BIOLOGICAL OPINION

CHANNEL IMPROVEMENT PROGRAM
MISSISSIPPI RIVER AND TRIBUTARIES PROJECT
LOWER MISSISSIPPI RIVER

Date
12 December 2013

Prepared by

Mississippi Field Office
U.S. Fish and Wildlife
Jackson, Mississippi

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United States Department of the Interior
FISH AND WILDLIFE SERVICE
Southeast Region
1875 Century Boulevard
Atlanta, Georgia 30345

December 12, 2013

In Reply Refer To:
FWS/R4/ES

Brigadier General Duke DeLuca
CORPS, Mississippi Valley Division
1400 Walnut Street
Vicksburg, Mississippi 39180

Dear Brigadier General DeLuca:

This document is the U.S. Fish and Wildlife Service's (Service) biological opinion for the U.S. Army Corps of Engineers (Corps) Mississippi Valley Division (Corps MVD) Channel Improvement Program (CIP) of the Mississippi River and Tributaries (MR&T), and its effects on the endangered Interior least tern, pallid sturgeon, and fat pocketbook mussel per section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq*.). We received your request for formal consultation on August 8, 2013, which included a request to consider the Corps MVD **Conservation Plan for the Interior Least Tern, Pallid Sturgeon, and Fat Pocketbook Mussel in the Lower Mississippi River (Endangered Species Act, Section 7(a)(1))**, dated July 23, 2013, as a biological assessment of the CIP and its potential for adverse effects on the three endangered species in the Lower Mississippi River (LMR).

This consultation considers the systemic impacts of the continued implementation of the CIP on the three listed species as projected 20 years into the future. The biological opinion is based on information provided in the July 23, 2013, Corps MVD **Conservation Plan for the Interior Least Tern, Pallid Sturgeon, and Fat Pocketbook Mussel in the Lower Mississippi River (Endangered Species Act, Section 7(a)(1))** (hereafter, referred to as the Conservation Plan/BA), and other sources of information. A complete administrative record of this consultation is on file at the U.S. Fish and Wildlife Services' (Service) Mississippi Ecological Services Field Office.

SPECIES COVERED IN THIS CONSULTATION

This consultation covers the following endangered species: Interior least tern (*Sternula (Sterna) antillarum*), pallid sturgeon (*Scaphirynchus albus*), and fat pocketbook mussel (*Potamilus capax*). By letter dated September 3, 2013, the Service concurred with the Corps' findings in its August 8, 2013, consultation request, that while current operating procedures and engineering practices are raising the habitat and population baselines of all three species in the LMR, the CIP may adversely affect the Interior least tern (ILT), pallid sturgeon (PS) and fat pocketbook mussel (FPM) through occasional take (harassment, injury, death) of individuals during construction activities. No critical habitat has been designated for these species; therefore, none will be affected.

TABLE 1: Species and Critical Habitat Evaluated for Effects and those where the Service has Concurred with a "not likely to adversely affect" Determination.

Species or Critical Habitat	Present in Action Area	Present in Action Area but "not likely to be adversely affected"
Louisiana black Bear		**X**

CONSULTATION HISTORY

FWS Log No: 2013-F-959
Date Started: August 8, 2013 **Ecosystem**: Lower Mississippi River
Action Agency: U.S. Corps of Engineers, Mississippi Valley Division
Project Title: Channel Improvement Program of the Mississippi River and Tributaries
Counties: **Louisiana**: Jefferson, St. Bernard, Plaquemines, St. Charles, Orleans, St. John the Baptist, St. James, Ascension, Iberville, West Baton Rouge, East Baton Rouge, Point Coupee, West Feliciana, Concordia, Tensas, Madison, East Carroll; **Mississippi**: Adams, Jefferson, Claiborne, Warren, Issaquena, Washington, Bolivar, Coahoma, Tunica, Desoto; **Arkansas**: Chicot, Desha, Phillips, Lee, St. Francis, Crittenden, Mississippi; **Tennessee**: Shelby, Tipton, Lauderdale, Dyer, Lake; **Missouri**: Pemiscot, New Madrid, Mississippi; **Kentucky**: Fulton, Hickman, Carlisle, Ballard
States: Louisiana, Mississippi, Arkansas, Tennessee, Kentucky, Missouri

1986 - Corps MVD and Memphis District initiate annual ILT counts on the LMR. Data is provided annually to appropriate Service Field Offices bordering the LMR.

