or permit issued to the USACE, as appropriate, for the exemption in Section 7(o)(2) to apply. The USACE has a continuing duty to regulate the activity covered by this ITS. If the USACE (1) fails to assume and implement the terms and conditions or (2) fails to adhere to the terms and conditions of the ITS through enforceable terms that are added to the permit or grant document, the protective coverage of Section 7(o)(2) may lapse. To monitor the impact of incidental take, the USACE must report the progress of the action and its impact on the species to the Service as specified in the ITS [50 CFR§ 402.14(i)(3)].

Surrogacy - Congress preferred that the take be enumerated and the regulations and policy echo that preference. However, it was recognized by Congress that if a number could not be ascertained, a surrogate could be used. H.R. Rep. No. 97–567, at 27 (1982). The Service explained the role of surrogates and their use by amending (§ 402.14(i)(1)(i)) of the regulations regarding incidental take in 2015. If surrogates are used, the biological opinion or ITS must (1) describe the causal link between the surrogate and take of the listed species; (2) describe why it is not practical to express the amount of anticipated take or to monitor take related impacts in terms of individuals of the listed species; and (3) set a clear standard for determining when the amount or extent of the taking has been exceeded. After receiving ISAP's comments on the incidental take summaries that the Service provided to the USACE, USACE recommended that the Service acknowledge the five process steps described in Murphy and Weiland (2014). During promulgation of the 2015 regulations, public input was sought and received on a draft proposed rule. All comments, including the Murphy and Weiland paper were reviewed and incorporated, as appropriate, in the final regulation. Consistent with the regulations and guidance contained in that final rule, the Service developed the ITS in this BiOp.

In many cases, the biology of a listed species or the nature of the proposed action makes it difficult to detect or monitor take of individual animals. Additionally, the impact of proposed actions may not be in the form of direct or immediate mortality to affected individuals, but rather a reduction in their biological fitness. For example, a decrease in fitness may occur if habitat loss or degradation likely to be caused by the proposed federal action results in less food available to individuals of the listed species. In those cases, impacts to a "surrogate" such as habitat, ecological conditions or a similarly affected species that is easier to monitor may be the most reasonable and meaningful measure of assessing and monitoring anticipated take of listed species. In this ITS, the surrogates we use are indirect measures of some characteristic of the species for which we are estimating anticipated take.

Revision - As this is an ongoing and long term action, should information become available that suggests a better metric or surrogate for approximating take, the Service, in coordination with the USACE, will take that information into consideration for amending this ITS.

17.1. Amount or Extent of Incidental Take Anticipated

17.1.1 Pallid Sturgeon

Incidental take is anticipated as a result of the implementation of the proposed action.

> (a) The Service anticipates that incidental take of adults in the form of harm, (impaired reproduction and growth), is reasonably certain to occur from the following factors or a combination of these factors: missing environmental cues (including spawning cues), the form and function of a natural hydrograph, colder temperature regimes, lack of sediment or turbidity regime, inadequate quantity and quality of available spawning and foraging habitat.
>
> (b) The Service anticipates that incidental take of eggs, larvae and juveniles in the form of harm, (impaired growth and survival), is reasonably certain to occur from the following factors or a combination of these factors: lack of the quantity and quality of a sufficient diversity of rearing and foraging habitat, and sufficient environmental factors noted in (a) above.

Describing the level of take for this proposed action is extremely difficult. It is difficult because the impacts occur over an entire river system, the pallid sturgeon demographic unit which includes lower Missouri River fish and extends into the Mississippi River, every fish that might be killed or injured is impossible to count, and there are a number of environmental conditions not directly related to the action that can also produce death or injury.

Because of this complicated circumstance, the Service is using surrogates for estimating the extent of take that is anticipated to result from the proposed action. Recognizing the broad extent of the action area and to insure a reasonable sensitivity of measure, we are also using similar metrics, but different measures for different areas of the river (upper and lower). The primary metrics for determining incidental take and the secondary metrics were developed with input from biologists and research scientists from the Service, USACE, and USGS.

In this BiOp, the Service has found little to no additional adverse effects likely to occur from the Proposed Action when compared to the previous proposed action evaluated in 2003. In fact, the Service has found that if the Science and Adaptive Management Plan is implemented as prescribed, the pallid sturgeon is expected to improve in the action area. Because the adverse effects have been found to be similar to past effects, the Service will use population parameters from the past decade to inform the threshold for anticipated take as it should be similar to that observed in the past decade. In this way the Service and the Corps will be operating in a manner that ensures that should anticipated take (as measured by population parameters) exceed that observed in the past under similar conditions – reinitiation can be triggered.

Metrics - To express the levels of anticipated incidental take from (a), (b), and (c) above, we will rely on data collected as part of the PSPAP. Data collected from other entities (e.g. tracking broodstock, Missouri Fish, Wildlife & Parks sampling funded by Western Power Area Power Administration) can be incorporated if made available to the USACE. We have selected primary and secondary metrics for each of the Upper River and the Lower River segments. Apparent survival in the Upper River and apparent survival and catch per unit effort (CPUE) in the Lower River will be the primary metrics for establishing an anticipated level of take. Monitoring these metrics will determine if take is exceeded. We will use the following secondary metrics, not to determine the anticipated level of take, but to help interpret and inform the primary metrics: abundance (Upper River only), growth rate, fish condition, and reproductive cycling. These metrics provide additional information regarding the response of pallid sturgeon to environmental stressors. For example, a decrease in condition could be attributed to lack of sufficient prey resources, exposure to contaminants, disease, etc. While a change in any of these metrics doesn’t establish a cause and effect relationship between take and USACE operations, it could provide an indicator that some unanticipated stressor(s) is negatively affecting pallid sturgeon and will warrant investigation even if incidental take currently remains within expected limits.

Given the spatial separation of pallid sturgeon between the upper and lower Missouri River basins (as geographically defined in the Scientific and Adaptive Management Plan), the varying challenges of estimating take within these areas, and the potential for differing biotic and abiotic factors to affect current conditions, this ITS addresses those populations separately and uses the metrics most appropriate for specific geographic locations.

Upper Basin

1) *Primary Metric: Apparent Survival*

Calculations of age-specific survival can be used to forecast population size and sustainability. While these data are somewhat more difficult to collect, this information is necessary for updating the ongoing pallid sturgeon population model currently being developed by Colvin et al. As such, calculating life stage-specific survival will be part of ongoing efforts and can be used to better understand the upper Missouri River pallid sturgeon population. As the new PSPAP sample design is implemented, if sufficient data are available, survival (i.e., survival estimates accounting for fish temporarily leaving the system) will be estimated using multi-state capture recapture models like the robust design.

Data requirements: Capture/recapture information (PSPAP).

Temporal requirements: Annual

Fish life stage(s): Age 1+

Analysis frequency: Annual

Benchmark[7]:
Survival estimates will be quantified using mark-recapture models (e.g., multistate or Cormack-Jolly-Seber) for hatchery-reared and wild (modeled separately) pallid sturgeon captured during Pallid Sturgeon Population Assessment Program (PSPAP) sampling from 2006 to 2017.

Survival of fish at age-4 and older will be used to index take because younger fish are not sampled effectively with current PSPAP gears (see Pierce et al. 2017). Therefore, survival estimates at early ages are primarily informed by recaptures of these fish later in life. Conversely, fish age 4 and older are recruiting to sampling gears and can provide a more immediate response metric to changes in the environment. Age-at-stocking and hatchery of origin should be evaluated as a covariate predictor of survival rate for hatchery-reared fish because previous research has indicated that survival rates differ by stocking age (Rotella 2017; Steffensen et al. 2010; Steffensen et al. 2016) and hatchery origin. Additionally, age-specific and stage-specific (i.e., juvenile or adult) survival and recapture probabilities should be evaluated because monitoring efforts have identified that recruitment to sampling gears is associated with fish age (either directly or as a surrogate for length; Pierce et al. 2017), and because stocking-age may not affect survival at older ages.

Survival estimates can vary widely and require additional population measures than those necessary to estimate abundance. The initial benchmark will be based on the average of the previous years of survival estimates (2006 to 2017). It should also be noted that future PSPAP

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[7] Benchmark –will be the term used in the calculation when determining the threshold level of take we anticipate. (Note: this is different from the use of the term “benchmark” in 3.2.4 Contaminants)

data collection may provide more reliable survival estimates which will need to be considered when evaluating against the benchmark.

Anticipated level of take:

Annual quantification of survival rate for take monitoring will utilize a three year running average of survival and model structures used to develop the benchmark. However, data used in this analysis will differ slightly from the benchmark because it will include data collected after 2017. That is, each year, newly collected sampling data (i.e., recaptures) will be added to the data set for that year's analyses.

Take will be exceeded if age-4+ survival estimates exceed two standard errors below the benchmark for three consecutive years

2) *Secondary Metric:* Abundance of pallid sturgeon

Pallid sturgeon abundance (population size) is the number of pallid sturgeon estimated to be present within a given year. Therefore, a decrease in abundance is indicative of a population where mortality exceeds recruitment. (This is currently the situation in the upper basin for wild pallid sturgeon – abundance is declining due to lack of natural recruitment to age-1 and senescence of adults). Past data collection efforts have allowed for regular updates to abundance estimates for both hatchery-reared and wild pallid sturgeon. It is anticipated that these types of data will continue to be collected with an additional emphasis on obtaining reliable, more frequent population estimates via the re-design of PSPAP that will utilize a Capture-Recapture Robust design. CPUE has been and will continue to be collected as part of PSPAP which can provide a relative index of population abundance (USACE 2017, Appendix F). CPUE data may help inform pallid sturgeon population trends moving forward. Additionally, both abundance and CPUE are aligned with the pallid sturgeon recovery plan and the MRRMP Science and Adaptive Management Plan (ISAP, 2018). Abundance of wild pallid sturgeon is proposed as a secondary metric because it will continue to indicate a decline until natural recruitment occurs. Changes in the benchmark for survival, however, can indicate unexpected impacts regardless of recruitment to age-1.