March 14, 1991 - The New Orleans District completes a BA on the MR&T project and its project features, including the CIP features in the Mississippi and Atchafalaya Rivers, as well as other water resource projects in the district.

April 4, 1991 - The Louisiana Ecological Services Office concurs with the Corps' "not likely to adversely affect" determination. Annual coordination of MR&T work in both the Mississippi and Atchafalaya Rivers, Louisiana, has been conducted since that time.

May 24, 1993 - The Service's Tennessee Field Office meets with MVD at the Memphis District. Information was exchanged about implementation of the MRTP with regard to provisions of the Endangered Species Act (Act), potential project impacts to the ILT and PS, and efforts made by the Corps to gather information about these listed species in the lower reach of the Mississippi River. The Corps agrees to prepare a biological assessment for the entire MRTP and to consider formal consultation with the Service.

May 10, 1996 - The Service's Tennessee Field Office sends a letter to MVD encouraging the Corps to expedite completion of the assessment.

April 7, 1997 - The Service's Tennessee Field Office receives a draft biological assessment for review which addressed project effects to the ILT.

July 3, 1997 - Service comments are submitted to Mr. James R. Hanchey, Director of Engineering and Technical Services.

December 2, 1999 - The Service's Tennessee Field Office sends letter to MVD urging expedited completion of the final biological assessment for the Mississippi River and Tributaries Project.

January 3, 2000 – The Corps transmits final biological assessment for the Lower Mississippi River CIP to the Service's Tennessee Field Office, concluding that the CIP is not likely to adversely affect the ILT.

March 3, 2000 - The Service's Tennessee Field Office transmits a letter to MVD acknowledging receipt of the final biological assessment, and providing comments on the biological assessment. The Service does not concur with the conclusion that the projects are not likely to adversely affect the ILT, and recommends CORPS initiate formal consultation.

June 18, 2001 - Service representatives meet with MVD personnel regarding programmatic consultation on the MR&T for the ILT and PS. The Corps stands by their BA for ILT, and notes the lack of information available to conduct a comprehensive BA for PS. Therefore, they would not consider conducting a programmatic consultation at that time. Discussions revolve around identifying and implementing conservation actions, and developing information under section 7(a)(1) of the Act, and the meeting concluded with agreement that additional interagency planning and coordination are needed.

December 4, 2001 - Service representatives meet with MVD personnel regarding recent actions, as well as interagency planning and coordination. MVD reports ongoing studies on aggradation behind dikes, a comprehensive survey of side channels in the LMR, development of evaluation criteria for channel restoration work, and proposed and on-going PS studies. Service reports on sturgeon sampling efforts and collections over the past year, and provides data to MVD. MVD notes that the Districts will coordinate annual meetings with State and Service representatives on future maintenance and construction work, as part of moving forward on a 7(a)(1) conservation strategy.

2001 to present - Research and monitoring efforts for PS and ILT are conducted by the Corps Engineer Research and Development Center and MVD Districts, and for PS by SERVICE Mississippi Field Office.

2002 to present - Annual interagency channel improvement project review meetings are initiated by the Memphis District. These meetings summarize research and monitoring efforts, identify navigation and channel integrity problems, propose engineering solutions, consider potential effects on listed species and habitats, and identify potential modifications to engineering plans to minimize or mitigate effects.

2003 – The Corps MVD and Vicksburg and Memphis Districts are notified by Service's Mississippi Field Office of the occurrence of FPM in secondary channels of the Lower Mississippi River.