Data requirements: Capture/recapture information (PSPAP).

Temporal requirements: Annual

Fish life stage(s): Age 1+

Analysis frequency: Annual

Approach for Determination of the Benchmark and Quantification of Take Metric

Benchmark:

Abundance will be estimated for hatchery-reared and wild (estimated separately) pallid sturgeon from data collected during past PSPAP efforts (2006 to 2017).

Anticipated level of take:
None – value is a secondary metric

3) *Secondary Metric: Condition*

Relative weight or predicted weight (both measures of condition) are a means to assess the weight of an individual fish against a standard derived from a larger sample of same-sized fish in the population. This index provides general information on individual fish health and provides insight into the environmental conditions to which pallid sturgeon may be exposed. For example, a decrease in condition could be attributed to lack of sufficient prey resources, overabundance, exposure to contaminants, disease, etc.

Benchmark:
Benchmark values for fish condition will be developed for hatchery-reared and wild pallid sturgeon captured during PSPAP from 2006 to 2017 using relative condition (Kn; Pope and Kruse 2007) with an updated pallid sturgeon standard weight developed by Randall et al. (2017). The previous standard weight for the pallid sturgeon was developed by Shuman et al. (2011). In addition, fish predicted weight will be evaluated as described by Randall et al. (2017). Benchmarks will be calculated using the range and as the mean (and 2 standard error) of annual means in fish condition. Benchmarks will be calculated for biologically meaningful sizes such as juvenile, sub-adult (piscivorous), and adult or by standard length categories (e.g., stock, quality).

When developing the benchmarks, some stratification will be necessary to account for known natural annual variability. Two time periods will be used: January through June and July through December. For example, individual pallid sturgeon will have differing condition scores if it was collected prior to spawning as opposed to post spawn. The change in weight, however, wouldn't be indicative of changing environmental factors but rather the loss of gametes. Further, pallid sturgeon undertake migrations in the spring, thus a fish can make large changes in weight loss if it migrates far, so depending on when a fish was caught during its migration, its weight could be very different just a couple weeks apart.

Data requirements: Capture information (PSPAP).

Temporal requirements: Annual

Fish life stage(s): Age 1+

Analysis frequency: Annual

Anticipated level of take:
None – value is a secondary metric

4) *Secondary Metric: - Growth rate of fish*

A year class of fish should exhibit positive growth from one growing season to the next until reaching sexual maturity, after which time we expect that positive growth will significantly decrease as reproductive maturity is reached. Available energy is used for gamete production rather than increases in body size. The time at which reproductive maturity is reached, however, will vary among reaches of the river, between males and females, and possibly the hatchery of origin. Additionally, new information regarding growth rates of specific parental crosses will need to be evaluated to better understand the effect of specific family lots on growth potential.

Benchmark:
Benchmarks for mean length at age from known age fish (hatchery) will be developed using data collected as part of PSPAP from 2006 to 2017 and adjusted based upon the variables discussed above. Benchmarks will be calculated as the mean (and two standard error) of annual mean growth rates for each age group of fish (i.e. 1-2, 2-3, 3-4…).

Data requirements: Capture/recapture information (PSPAP); Hatchery of origin; Genetics; Stocking database.

Temporal requirements: Annual

Fish life stage(s): Age 1+

Analysis frequency: Annual

Anticipated level of take:
None – value is a secondary metric

5) *Secondary Metric: - Reproductive Cycling*

The number of reproductive female pallid sturgeon can have a significant effect on population growth rates and population sustainability. Therefore a change in the frequency of reproduction could be an indicator of new or additional stressors and indicate increased take. For wild fish, and as hatchery stocked fish come into maturity, an index of the proportion of sexually mature fish that produce viable gametes (e.g., black egg females) could be used.

Benchmark:
Because tracking reproductive frequency of individual fish is time consuming, costly, and infeasible for large numbers of pallid sturgeon an alternative means of determining frequency of reproduction is necessary. The proportion of reproductively ready individuals from past broodstock collection efforts could be used to inform the benchmark and provide a metric for assessment. For example, if reproductive frequency occurs every four years after reaching maturity (one out of four years), we would expect 25 % of randomly sampled, mature adults to have gametes ready for reproduction annually. Adults sampled from past broodstock collection efforts will be used to calculate the expected proportion of reproductively ready adult female pallid sturgeon.

Data requirements: Capture information (Broodstock collection); Reproductive readiness.

Temporal requirements: Annual

Fish life stage(s): Mature adults

Analysis frequency: Annual

Anticipated level of take:
None – value is a secondary metric

Lower Basin

Developing an ITS for pallid sturgeon in the lower Missouri River basin presents a unique set of challenges given the "open" nature of the system and movement of pallid sturgeon between the lower Missouri River and Mississippi River. As such, this is not a "closed" system and immigration and emigration will occur. Unfortunately, current data and understanding regarding the geographic boundaries of this pallid sturgeon demographic unit limit the ability to fully utilize some measures of take that rely on population abundance or survival rates due to the concerns previously described. These limitations, however, do not preclude the Service from developing an ITS that utilizes the best information available. Therefore, metrics such as abundance, apparent survival, etc. may still provide a relative index for comparative purposes, even if absolute values cannot be determined. Explicit acknowledgement of these limitations and required assumptions are discussed in several of the metrics below. Ongoing science efforts will help fill these information gaps and as new information becomes available, this ITS can be modified accordingly. For example, as more information is gained regarding emigration from the Missouri River, models that estimate population size can account for dispersal and provide an estimate of true survival. Several approaches, including direct measurement of emigration/immigration by telemetry and mark-recapture models (e.g., multistate models) are available to estimate emigration/immigration. Increased quantification of emigration/immigration could be used to refine survival estimates for the benchmark and future, as long as environmental factors associated with emigration/immigration have not changed. Simulation modeling of the revised PSPAP, mark-recapture sample design, may be used to evaluate benefits of this increased precision in measuring take.

1) *Primary Metric: Apparent Survival*

As previously discussed, accurately calculating survival in the lower Missouri River is challenging. One approach, however, is to treat apparent survival as the operational metric without differentiation between mortality and emigration. This requires acknowledgement that the results may underestimate survival of lower Missouri River pallid sturgeon and therefore, would overestimate take. This could be overcome however, if emigration is assumed to be constant over time. Given this assumption, the annual loss of individuals due to emigration would be accounted for in the benchmark apparent survival assessment (derived from data collected by PSPAP from 2005 to 2017) to which future comparisons will be made. While actual survival would not be measured by this approach it does provide an index of apparent survival that could serve to indicate if take exceeds the anticipated level.

Data requirements: Capture/recapture information (PSPAP).

Temporal requirements: Annual (PSPAP)

Fish life stage(s): Age 1+

Analysis frequency: Annual (PSPAP)

Benchmark:
Survival estimates will be quantified using mark-recapture models (e.g., multistate or Cormack-Jolly-Seber) for hatchery-reared and wild (modeled separately) pallid sturgeon captured during Pallid Sturgeon Population Assessment Program (PSPAP) sampling from 2005 to 2017. Alternatively, if sufficient data is available, survival (i.e., survival estimates accounting for fish temporarily leaving the system) will be estimated using multi-state capture recapture models like the Robust Design.

Survival of fish at age 4 and older will be used to index take because younger fish are not sampled effectively with current PSPAP gears (see Pierce et al. 2017). Therefore, survival estimates at early ages are primarily informed by recaptures of these fish later in life. Conversely, fish age 4 and older are recruiting to sampling gears and can provide a more immediate response metric to changes in the environment. Age-at-stocking and hatchery of origin should be evaluated as a covariate predictor of survival rate for hatchery-reared fish because previous research has indicated that survival rates differ by stocking age (Rotella 2017; Steffensen et al. 2010; Steffensen et al. 2016) and hatchery origin. Additionally, age-specific and stage-specific (i.e., juvenile or adult) survival and recapture probabilities should be evaluated because monitoring efforts have identified that recruitment to sampling gears is associated with fish age (either directly or as a surrogate for length; Pierce et al. 2017), and because stocking-age may not affect survival at older ages.

Survival estimates can vary widely and require additional population measures than those necessary to estimate abundance. The initial benchmark will be based on the average of the previous 12 years of survival estimates, (2005 to 2017). It should also be noted that future PSPAP data collection may provide more reliable survival estimates which will need to be considered when evaluating against the benchmark.

Anticipated level of take:

Annual quantification of survival rate for take determination will utilize a three year running average of survival and model structures used to develop the benchmark survival rates. However, data used in this analysis will differ slightly from the benchmark estimates because it will include data collected after 2017. That is, each year, newly collected sampling data (i.e., recaptures) will be added to the data set for that year's analyses.

Take will be exceeded if age-4+ survival estimates exceed two standard errors below the benchmark for three consecutive years

2) Primary Metric: CPUE of adult wild pallid sturgeon

A majority of the wild pallid sturgeon captured in the lower Missouri River are at or near sexual maturity. Although these fish do move between the Missouri and Mississippi Rivers, our expectation is that they return to the Missouri River as adults where they are susceptible to past and proposed monitoring and broodstock collection efforts. Since 2005, catch rates of wild pallid sturgeon have been relatively stable (Figure 15). While CPUE doesn't estimate population size, it can serve as a relative index of population size and is not subject to assumptions associated with calculating abundance or survival rates. For example, in the lower Missouri River, this may indicate a relatively static low number of individuals that continue to persist (i.e. stable, low numbers). A decrease in CPUE of adult wild pallid sturgeon, therefore, may be indicative of population declines. Utilization of CPUE as a metric for take assessment is also advantageous in that it corresponds with the pallid sturgeon recovery plan and the MRRP Science and Adaptive Management Plan. As the new PSPAP design is implemented and population size estimates are produced, the utility of population size as a measure of abundance for the purposes of this ITS will be evaluated.

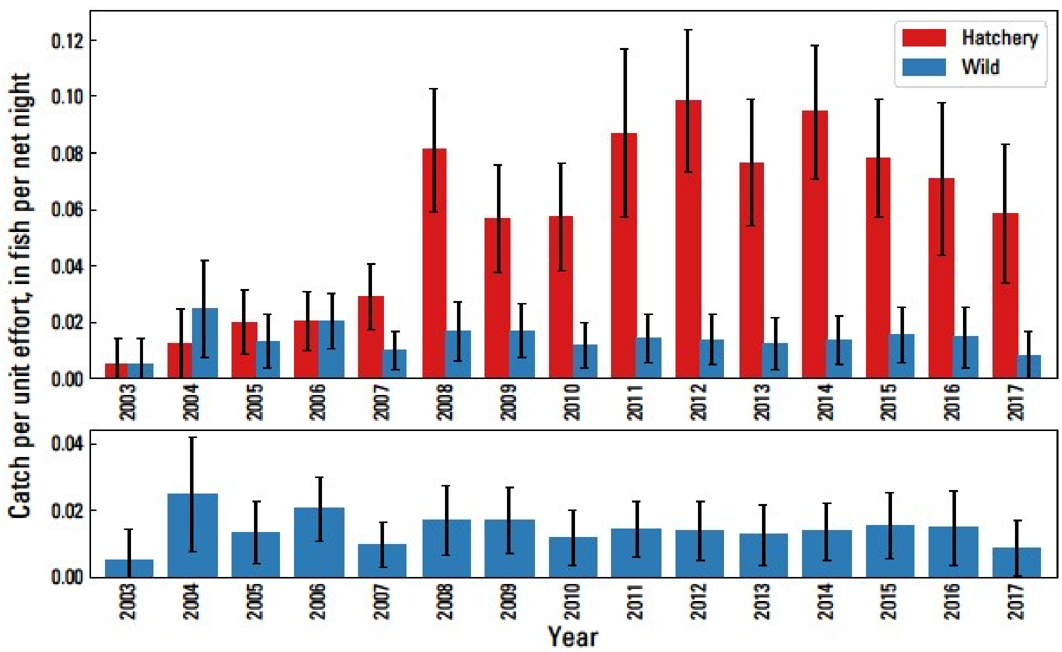

Figure 15. Lower River CPUE using gill nets, all seasons, standard gears, and combined segments 7, 8, 9, 10, 13, and 14. Note that segments 13 and 14 were not sampled during 2016 and 2017. Data source: PSPAP, as of November 3, 2017.

Data requirements: Capture information (PSPAP).

Temporal requirements: Annual (PSPAP)

Fish life stage(s): Wild Adults

Analysis frequency: Annual (PSPAP)

Benchmark:
Benchmarks for CPUE of adult wild pallid sturgeon will be developed utilizing catch rates from PSPAP monitoring efforts from 2005 to 2017.

A change in CPUE will be used to establish a level of anticipated take.

As discussed above, two standard errors of a measurement can generally approximate a 95 % confidence interval, thus anything within two standard errors of the benchmark CPUE can be interpreted as the benchmark. Future CPUE values lower than this benchmark indicate that numbers have decreased and take has likely been exceeded.

Anticipated level of take:
Annual calculations of CPUE will be compared to benchmark conditions to determine if the annual rate of take has been exceeded.

Take will be exceeded if CPUE values exceed two standard errors below the benchmark for three consecutive years

3) *Secondary Metric: Condition*

Relative weight or predicted weight (both measures of condition) are a means to assess the weight of an individual fish against a standard derived from a larger sample of same sized fish in the population. This index provides general information on individual fish health and provides insight into the environmental conditions that pallid sturgeon may be exposed to. For example, a decrease in condition could be attributed to lack of sufficient prey resources, exposure to contaminants, disease, etc.

Benchmark:
Benchmark values for fish condition will be developed for hatchery-reared and wild pallid sturgeon captured during PSPAP from 2005 to 2017 using relative condition (Kn; Pope and Kruse 2007) with an updated pallid sturgeon standard weight developed by Randall et al. (2017). The previous standard weight for pallid sturgeon was developed by Shuman et al. (2011). In addition, fish predicted weight will be evaluated as described by Randall et al. (2017). Benchmarks will be calculated as the mean (and 2 standard error) of annual means in fish condition. Benchmarks will be calculated for biologically meaningful sizes such as juvenile, sub-adult (piscivorous), and adult or by standard length categories (e.g., stock, quality).

When developing the benchmark condition values for the lower Missouri River, those factors that influence the normal, expected variability, which are discussed in the upper basin section on condition, should be accounted for as well.

Data requirements: Capture/recapture information (PSPAP).

Temporal requirements: Annual (PSPAP)

Fish life stage(s): Age 1+

Analysis frequency: Annual (PSPAP)

Anticipated level of take:
None – value is a secondary metric

4) *Secondary Metric: - Growth rate of fish*

A year class of fish should exhibit positive growth from one growing season to the next until reaching sexual maturity, after which time we expect that positive growth will significantly decrease as reproductive maturity is reached. The time at which reproductive maturity is reached, however, will vary among reaches of the river, between males and females, and possibly the hatchery of origin. Additionally, new information regarding growth rates of specific parental crosses will need to be evaluated to better understand the effect of specific family lots on growth potential.

Benchmark:
Benchmark values for mean length at age from known age fish (hatchery) will be developed using data collected as part of PSPAP from 2006 to 2017 and adjusted based upon the variables discussed above. Benchmarks will be calculated as the mean (and two standard error) of annual mean growth rates for each age group of fish (i.e. 1-2, 2-3, 3-4…).

Data requirements: Capture/recapture information (PSPAP); Hatchery of origin; Genetics Stocking database.

Temporal requirements: Annual

Fish life stage(s): Age 1+

Analysis frequency: Annual

Anticipated level of take:
None – value is a secondary metric

Secondary Metric: - Reproductive Cycling

The number of reproductive female pallid sturgeon can have a significant effect on population growth rates and population sustainability. Therefore a change in the frequency of reproduction could be an indicator of new or additional stressors and indicate increased take. For wild fish, and as hatchery stocked fish come into maturity, an index of the proportion of sexually mature fish that produce viable gametes (e.g., black egg females) could be used.

Benchmark:
Because tracking reproductive frequency of individual fish is time consuming, costly, and infeasible for large numbers of pallid sturgeon, an alternative means of determining frequency of reproduction is necessary. The proportion of reproductively ready individuals from past

broodstock collection efforts could be used to inform the benchmark and provide a metric for assessment. For example, if reproductive frequency occurs every four years after reaching maturity one out of four years, we would expect 25 % of randomly sampled, mature adults to have gametes ready for reproduction annually. Adults sampled from past broodstock collection efforts will be used to calculate the expected proportion of reproductively ready adult female pallid sturgeon.

Data requirements: Capture information (broodstock collection); Reproductive readiness

Temporal requirements: Annual

Fish life stage(s): Mature adults

Analysis frequency: Annual

Anticipated level of take:
None – value is a secondary metric
EFFECT OF THE TAKE

The accompanying BiOp, found that the proposed action, including the resulting adverse effects is not likely to jeopardize the continued existence of the pallid sturgeon. The anticipated take described above is simply a recasting of a subset of those adverse effects (those that meet the definition of take) discussed and analyzed in the opinion. It follows then, that the level of take described above is not likely to jeopardize the continued existence of the pallid sturgeon.

REASONABLE AND PRUDENT MEASURES

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. The Service believes the following reasonable and prudent measures (RPM) are necessary and appropriate to minimize impact of incidental take of pallid sturgeon:

RPM 1 – Monitoring
In order to monitor the impacts of incidental take, the USACE must report the progress of the action and its impact on the species to the Service as specified in the ITS (50 CFR 402.14 (i)(3)). These reporting and monitoring requirements are non-discretionary and must be undertaken by the USACE.

TERMS AND CONDITIONS
To be exempt from the prohibitions of Section 9 of the ESA, the USACE must comply with the following terms and conditions, which implement the reasonable and prudent measure described above and outline required reporting/monitoring requirements. These terms and conditions are nondiscretionary.

To Implement RPM 1:

1.1 The USACE shall monitor the attributes described above to calculate the primary metric that will be used to determine the incidental take anticipated from this project and the secondary metrics that will inform and interpret the primary metric.

1.2 The USACE shall include the information collected under Term and Condition 1.1 in their annual Adaptive Management Report that is provided to the Service for review (typically by January of each year).

Incidental Take from Monitoring and Research Studies
The adaptive management process described in the Proposed Action is based on the continuation and expansion of existing monitoring programs. The information obtained from these programs directs future management actions. Incidental take for these monitoring programs can be quantified and some of these activities have been previously and will continue to be authorized under individual ESA section 10 permits. USACE will continue to require all entities conducting the research/monitoring activities to possess a valid permit or instrument that exempts them from ESA section 9 prohibitions.

The following activities will be covered by other permits or instruments. These programs will include netting, handling, tagging, and collection of biological samples and individuals of pallid sturgeon.

1. **Pallid Sturgeon Population Assessment Project** and **Propagation and Augmentation–**
    a. Sampling to meet fundamental objective 1 (increase pallid sturgeon recruitment to age 1).
    b. Sampling to meet fundamental objective 2 (Maintain or increase numbers of pallid sturgeon until sufficient and sustained natural recruitment occurs).
2. **Level 1 and 2 Studies –**
    a. Research and Monitoring to test hypotheses related to Fundamental Sub-objective 1.
    b. Research and Monitoring to test hypotheses related to Fundamental Sub-objective 2.
3. **Spawning Habitat Construction –** Biological Monitoring.
4. **Channel Reconfiguration for IRCs (Includes modifications to existing SWH sites – Pre and Post Construction Monitoring of IRC's**

Annual anticipated take for all sampling programs listed above:

- Take in the form of harm from death during collection for monitoring and research is anticipated to be less than 100 free embryos/larvae per year.
- Take in the form of harm from death for capture and handling of juvenile and adults is anticipated to be less than 15 individuals per year.
- Take from capture and handling of juvenile and adults is anticipated to be less than 1,500 individual per year.