2004 to present - Annual interagency channel improvement project review meetings are initiated by the Vicksburg District. These meetings summarize research and monitoring efforts, identify navigation and channel integrity problems, propose engineering solutions, consider potential effects on listed species and habitats, and identify modifications to engineering plans to minimize or mitigate potential effects.

February 3, 2012 - Mississippi Field Office meets with MVD. Informal LMR section 7(a)(1) consultation history is summarized and discussed, and a draft Service Lower Mississippi River Strategic Conservation Plan is presented to MVD. Mississippi Field Office invites MVD to review and comment on the Services plan, and notes potential to formalize MVD section 7(a)(1) conservation plan. MVD agrees to collaborate on a strategic plan, and upon finalization, to draft a formal LMR CIP conservation plan. MVD also agrees to consider formal consultation on CIP when these are completed.

October 9, 2012 - Service transmits final **Lower Mississippi Strategic Habitat Conservation Plan** to the Corps MVD. Developed in collaboration with the Corps MVD and Districts, the plan outlines the process by which components of the CIP serve as conservation tools to maintain and improve habitat values of endangered species inhabiting the river channel.

August 8, 2013 – The Corps MVD transmits a **Conservation Plan for the Interior Least Tern, Pallid Sturgeon, and Fat Pocketbook Mussel, in the Lower Mississippi River (Endangered Species Act, section 7(a)(1))** developed in consultation with the Mississippi Field Office. MVD requests formal consultation on the CIP, with consideration of the Conservation Plan as a Biological Assessment (Conservation Plan/BA) for the CIP.

September 3, 2013 - The Service acknowledges the request to enter into formal consultation with the Corps.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

The following information is summarized from the Corps/MVD Conservation Plan/BA.

Action Area

The Lower Mississippi River (LMR) extends over 950 miles from the confluence of the Ohio River to the Gulf of Mexico. In response to the 1927 flood, the Mississippi River and Tributaries (MR&T) project was initiated by the CORPS. The project consists of levees, revetments, flood storage reservoirs, and floodways to reduce flood risk, as well as dikes, and other river training structures in the channel to facilitate low-water navigation by towboats. Construction of the MR&T, which still continues today, has resulted in a highly engineered river channel. The MR&T Project CIP encompasses three separate Corps districts: the New Orleans District includes the LMR from the Gulf of Mexico (River Mile (RM) 0.0) to RM 320; the Vicksburg District from RM 320 to RM 614; and the Memphis District, from RM 614 to RM 952, at the confluence of the Ohio River.

Although channel engineering affects the entire length of the LMR, and loss of channel habitat complexity is measurable and significant, the LMR has not experienced extirpations or extinctions of any channel species, such as have occurred in other large rivers of the United States. The LMR channel continues to be a highly functional and valuable fluvial ecosystem. There are several reasons for this: 1) the LMR remains unimpounded, experiencing a natural flood cycle hydrograph; 2) although size and quantity of sediment input to the system has been significantly reduced through bank protection and construction of multiple impoundments of all major LMR tributaries, large quantities of stored sediment are available in its large channel that are continuously reworked during flood cycles; and, 3) implementation of the Clean Water Act (CWA) throughout the drainage basin has significantly improved water quality in the LMR.

Proposed Action

The proposed action is the continuance, for the next 20 years, of the CIP under the MR&T project, which has been on-going for the past 60-70 years. The MR&T Project includes an extensive, 2,216-mile levee system; three floodways to divert excess flows past critical reaches; and channel improvement and stabilization features to protect the integrity of flood reduction measures and to ensure proper alignment and depth of the navigation channel (CIP). The Channel Improvement Program of the MR&T project provides for a low-water navigation channel nine feet deep and 300 feet wide from Baton Rouge, Louisiana, to Cairo, Illinois, and for stabilization of river banks to protect the flood control levees from Head-of-Passes, Louisiana, to Cairo, Illinois, and on the lower 9 miles of the Ohio River. This Biological Opinion applies to the CIP. The CIP includes the construction and maintenance of river engineering structures and periodic dredging to maintain channel depth and alignment.