17.1.2 Piping Plover

As a result of the Proposed Action incidental take is reasonably certain to occur as a result of the following:

1. ***Suppression of natural disturbance dynamics*** due to dam operations that will limit the amount of nesting and brooding habitat along riverine reaches in the action area, concentrate nests and chicks, and force piping plovers to nest in suboptimal habitats (e.g., near trees where predators will perch) and increase exposure to human disturbance. The higher densities of nests and chicks will kill piping plovers by causing increased predation of piping plover at all life stages, increased nest abandonment, and will injure and kill (harm) chicks and fledglings by limiting food availability, interfering with normal behavior – especially feeding – and cause death and injury (harm) due to interactions with humans and their pets. Reduced food availability and interference with normal behavior patterns will lead to degraded body condition and decreased survival among the affected birds during their hatch-year (i.e., 0-1 year post-hatch) and later, when they are adults. Piping plover abundance and population dynamics are strongly tied to the extent of nesting habitat, which is dependent on repeated habitat building events over time (Anteau et al. 2014a, p. 1041).
2. ***Hypolimnetic releases*** below Garrison Dam and Ft. Randall Dam will harm chicks and fledglings by reducing forage in the affected reaches. Reduced food availability will lead to degraded body condition and decreased survival among the affected birds during their hatch-year (i.e., 0-1 year post-hatch) and later, when they are adults.
3. ***Unintended effects of nest caging –*** Increased rate of death of adults and eggs due to predation and nest abandonment, respectively, at some caged nests.
4. ***Inundation of nests*** resulting in the death of eggs and young due to operational-caused flooding – that is, daily dam operations, including storage and releases, and flood control operations.

Amount or Extent of Take

Suppression of natural disturbance dynamics, hypolimnetic releases, and unintended effects of nest caging in riverine reaches – We will use two surrogates to express the amount of incidental take that will occur on all riverine reaches as a result of the suppression of natural disturbance dynamics and the unintended effects of nest caging and from hypolimnetic releases in two of those reaches. The surrogates are a) the numbers of adults present on riverine reaches and b) the numbers of piping plovers fledged from those reaches. The riverine reaches are the Garrison reach; the Fort Randall reach; the delta segment of Lewis and Clark Lake; and the Gavins Point reach (USACE 2017, p. 68). The USACE will collect the data needed to track these surrogates as part of its annual monitoring of adults and fledglings, respectively, as part of its Least Tern and Piping Plover Monitoring Program (USACE 2017, p. 51).[8]

Several factors affect piping plover abundance on the Missouri River, but the amount of available habitat may be the primary factor that determines carrying capacity (Catlin et al. 2015, p. 34). When the amount of habitat declines and when adults are predated or nests fail due to unintended effects of nest caging, the number of piping plovers that survive

[8] See the section, **Potential Changes to the USACE Piping Plover and Least Tern Monitoring Program**, below with regard to what would occur if the USACE chose to change its monitoring methods.

and return to these reaches to nest in subsequent years is affected. In addition, the amount of sandbar habitat in the riverine reaches will influence the numbers of fledglings produced by nesting adults. Despite the large impact that the amount of suitable habitat has on the number of nesting adults and on the production of fledgling piping plovers on the Missouri River, these measures of abundance and productivity may also be affected by factors outside of the action area. These include movements to and from habitats outside of the action area and survival during migration and on the wintering grounds. We anticipate that any unexpected changes to the levels of these surrogate measures of take will be examined collaboratively by the USACE and the Service.

These are also appropriate surrogates for the incidental take that we expect to occur due to the effects of prey limitations caused by cold water releases. These releases are likely to result in fewer fledglings in the affected reaches – below the Garrison Dam and the Ft. Randall Dam – and will also affect the number of adults returning to the affected reaches to nest.

We chose total fledglings as a surrogate measure of take in this ITS instead of fledge ratio to avoid confusion with the use of this metric as part of the proposed action's adaptive management plan. If we had used fledge ratios as a surrogate in the incidental take statement, it may not have been based on the same timeframes or targets used in the Science and Adaptive Management Plan. This would have caused confusion and it is important that the Science and Adaptive Management Plan is based on metrics, targets, and timeframes that are distinct from those used in the ITS to ensure that the Science and Adaptive Management Plan framework is not compromised.

It is impractical to monitor take that is reasonably certain to occur as result of suppression of natural disturbance dynamics and the unintended effects of nest caging in terms of individual piping plovers. Predation of eggs, chicks, fledglings, and adults will often go undetected. Likewise, the secondary effects of decreased survival of piping plovers that is likely to result as results of food limitation and disruptions to normal feeding behaviors will typically not be detected. It is also not practical to measure the death and injury (harm) from and decreased survival of piping plovers that is likely to be caused by food limitation caused by hypolimnetic releases. Doing so would require an intense monitoring program that would likely cause high levels of disturbance to piping plovers; in addition, many effects would occur away from the action area and would never be detected.

We will rely on the period from 1993 to 2017 for which data are available for the two surrogate measures to reflect what we anticipate to occur as a result of the proposed action over the next 15 years. We consider take over the next 15 years to align with the implementation timeframe chosen for the MRRMP. We chose a 15-year moving average as the bases for the anticipated levels of incidental take described below for a similar reason and because we know that levels of incidental take will vary among years, but do not know which years will have high or low levels of take. For each year, 15-year moving averages will be calculated using the data for the 15 year period that concludes with the year in question. The moving averages for 2017 and 2018, for example, will be averages for the periods 2003-2017 and 2004-2018, respectively.

The three standards for determining when the level of anticipated take due to the forms of take, numbers 1-3 above, are described below. We have chosen to assume that the numbers of piping plover adults on riverine reaches over the next 15 years will be the same as was recorded during the period 1993-2007. That is, the conditions that affected piping plovers during the period 1993-2007 and the species' response to those conditions would repeat themselves over the next 15 years.

1. The anticipated level of incidental take will be exceeded if the 15-year moving average for the number of adult piping plovers on all riverine reaches combined falls below 402 adult plovers in any of the next 15 years.
2. The anticipated level of incidental take will be exceeded if during the next 15 years, the 15-year moving average for the number of adult piping plovers on all riverine reaches combined is not greater than 600 during at least three years; or, is not greater than 500 during at least eight years.
3. The anticipated level of incidental take will be exceeded if the 15-year moving average of the number of piping plovers fledged for all riverine reaches combined falls below 226 during any of the next 15 years or does not exceed 300 during at least twelve of the next 15 years.

We considered the use of Sub-Objective 2 from the Adaptive Management Plan (USACE 2016) as a surrogate for the forms of take numbers 1 and 2 above, but rejected it. The metric for this sub-objective, acres of emergent sandbar habitat, is likely to change substantially due to model improvements and updating. This sub-objective will be an integral component of the USACE Adaptive Management Plan and we expect that it will drive the mechanical creation of emergent sandbar habitat sufficient by the USACE to meet it. Due to the likely changes to the specific targets it does not make a suitably stable standard for monitoring whether or not the extent of take will be exceeded.

Inundation of nests **–** Variations in the magnitude of runoff over the next 15 years are likely to result in fluctuations in the amount of egg loss due to nest inundation on the reservoirs (i.e., Lake Sakakawea and Lake Oahe). We cannot predict, however, in which years inundation will be high and in which it will be low. Therefore, we will describe the amount of anticipated take as a 15-year moving average. Similar to numbers of adults and fledglings, we will assume that the extent of egg loss during the next 15 years will reflect what occurred during the period 1993-2007. Based on that, we expect that during the 15 years beginning in 2018 the 15-year moving average of the percentage of eggs on the reservoirs that will be lost due to nest inundation will not exceed 27.3 % of all eggs in any single year and will remain below 18 % of all eggs laid in at least two years. Through 2028, the calculation of moving averages will exclude one year, 2013, when nest searching was not conducted on reservoirs and for which an estimate of egg loss is not available. The moving average for 2018, for example, will be an average of percentage egg loss for the years 2003-2018 with no data from 2013.

For river reaches, we also assumed that conditions similar to those that occurred during the period 1993-2007 would occur over the next 15 years, beginning in 2018. Based on this assumption, we expect that the 15-year moving average of the proportion of piping plover eggs lost due to inundation on riverine reaches will not exceed 7.6 % over the next 15 years and will remain below 3.4 % during at least three of the next 15 years.

17.1.3 Interior Least Tern

As a result of the Proposed Action incidental take is likely to occur as a result of the following:

1. ***Inundation of nests*** resulting in the death of eggs and young due to operational-caused flooding – that is, daily dam operations, including storage and releases, and flood control operations.
2. ***Suppression of natural disturbance dynamics*** that will limit the amount of nesting habitat and increase nesting densities in the action area.

Inundation of nests – Due to the large amount of variation that may occur in the amount of nest inundation on reservoirs, we will describe the amount of take as a 15-year moving average using the 1993-2017 dataset. We assume that the amount of egg loss similar to those that occurred during the period 1993-2007 will occur over the next 15 years, beginning in 2018. Based on that, we expect that during the 15 years beginning in 2018 the 15-year moving average of proportion of all interior least tern eggs lost on reservoirs will not exceed 15.6 % in any single year and will remain below 11.8 % in at least six of the next 15 years.

For river reaches, we also assumed that conditions similar to those that occurred during the period 1993-2007 would occur over the next 15 years, beginning in 2018. Based on this assumption, we expect that the 15-year moving average of the proportion of interior least tern eggs lost due to inundation on riverine reaches will remain below 6.9 % over the next 15 years; will be 1.1 % or less during at least two years; and, will remain below 3.1 % during at least three years.

Suppression of natural disturbance dynamics – We will use two surrogates to express the amount of incidental take that will occur on all riverine reaches as a result of the suppression of natural disturbance dynamics – a) the numbers of adults present and b) the numbers of interior least terns fledged on riverine reaches. The amount of emergent sandbar habitat will have significant impacts on both of these metrics. When the amount of habitat declines, the number of interior least terns that survive and return to these reaches to nest in subsequent years is affected; also, the amount of sandbar habitat in the riverine reaches will influence the numbers of fledglings produced by nesting adults.