River Engineering Structures

Three main types of river engineering structures are used in CIP: revetments, dikes, and bendway weirs. In addition, hard points, roundpoints, and chevron dikes are used in some instances. Generally, a combination of engineering structures work synergistically to achieve both flood control and navigation objectives within a river reach.

Revetments

Revetments have been used on the Mississippi River for more than a century to arrest bank caving and protect levees and other structures, and to maintain an efficient channel alignment. Caving banks of the LMR have been typically stabilized with articulated concrete mat (ACM) since the 1920s. ACM is comprised of concrete blocks 46.5 inches long, 17.75 inches wide, and three inches thick, spaced one inch apart and tied together with corrosion-resistant wire to form a continuous mattress. ACM is laid on the graded bank slope from just above the low-water elevation to the channel bottom. The upper bank area is graded to a maximum slope of 1 vertical to 3 horizontal and paved with riprap stone. ACM is flexible, strong, and durable and insures complete coverage of the bank. About eight percent of the ACM surface is comprised of spaces between the individual blocks. Trench fill revetment is also occasionally used in the LMR for major channel realignment. A trench is excavated on the land or island along the design channel alignment and filled with quarry stone. When the river migrates laterally into the filled trench, the stone launches and stabilizes the bank.

Between 2003 and 2012, linear feet of revetment installed annually averaged (± standard deviation) 48091.9 ± 9853.9. The majority of revetment laid was to repair banks damaged by floods. Annual variability is due to magnitude of flood damage and length of low stages conducive for construction activities. As of 2012, there are 1054 miles of revetment along the banks in the LMR. When completed, revetments will cover approximately 50 percent of the banks of the Lower Mississippi River (Baker *et al*. 1988). Revetment construction is currently >90% completed, and over the next 20 years, most revetment activities will be related to repair and maintenance of existing revetment.

Environmental features: In the 1980s, ACM design was modified for environmental enhancement. ACM is now constructed with longitudinal grooves over the surface of each block to reduce current velocity and increase surface area for the attachment of macroinvertebrates (Way *et al*. 1995). Pokrefke (2012) describes Off-Bankline revetments as an environmental enhancement alternative, providing slack water habitat compared to traditional On-Bankline revetments. Off-Bankline revetment is a row of stone, typically "A" stone, and is placed 5 feet to 15 feet riverside of the existing bankline at an elevation of the existing bank height. Notches are typically left in the revetment to allow fish to access the slack water areas.

Dikes

Dikes have been used intermittently on the Mississippi River for over a hundred years; however, beginning in the 1960s, a comprehensive dike program was initiated in an effort to reduce dredging costs, and establish improved navigation alignments. Stone dikes are constructed in the river channel to develop a self-maintaining (minimal maintenance dredging), low-water navigation channel with authorized project dimensions and alignment. Dike systems function, in conjunction with revetments, to modify and stabilize channel alignment, reduce discharge through secondary channels, and decrease width and increase depth of the low-water (navigation) channel through bed degradation,

mainly in channel crossings (Fenwick 1969; Cobb & Magoun 1985). A total of 774 dikes, averaging 1.0 dike/rm, have been constructed between river miles 212 to 953.5 since the beginning of the dike construction effort on the LMR.

The morphological response to the construction of dikes is site specific and depends upon a number of factors such as dike type (permeable or impermeable), dike elevation, configuration (level crest, sloping crest, and stepped up or stepped down), dike angle and length, sediment characteristics (size and concentration) of the channel, and the hydraulic and hydrologic characteristics of the channel. However, there are some general trends associated with dikes that typically occur. First, the hydraulic effects of dikes will vary with stage. The top elevation of a dike is often designed well below the top bank elevation to minimize impacts of dike construction at higher flows. Secondly, the hydraulic and sedimentation impacts of dikes also change with time. When first constructed, the cross-sectional area of the channel will be reduced due to the presence of the dikes. However with time, the dikes will typically induce sediment deposition in the area between the dikes, and increase the area and depth in the main channel due to erosion.