It is impractical to monitor take-related impacts for that are reasonably certain to occur as result of suppression of natural disturbance dynamics in terms of individual interior least terns because predation of eggs, chicks, fledglings, and adults will often go undetected.

We will rely on the period of record for the two metrics, 1993-2017, to reflect what we anticipate to occur as a result of the proposed action. The level of incidental take that we anticipate to occur as a result of the proposed action due to the forms of take, described above (1, 2, and 4 in riverine reaches), will have been exceeded as described below.

1. The anticipated level of incidental take will have been exceeded if the 15-year moving average for the number of adult interior least terns on all riverine reaches combined falls below 488 in any year over the next 15 years. This is the lowest that the 15-year moving average would be if we assume that numbers of adult interior least terns counted in riverine reaches were the same during the next 15 years as during the period, 1993-2007.

2. The anticipated level of incidental take will have been exceeded if during the next 15 years, the 15-year moving average for the number of interior least terns on all riverine reaches combined is:
    a. 600 during for fewer than three years; and,
    b. 500 during for fewer than 14 years. In other words, the level of anticipated incidental take will have been exceeded if the 15-year moving average is less than 500 in more than one year.
3. The anticipated level of incidental take will have been exceeded if the 15-year moving average of the number of interior least terns fledged for all riverine reaches combined:
    a. Falls below 228 during any of the next 15 years or does not equal or exceed 257 during at least seven of the next 15 years.

We considered the use of Sub-Objective 2 from the Adaptive Management Plan (USACE 2016) as a surrogate for the forms of take numbers 1 and 2 above, but rejected it. The metric for this sub-objective, acres of emergent sandbar habitat, is likely to change substantially due to model improvements and updating. This sub-objective will be an integral component of the USACE Adaptive Management Plan and we expect that it will drive the mechanical creation of emergent sandbar habitat sufficient by the USACE to meet it. Due to the likely changes to the specific targets it does not make a suitably stable standard for monitoring whether or not the extent of take will be exceeded.

Potential Changes to the USACE Piping Plover and Least Tern Monitoring Program
The USACE will collect the data needed to monitor egg loss according to the methods described in its Least Tern and Piping Plover Monitoring Program (USACE 2017c, p. 51). The USACE may, however, revise its methods. This could include, for example, the use of sampling to estimate adult population size, egg loss due to inundation, and/or fledgling number. If changes to the USACE monitoring program occur in a manner that would not allow incidental take to be monitored according to the measures described above, the USACE may do so only with the written approval from the Service.

Reasonable and Prudent Measures
The USACE has already incorporated into the proposed action a wide variety of measures to minimize impacts of the proposed action on both piping plovers and the interior least terns. As a result, there are few ways to further minimize the effects the incidental take on these two species that would not alter the basic design, location, scope, duration, or timing of the proposed action. Such alterations are beyond the scope of reasonable and prudent measures.

Reasonable and Prudent Measure #1

When caging nests to minimize the risk of predation, incorporate measures to reduce the likelihood that the caging will result in an increased incidence of predation, especially to adults, or nest abandonment.

Reasonable and Prudent Measure #2

Implement monitoring sufficient in scope and intensity to ensure that the levels and types of incidental take for both the piping plover and interior least tern, as described above, are available as soon as is practicable after each nesting season.

Reasonable and Prudent Measure #3

Consistent with the Science and Adaptive Management Plan evaluate the potential to isolate or secure habitat on the reservoir reaches that would minimize or eliminate the take of interior least terns and piping plovers due to water inundation resulting from reservoir fluctuation. If such an evaluation indicates that there is potential to reduce such take, continue to evaluate this measure through the adaptive management process to implement strategies identified.

Terms and Conditions

1) Reasonable and Prudent Measure #1
   a) Remove any cages from nests within 3 km at the first signs of predation to protect the remaining adults.
2) Reasonable and Prudent Measure #2
   a) Implement monitoring in accordance with the tern and plover monitoring program (TPMP, USACE 2009; 2017c) except as modified by any term and condition in this Incidental Take Statement or as modified and approved in writing by the Service.
   b) Ensure that egg loss due to inundation is not underestimated for nests where egg laying was likely incomplete during the penultimate nest check and found to be destroyed during the next visit. The USACE shall develop and implement methods to estimate egg loss at such nests in a manner that avoids underestimation of total egg loss.
3) Reasonable and Prudent Measure #3
   a) Complete an evaluation of the potential to implement measures on the reservoir reaches that would minimize or eliminate the take of interior least terns and piping plovers due to water inundation resulting from reservoir fluctuation.
   b) This evaluation would consist of the following, at a minimum:
      i) A qualitative or quantitative evaluation of sites where measures may be implemented to reduce egg loss due to inundation and to increase fledgling production and of methods that may be implemented at those sites. The evaluation shall include descriptions of the relative expected benefits of the potential actions as well as the authorities and resources necessary to implement each. This evaluation shall be done within the first three years of the program.
      ii) These efforts shall be incorporated into the Science and Adaptive Management Plan, including utilizing the "Bird Team" and associated processes for the Science and Adaptive Management Plan.
      iii) At a minimum, should any potential action(s) be deemed feasible and likely effective at reducing egg loss and increasing fledgling production on one or more reservoir reaches, incorporate the implementation of a pilot project into the 5 year strategic plan.

Incidental Take from Monitoring and Research Studies

The adaptive management process described in the Proposed Action, is based on the continuation and expansion of existing monitoring programs. The information obtained from these programs directs future management actions. Incidental take for these monitoring programs can be quantified and some of these activities have been previously and will continue to be authorized under individual ESA section 10 permits. USACE will continue to require all entities conducting the research/monitoring activities to possess a valid permit or instrument that exempts them from ESA section 9 prohibitions.

The following activities will be covered by other permits or instruments. These programs will not include collection of any live specimens of either piping plover or interior least tern. Piping plover and interior least tern population and productivity monitoring will include the following:

1. Nest and chick monitoring and adult censuses;
2. Resighting banded adult piping plovers through the use of high resolution point and shoot cameras, game cameras or Kodak PixPro video cameras at nests; and,
3. Habitat monitoring.

Level of Anticipated Take

During monitoring the USACE may observe large numbers interior least tern and piping plover eggs, chicks, fledglings, and adults. The anticipated number of piping plovers observed annually is approximately 1500 adults and 2000 chicks and the anticipated number of least terns observed annually is approximately 1000 adults and 1000 chicks.

Occasional incidental take is anticipated to occur during monitoring. Levels of take are expected to remain low and likely to resemble what occurred during the last four years, 2014-2017. During that period, no interior least tern or piping plover adults were injured or killed during monitoring activities; four interior least tern eggs and one chick have been damaged or killed; and, twelve piping plover eggs have been damaged. There is a reasonable likelihood that there would be a small increase in these levels. We do not expect adults of either species to be taken as a result of monitoring, but the take of eggs and chicks could be increase by a small amount – maybe less than 3-4 per year for each species. This would still constitute a small proportion of eggs and chicks. During the period 2013-2017, for example, four was the highest number of eggs or chicks of either species taken. In each case a 4-egg piping plover nest was stepped on. If that occurred twice in one year, for example, it would affect less than of piping plover eggs in the action area based on the average egg counts during the period 1993-2017.

18. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a Proposed Action on listed species or critical habitat, to help implement recovery plans, or to develop information.

- Coordinate pallid sturgeon monitoring efforts and information with those entities working on the Mississippi River.
- Continue to pursue completion of fish passage at Intake Dam on the Yellowstone River as authorized by WRDA (2007).
- Implement recovery actions for pallid sturgeon, piping plover, interior least tern, and other listed species, in coordination with the Service, as identified in the most recent recovery plans for those species.
- Consider sturgeon and sicklefin chub when implementing project actions, research, and monitoring. Gathering data on these species will inform future listing decisions.

- Available data on contaminant hazards provide limited capability to conduct a risk assessment (J. Skorupa, U.S. Fish and Wildlife Service, personal communication, January 2018). We recommend that the USACE support the collection of data necessary for the development of a risk assessment for pallid sturgeon.
- We recommend that the USACE support studies to increase the accuracy of estimations of piping plover annual survival rates; to better predict reservoir habitat availability and dispersal to reservoir habitats; and, to address the wider range of data gaps that limit the ability to model the dynamics of plovers nesting on the reservoirs. In an adaptive management context, "quantifying uncertainties is a key step as the process of developing and using models identifies data gaps and priorities for learning" (Buenau et al. 2014, p. 974). These authors found that uncertainty of annual survival rates limited their ability to accurately predict the effects of changes in river flow and ESH on population growth. In addition, they lacked information to realistically include the role of reservoir habitats in their model.
- Le Fer et al. (2008, p. 591) noted that "On the Missouri River, protected shorelines, which include backwater areas, inlets, inter-sandbar channels and ephemeral pools, are important foraging sites for Piping Plovers during the breeding season." We recommend that the USACE determine whether it would be feasible to manage flows to create these shoreline habitats and whether engineered habitats may be designed, located, and constructed to maximize the likelihood of creating these habitat components.
- Catlin et al. (2016, p. 4-5) found that piping plovers selected sites with gravel and cobble for nesting and "that gravel and cobble are relatively rare on sandbars of the Missouri River." They suggested increasing gravel and cobble "on areas of mechanically created sandbars that are less likely to be inundated during the nesting season" and considering the removal of gravel and cobble from areas that may function as sinks for nesting plovers after a thorough evaluation of this within an adaptive management framework.
- Anteau et al. (2014b, p. 25) stated that "a major shortcoming of our remote sensing data is that we have not yet developed a method for estimating the spatially explicit distribution of gravel, an important component of plover habitat. Remotely-sensed classifications that ignore substrate may classify some areas as habitat, but those areas might be poor habitat because of non-optimal substrate conditions." As part of the adaptive management research process, consider the potential to address this current shortcoming to ensure that the extent and distribution of suitable nesting habitat for piping plovers is estimated with sufficient accuracy.
- Adaptive management priorities should be assigned to monitoring and to analysis of the Missouri River ESH targets based on modeling that considers the entire piping plover population unit, including birds on river segments, reservoirs, and alkali lakes.
- The degree to which immigration between alkali lakes and piping plover habitats in the Northern Region of the action area occurs is not yet understood at the level of precision needed to inform habitat targets for the Missouri River habitats, including reservoir habitats. Adaptive management priorities should be assigned to develop a monitoring scheme to understand this immigration to properly inform these targets.

For the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

19. REINITIATION NOTICE

This concludes formal consultation on the USACE's Proposed Action for Operation of the Missouri River Mainstem Reservoir System, the Operation and Maintenance of the Bank Stabilization and Navigation Project, the Operation of Kansas River Reservoir System, and the Implementation of the Missouri River Recovery Management Plan. As provided in 50 CFR § 402.16, reinitiation of formal consultation is required and shall be requested by the Federal agency or by the Service, where discretionary Federal involvement or control over the action has been retained or is authorized by law and: (a) If the amount or extent of taking specified in the ITS is exceeded; (b) If new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (c) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the BiOp; or (d) If a new species is listed or critical habitat designated that may be affected by the identified action.

Because of the complexity of this Proposed Action and the length of the action period, many aspects of the abiotic and biotic community will be subject to monitoring and are likely to exhibit both negative and positive change. While changes in those features may inform our understanding regarding this complex system, simple changes in their measurements, do not necessarily indicate that reinitiation is required. Changes observed should be subjected to assessment and consideration as to whether they have revealed effects to the listed species or critical habitat that is outside the analysis framework articulated in this opinion and reinitiation is warranted.

If, during implementation of the Proposed Action, changes in circumstances, situation, or information regarding this Proposed Action occur, the USACE will assess the changes and any potential impacts to listed species, review the re-initiation triggers above, coordinate with the Service's Prairie Mountain Regional Office (if needed) and make a determination as to whether re-initiation is necessary.

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21. APPENDIX A

SERVICE MRRP ADAPTIVE MANAGEMENT ROLES AND RESPONSIBILITIES, ORGANIZATIONAL STRUCTURE, & ANNUAL TIMELINE

USFWS MRRP Adaptive Management Roles and Responsibilities, Organizational Structure, and Annual Timeline

Membership, Roles and Responsibilities (Figure 1)

USFWS Leadership

USFWS Membership
Regional Director, USFWS Region 6 (Lead)
Regional Director, USFWS Region 3

The Regional Director from Region 6 is the lead for the U.S. Fish and Wildlife Service (USFWS) on the Missouri River system and represents the USFWS on this team providing ultimate guidance and will ensure all appropriate information, reviews, and input from Ecological Services and Fish and Aquatic Conservation staff in both Regions 3 and 6 have been obtained and considered before USFWS decisions and recommendations are finalized and delivered. Regular communication and coordination between Region 6 and Region 3 within the USFWS is important given Region 3 contains a lengthy portion of the lower Missouri River. The Regional Directors will maintain close communication with members of the USFWS Agency Oversight team.

Agency Oversight

USFWS Membership
Assistant Regional Director Ecological Services Region 6 (Lead)
Missouri River Coordinator
Representative(s) – To Be Determined

The Assistant Regional Director for Ecological Services (ARD-ES), from Region 6 serves as the lead of the Agency Oversight Team. As the USFWS lead, the ARD-ES R6 will ensure all appropriate information, reviews, and input from Ecological Services and Fish and Aquatic Conservation staff in both Regions 3 and 6 have been obtained and considered before USFWS decisions and recommendations are finalized and carried forward. Additional members of the oversight team include the Missouri River Coordinator and a Representative (to be determined). The open slot allows for flexibility based upon the subject matter and required policy expertise. To enhance vertical continuity there is overlap between team members throughout this structure, e.g. the Missouri River Coordinator while a member of the Oversight team serves as the lead of the Agency Management Team. Roles and responsibilities specific to the Missouri River Recovery Program (MRRP) Adaptive Management (AM) Program Agency Management Team include the following:

- Provide input to decisions about priorities
- Provide input to decisions about targets and objectives
- Provide input to decisions about program structure and changes

Agency Management Team:

USFWS Membership
Missouri River Coordinator
AM/Section 7 Lead
Fish Team Lead
Bird Team Lead
Representative(s) TBD

The Missouri River Coordinator serves as the USFWS lead of the Agency Management Team. As the USFWS lead, the Missouri River Coordinator will ensure all appropriate information, reviews, and input from Ecological Services Project Leads and Fish and Aquatic Conservation Program Supervisors in both Regions 3 and 6 have been obtained and considered before USFWS decisions and recommendations are carried forward. The Missouri River Coordinator provides general program guidance and ensures full coordination with the USFWS Fish Team, Bird Team, Human Consideration (HC) Team, Technical Team USFWS representatives and broader USFWS team engaged in MRRP activities. The AM/Section 7 Lead assists with compliance issues and advising inter- and intra-agency direction within the AM context. The AM/Section 7 Lead serves to ensure the USFWS staff are engaged appropriately in the AM process and works closely with the USACE AM lead to help guide the process. Additional members of the Agency Management Team include the Fish Team Lead and Bird Team Lead to further enhance vertical continuity.

Roles and responsibilities specific to the MRRP AM Program include the following:

- Provides input to decisions regarding allocation of budget, staff, and material
- Make recommendations on action and research prioritization and flow modifications
- Prepare draft Work Plans
- Recommend changes to program components and governance

Bird, Fish and Human Considerations Teams:

USFWS Membership

Fish Team
Pallid Sturgeon Recovery Coordinator (Lead)
USFWS Pallid Sturgeon Technical Team Coordinator

Bird Team
Bird Team Coordinator (Lead)
USFWS Bird Technical Team Coordinator

HC Team
HC Team Lead

The Bird, Fish and HC Team Leads represent the USFWS and will ensure all appropriate information, reviews, and input from Ecological Services and Fish and Aquatic Conservation staff in both Regions 3 and 6 (see Figure 1) have been obtained and considered before USFWS decisions and recommendations are

carried forward. The Fish and Bird Technical Team Leads also serve on each of the respective teams to further enhance vertical continuity. The Human Considerations Team Lead works closely with Missouri River Recovery Implementation Committee (MRRIC) members and the broader stakeholder community to ensure an understanding within the USFWS of Human Considerations issues.
Roles and responsibilities specific to the MRRP AM Program include the following:

- Review research, monitoring and assessment results and make related recommendations
- Identify needed research, technical assessments, etc.
- Resolve issues related to project siting, construction, operations, etc.
- Develop recommendations on prioritizations for management action implementation based on discussions at AM workshops
- Conduct "on the ground" tasks necessary for implementation

Bird and Fish Technical Teams:

USFWS Membership

Fish Technical Team
USFWS Pallid Sturgeon Technical Team Coordinator (Lead)
2 additional members ensuring that each Missouri River Fish and Aquatic Conservation office is represented

Bird Technical Team
USFWS Bird Technical Team Coordinator (Lead)
Tern/Plover Biologist

The Bird and Fish Team Technical Team Coordinators (Leads) provide technical insight and expertise on their respective teams and ensure communication, feedback and engagement is occurring within the team and between lateral USFWS staff as shown in Figure 1. The Fish Technical Team has three members representing each of the three USFWS Fish and Aquatic Conservation offices along the Missouri River with the USFWS Pallid Sturgeon Technical Team Coordinator serving as the lead. The Bird Technical Team should have two members with a representative from each Region (3 and 6). One of the Bird Team members serves as the Coordinator (Lead). Roles and responsibilities specific to the MRRP AM Program include the following:

- Conduct monitoring and assessment of projects
- Analyze and evaluate data and hypotheses
- Develop and apply models as needed
- Interpret results and present findings in reports and at biannual science meetings
- Assess potential courses of actions and outcomes
- Conduct research and undertake studies as directed

Recovery Teams and Recovery Workgroups: Associated Recovery Teams and Workgroups serve at the request of the USFWS providing reviews, input and recommendations to the USFWS for consideration on issues facing the recovery of listed species. Within the AM structure the USFWS will make regular formal requests to the Recovery Team and associated Recovery Workgroups to provide input directly to the USFWS to provide a broad spectrum of input and better inform USFWS decisions. Recovery Team and Workgroups engagement is described within this document.

The efforts of Recovery Teams and workgroups are founded in the Endangered Species Act (Act) of 1973, as amended. The USFWS administers the Act and oversees the recovery of threatened and endangered species.