Design of stone dike systems is variable depending on purpose, site conditions, and economics (Pokrefke 2012). Spacing of dikes is based on experience and local factors, but is typically one to two times the length of the next upstream dike. Dikes comprising a system may be stepped-up, i.e., dike crown elevations increase downriver, or stepped down, i.e., dike elevations decrease downriver. Stepped-down dike systems tend to increase deposition between dikes during high discharges which successively overtop each dike as stages rise, while stepped-up systems tend to promote scour between successive dikes (Franco 1967; Fenwick 1969). However, studies of dike systems on the LMR have shown that sedimentation was higher in level and stepped-up systems than in stepped-down systems. This may be due to the large channel width and wide spacing of dikes.

As a result of the MR&T dike program, dredging costs on the Lower Mississippi River have been reduced dramatically. However, the associated deposition of sediment within the dike fields reduces aquatic surface area, degrading the quality of these valuable aquatic habitat areas. In response to these concerns, a detailed data collection program was established by the Mississippi Valley Division (MVD) in order to quantify the sedimentation trends in these dike fields. Utilizing these data, Biedenharn *et al*. (2000) conducted a detailed study of the sedimentation trends of 28 individual dike fields on the Lower Mississippi River. For this study, the channel was divided into three distinct areas (main channel, pools, and sandbars) based on the classification scheme developed by Cobb and Magoun (1985). The pools are basically the area between the dikes as defined by the area circumscribed by the bank line and a line connecting the channel-ward tips of the dikes. The sandbar areas were defined as the bar area between the pool boundary and the -10 foot Low Water Reference Plane (LWRP) contour. The boundary of the main channel is the remainder of the channel up to the -10 foot LWRP contour. Although there was considerable uncertainty and variability in the individual dike-field trends, some general trends were observed.

- The largest impacts of the dikes occurred in the initial response period (first 5 to 15 years following dike construction) after which the response decreases significantly.
- The pool (area between the dikes) response was dominated by decreases in surface area, volume, and depth.
- The main channel response was dominated by increases in surface area, volume, and depth.
- The sandbar area (identified as a transition area between the main channel and the pools) was highly variable, experiencing both scour and fill.
- The volume trends for the overall reaches (combined main channel, pools, and sandbars) indicate that the overall reaches have either enlarged or experienced no significant change, while the surface area showed no significant change or minor decreases. Thus, it appears that the dikes have either produced a larger, more efficient channel, or had no significant impact on the overall channel cross section at all.

Environmental features: In recognition of the potential loss of habitat resulting from sedimentation in the dike fields, the Corps began a dike notching program on the Lower Mississippi River in the late 1980s. A dike notch is a weir section in the dike that is designed to maintain flow through the dike fields at low river stages, thereby minimizing the adverse sedimentation impacts in the secondary channels. The size of the weir section depends on local site conditions, but typically the width varies from about 100 to 300 feet, with a weir invert of about +5 feet above the LWRP. Not all dikes are subject to notching, either because of location and minimal environmental benefits, or because a notch would reduce their integrity or purpose (e.g., short dikes). Of the 774 dikes constructed, 225 (29 percent) have been notched to diversify bathymetry below the dike.

Notching closing dikes of secondary channels may be most effective in diversifying habitat conditions by maintaining flows in secondary channels for extended periods during low river stages. To date, combined efforts with LMRCC have utilized notches to cost-efficiently rehabilitate nine secondary channels. These efforts have increased flows in almost 40 miles of secondary channel habitat and enhanced hundreds of acres of seasonally flooded habitats.