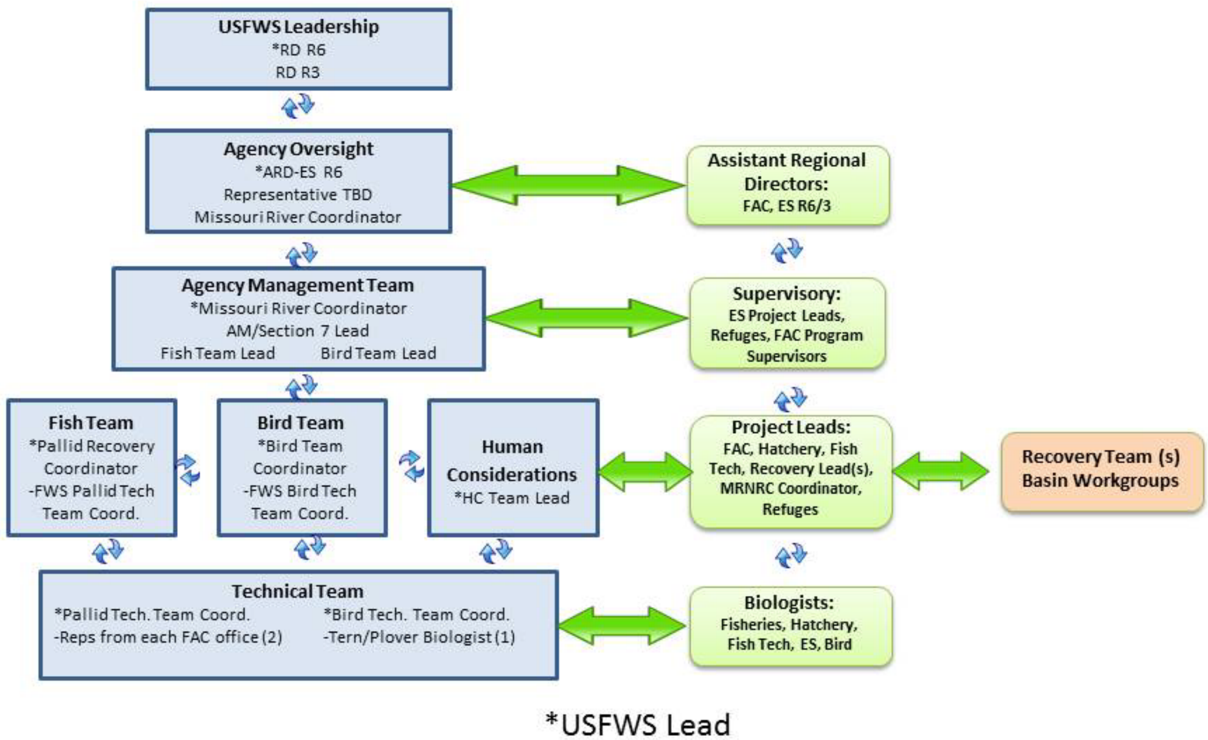


Figure 1. USFWS Missouri River Organization Structure for the MRRP Science and Adaptive Management Plan.

USFWS Lead Roles and Responsibilities

- Communicate and seek input laterally within the USFWS, Recovery Team(s), and Basin Workgroups (especially prior to and following major engagements in the AM process).
- Coalesce information and ensure all appropriate reviews, input from Ecological Services and Fish and Aquatic Conservation staff in both Regions 3 and 6 have been obtained and considered before USFWS decisions and recommendations are finalized and provided up the vertical chain.
- Ensure that USFWS staff understand decisions and direction of the MRRP AM program through appropriate communication.

USFWS Engagement in the AM Process

NOTE: this represents the order of events as characterized in the Process Map and in the Science and Adaptive Management Plan (SAMP) however the specific dates, including months, will need to be assessed and adjusted each year.

This document focuses on key USFWS AM process engagements denoted by the symbol to the left in Figure 2.

The USFWS engages in other venues with many other entities (USACE, States, MRRIC, Tribes, etc.), however that engagement is not described in this document, with the exception of overlaps of the AM process.

April 13, 2018

USFWS Process (Internal) of Adaptive Management Annual Governance Activities Process Map

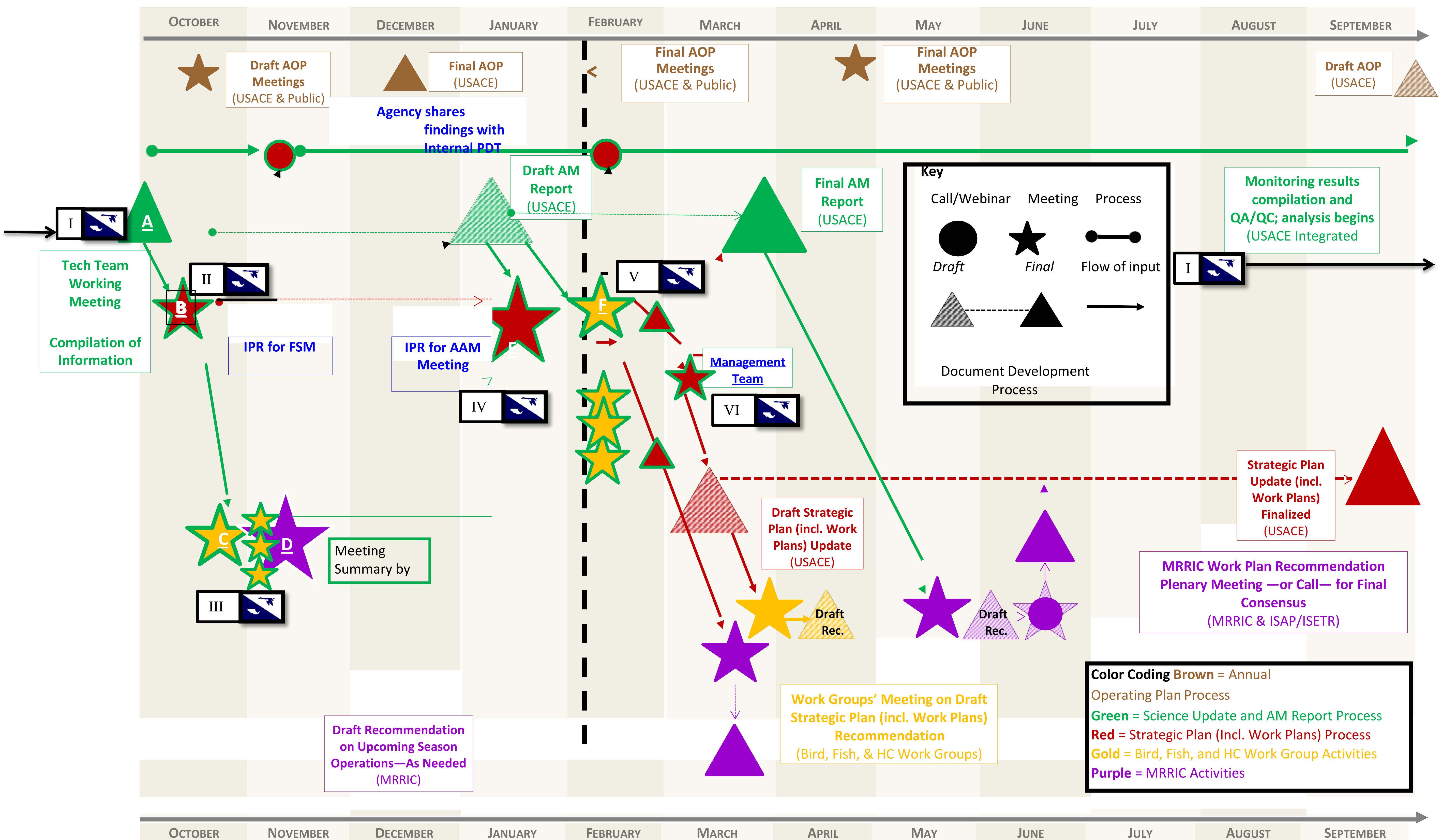
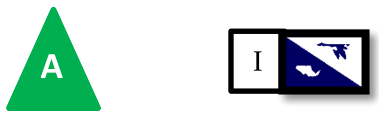


Figure 2. This process map depicts the proposed governance activities to be undertaken annually by the USACE, USFWS, MRRIC in the implementation of AM related to the endangered piping plover and pallid sturgeon in the Missouri River. This process map reflects the governance recommendations developed by the MRRIC AM Ad Hoc Group for consideration by MRRIC in August 2016.

Information development for Fall Science Meeting (FSM):



I. USFWS Preparation for Fall Science Meeting (FSM)

Time Frame: July – September

Who: Technical Team Leads, Fish Team Lead, Bird Team Lead, Technical Staff

Objective: Coalesce relevant science as related to Hypotheses, Big Questions, and Emerging/New Science related to reserve or yet to be developed hypotheses. The USFWS Code of Scientific and Scholarly Conduct will serve as guide for USFWS staff working on this objective - https://www.fws.gov/science/pdf/ScientificIntegrityFWSCode212fw7.pdf

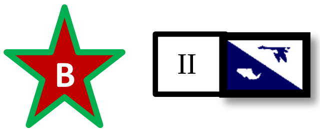
Process: Technical staff prepare concise briefing papers related to Hypotheses, Big Questions, and Emerging/New Science related to reserve or yet to be developed hypotheses. Information related to other technical aspects such as monitoring should also follow this format. Briefing papers are then brought forward to the appropriate Team Lead. The Team Lead facilitates a process with lateral internal USFWS staff as shown in Figure 1 (USFWS Org Structure) to determine the disposition of information. Concurrent work will be occurring with the broader Technical team as described here:

"The Green triangle (A) represents work done (by the USFWS Technical staff, AM Technical Team and Integrated Science Program) to gather data together for the FSM. It does not represent a meeting, although there may be a meeting of technical folks in preparing the data. Data gathered includes species and habitat monitoring, species and habitat related research, habitat creation and maintenance activity, and hydrology information. The Technical Team conducts preliminary analyses and organizes the information to address previous year's management actions, monitoring, and research to present at the FSM. ISP PM and AM PM will coordinate on presentations needed for the Agencies Coordination Meeting and set an agenda highlighting preliminary findings through presentations from Technical Team members, ISP staff, Researchers and monitoring team individuals. Topics covered would include: Species Status Updates; Preliminary Species Research Findings; Preliminary Performance Information (habitat and pilot projects)"

USFWS Species Recovery Lead(s), USFWS Species Recovery Teams and USFWS Species Workgroups:

- Species Recovery Lead(s) will facilitate a discussion with Species Workgroups and/or Species Recovery teams to determine important issues to focus on related to Hypotheses, Big Questions, and Emerging/New Science in early July.
- Prepare concise briefing papers related to Hypotheses, Big Questions, and Emerging/New Science related to reserve or yet to be developed hypotheses. Information related to other technical aspects such as monitoring should also follow this format. (Template will be provided in July)
- Species Recovery Lead(s) will facilitate a discussion with Species Workgroups and/or Species Recovery teams to prioritize issues and provide recommendations to the USFWS to be considered for inclusion in the Fall Science Meeting.

In Progress Review (IPR):



II. In Progress Review preparation for Fall Science Meeting

Time Frame: October

Who: Agency Management Team, Fish Team, Bird Team, Human Considerations Team and Technical Staff as determined by relevant science moving forward from the previous step.

Objective: Review information to be presented at Fall Science Meeting and ensure presentations are high quality, and focused on program objectives and conclusions that are scientifically sound.

Process: The Red Star with Green outlines (B) is similar to the IPR's that have been utilized over the course of the Management Plan and SAMP development and represents the Agencies (USACE and USFWS) review of preliminary information and trends in an effort to prepare for the Fall Science Meeting and AM Team engagements, including the MRRIC Workgroups.

The Fall Science Meeting is a Science and AM component and will be set up and carried out by the USACE Integrated Science Program Manager (PM), USACE AM PM, USFWS AM/Section 7 Lead and critical USACE and USFWS agency staff. This star represents a meeting to share the preliminary information on research, monitoring, habitat actions and pilot projects.

Information will be presented by the Technical Team and Principle Investigators. This first look provides agency staff an opportunity to ask questions and gain understanding. It also provides opportunity to ensure presentations are high quality and focused on program objectives (Big Questions, Hypotheses, Emerging New Science) and that conclusions are scientifically sound.

Code of Scientific and Scholarly Conduct will serve as guide for USFWS staff working on this objective - https://www.fws.gov/science/pdf/ScientificIntegrityFWSCode212fw7.pdf.

Based on this meeting an agenda for the Fall Science Meeting and the Team Meetings will be developed.

Fall Science Webinar and Fall Science Workgroup Meeting

III. Fall Science Meeting

Time Frame: October

Who: Agency Management Team, Fish Team, Bird Team, Human Considerations Team and Technical Staff as determined by topics and participation needs

Objective: Develop a preliminary understanding of technical results and implications of the science on the MRRP Science and Adaptive Management Plan.

- Implications of science on actions in the context of the 5-year strategic plan
- Implications of science on Technical Team work efforts
- Implications of science on potential topics for Independent Panel review

Process: The Fall Science Meeting (Yellow star with green outline and labeled [C]) is the venue to review initial outcomes of the previous year's management actions, monitoring, and research, and to identify specific analytical topics of interest to the Management Team, Bird, Fish and HC Teams.

The Fall Science Meeting is held annually in October. It is led by the Integrated Science Program (ISP), to provide a focused opportunity for the Technical Team, Bird, Fish, and HC Teams, to meet, hear about, question, assess, and understand the **preliminary** technical results and implications of AM Plan implementation.

In particular, the Fall Science Meeting is intended to (a) serve as a **preliminary** update for ongoing research and technology development activities, (b) provide opportunities to share early observations regarding system conditions, project performance, and monitoring activities, and (c) identify and assign additional analyses needed for the upcoming AM workshop, and (d) allow Water Management to provide a briefing on the draft Annual Operating Plan and receive feedback relative to MRRP needs.

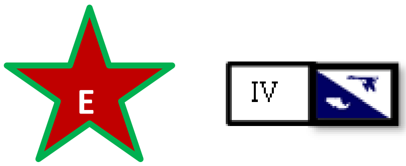
Bird, Fish and HC Teams are the primary collaborative component of the AM Plan governance process. They are focused on learning and understanding the scientific findings and performance of the program over time. Members (USACE, USFWS and MRRIC) serve to coordinate with associated teams to keep them informed of new information and developments. Team members are expected to interact with the entities they represent before and after each engagement, and keep the groups they represent apprised of the activities and decisions/recommendations of the Team. Interactions during the development of the Strategic Plan/Work Plan generally involve multiple engagements, including at least one joint meeting of the Bird, Fish, and HC Teams.

Process: Webinar meeting provides a preliminary update and allows for clarifying questions and limited discussion. Following the Fall Science Meeting webinar and prior to the Fall Science Workgroup in person meeting USFWS Team Leads and Technical Leads should discuss implications of the presentations with lateral agency staff to develop concise input, suggestions and observations to be shared at the Fall Science In-person workgroup meetings. At the Fall Science In-person workgroup meetings Fish, Bird and HC Team Leads should share key suggestions and observations.

USFWS Species Recovery Lead(s), USFWS Species Recovery Teams and USFWS Species Workgroups: Technical staff identified through the Fall Science preparation process (I.) will present and discuss new or ongoing science information at the Fall Science meeting and further discuss the information as needed at the Fall Science Workgroup meeting(s). Technical staff may be called upon to provide technical insight and information as the draft AM Report is developed (Nov-Dec). Species Workgroup chairs will be called upon by the USFWS to participate in person at Fall Science

Workgroup meeting(s).

In Progress Review (IPR)



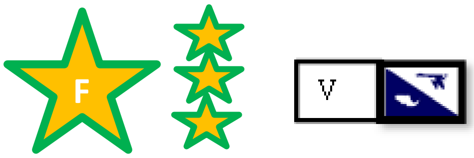
IV. In Progress Review preparation for AM Workshop
Time Frame: January
Who: Agency Oversight, Agency Management Team, Fish Team, Bird Team, Human Considerations Teams. Attendance by Technical staff will be issue driven.
Objective: Review draft AM Report in preparation for the AM Workshop, Ensure presentation are high quality, focused on program objectives and conclusions are scientifically sound.

Process: This meeting is similar to the Fall Science Meeting Agency Coordination Meeting in that the agencies hear the information included in the draft AM Report on project and program performance and ask refining questions on science and performance findings. It is a 1-2 day meeting led by the ISP PM. The Red Star with Green outlines (F) represents the Agencies (USACE and USFWS) review of information and trends in an effort to prepare for the AM Team and MRRIC engagements during the Annual AM Workshop. A dry run of the information will be presented by the Technical Team and Principle Investigators of research, monitoring and pilot projects after further evaluation and consideration of comments received during the Fall Science Meeting. This meeting will allow for ensuring presentations are high quality and focused on program objectives and that conclusions are scientifically sound. Based on this review an agenda for the Annual AM workshop and the Team Meetings will be developed.

Prior to the Annual AM Workshop Team Leads should coordinate key messages and issues to be discussed at the workshop with lateral USFWS.

USFWS Species Recovery Lead(s), USFWS Species Recovery Teams and USFWS Species Workgroups: Species Recovery Lead(s) will coordinate key messages and issues to be discussed at the AM workshop with Species Workgroups during annual winter meetings or via other communication means as appropriate.

Annual Adaptive Management Workshop



V. AM Workshop
Time Frame: February
Who: Agency Oversight, Agency Management Team, Fish Team, Bird Team, Human Considerations Teams. Attendance by Technical staff will be issue driven.
Objective: Report results and have scientific discourse determining recommendations regarding direction for future actions.

Process: The purpose of the AM Workshop is to report on results of project and Program performance monitoring and promote the exchange of scientific information among technical experts involved with the Program, decision-makers, and stakeholders. Workshop organizers will optimize opportunities for interaction among participants with the aim of supporting program decisions for subsequent years. This Workshop is facilitated and is held early February of each year (led by the ISP) to provide an opportunity for Federal and State agency staff, contractors, and stakeholders to interact and discuss results of research and monitoring efforts for the previous year (various presentations and the draft AM Report) and plans for the upcoming year.

The USACE ISP PM, USACE AM PM and the USFWS AM/Section 7 Lead, with assistance from the Facilitator, are responsible for organization of the annual AM Workshop, and for summarizing and disseminating summary materials to support draft updates to the Strategic Plan (including the Execution Plan).

USFWS Species Recovery Lead(s), USFWS Species Recovery Teams and USFWS Species Workgroups: Species Recovery Lead(s) will ensure appropriate technical experts are present to discuss issues emanating from the preceding Fall Science, Fall Workgroup meetings and preparation of the draft AM Report. Species Workgroup chairs will be called upon by the USFWS to participate in person at the AM Workshop.

<u>Structure:</u>

Three-day workshop.

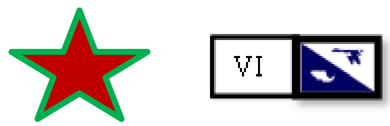
- Birds (and associated HC), Pallid (and associated HC) – day one and two
- Bird, Fish, and HC Teams – day three

<u>Products:</u>

- An overall summary of the Workshop presentations and discussion developed by the ISP PM
- Separate summaries of the Team meetings developed by the Team Lead and facilitation staff

➢ These are shared with Agencies and MRRIC in preparation for March MRRIC meeting (and assist the USACE' efforts to develop the draft updates to the Strategic Plan (including the Execution Plan).

Management Team Engagement



VI. Management Team Engagement
Time Frame: March
Who: Agency Management Team. Participation by additional staff will be issue driven.
Objective: Development of draft Strategic Plan for presentation to agency leadership and MRRIC.

Process: The smaller Red Star outlined by Green represents the Management Team part of the AM Governance structure. The Management Team develops the draft Strategic Plan for presentation to agency leadership and the MRRIC based upon the recommendations of the Bird, Fish, and HC Teams and following guidance provided by the USFWS Agency Oversight Team and USFWS Leadership. The Management Team makes recommendations to leadership on issues requiring Oversight-level decisions. They also provide leadership for the HC, Bird, and Fish Teams, and ensure day-to-day implementation of the MRRP is consistent with requirements in the SAMP and direction from leadership.

USFWS Species Recovery Lead(s), USFWS Species Recovery Teams and USFWS Species Workgroups: Species Recovery Teams and/or Species Workgroups will provide consolidated Team and/or Workgroup recommendations to the USFWS Species Recovery Lead(s) for USFWS consideration regarding the draft Strategic Plan and draft AM Report prior to the USACE/USFWS Management Team Engagement.

Products:

- A draft update to the Strategic Plan (including the Execution Plan) by the USACE' MRRP PM including the following:
    - Updates to the Calendar Fiscal Year Work Plan
    - A draft of the FY+1 Execution Plan [e.g., version of work plan shared for SAMP deliberations at present]
    - Level of effort assessments of program needs for FY+2 through 4
    - Significant study proposals
    - Proposed changes to components of the AM Plan
    - Other recommendations for consideration of the MRRIC and agency leaders