Bendway Weirs

Bendway weirs were first constructed by the St. Louis District, and are used extensively on the Middle Mississippi River (MMR) and LMR. Bendway weirs are linear stone structures, similar to transverse stone dikes, except for where they are placed in the channel. These structures are placed from the concave bank across the main or navigation channel. A series of weirs are constructed in a bend to form a functional system. These structures typically have elevations 20 feet or more below the LWRP, thereby allowing passage of navigation traffic, and are variously angled upstream depending on site conditions. Bendway weir systems are designed to increase uniformity of flow, to lower velocities, and to reduce shoaling in a bend. These effects are accomplished by widening the low-water channel and making it shallower, resulting in a

more rectangular, as opposed to a triangular, channel cross-section. The number, length, elevation, angle, and spacing of bendway weirs are based on site conditions and physical model tests. There are eight bendway weir systems constructed in the LMR, six within the Memphis District, and two in the Vicksburg District.

Environmental features: Bendway weirs may reduce channel degradation in some locations, contributing to maintaining flows in nearby side channels, important nursery areas for fish forage species (Service 2000, Ecological Specialists, Inc. 1997a).

Hardpoints

Hardpoints were designed to stabilize river banks as a cost-effective alternative to revetment. Hardpoints consist of stone fills spaced along an eroding bank line, protruding only short distances into the channel; a root section extends landward to preclude flanking. Hardpoints are most effective along straight or relatively flat convex banks where the streamlines are parallel to the bank lines and velocities are not greater than 10 ft/s (3 m/s) within 50 ft (15 m) of the bank line. Hardpoints may be appropriate for use in long, straight reaches where bank erosion occurs mainly from a wandering thalweg at lower flow rates. They would not be effective in halting or reversing bank erosion in a meander bend unless they were closely spaced, in which case spurs, retarder structures, or bank revetment would probably cost less. Hardpoints are most commonly placed in lieu of revetment along the concave bank in secondary channels in the LMR.

Environmental features: Compared to revetment, hardpoints conserve natural river bank, diversify riverine habitat through deposition and scour, and provide velocity refugia for aquatic organisms.

Roundpoints

Multiple Roundpoint Structures (MRS) are alternating rows of rock mounds within the footprint of a typical dike. These structures are built to a two-thirds bankfull stage, with the spacing of the rock mounds a function of the roundpoint height. MRS are used like a dike to maintain the navigation channel.

Environmental features: MRS have been used to create flow and bathymetric diversity for aquatic habitat improvement within some dike fields (Pokrefke 2012).

Chevrons

Only a few chevrons have been built in the LMR. Chevrons are typically used in wider reaches of the river where a flow split is desired. A C-shape rock dike is constructed and aligned to split flow while protecting the existing shoreline. A series of chevrons are usually required to obtain the desired effect. The split flow scours the substrate along the outside trailing edges of the chevron. Scour also occurs within the interior of the chevron

and can form small islands immediately downstream as sand deposits in more slackwater areas.

Environmental features: Chevron dikes are used, where appropriate, to simultaneously provide bank protection, channel scour, and habitat diversity. These structures provide habitat heterogeneity, appear to increase invertebrate abundance and diversity (Ecological Specialists, Inc. 1997b), and provide useful and valuable habitat for a large variety of riverine fishes (Atwood 1997).

Dredging

One of the primary missions of the Corps is to maintain the channel depth and width for commercial navigation. Between Cairo, IL and Baton Rouge, Louisiana in the LMR, the Corps maintains a 9-foot deep channel that is 300-feet wide and a 9-foot deep channel in the ports and harbors. Dredging occurs mostly at crossings, of which there are approximately 200 between the mouth of the Ohio and Baton Rouge, Louisiana (Baker *et al*. 1991). Dredging can be substantial below Baton Rouge at low river stages to maintain a deep draft (45 feet) channel. However, dredging below Baton Rouge is not accomplished under the MR&T project, but rather under the Mississippi River, Baton Rouge to the Gulf of Mexico Project. Dredged material from the LMR is usually deposited directly in flowing water where it disperses throughout the channel. This method is referred to as within-banks or flow-lane disposal and is used above and below Baton Rouge.

Different types of dredges (cutterhead, dustpan, hopper) are used depending upon the area. In the LMR, large dustpan dredges are most commonly used by the Corps. The suction head, approximately the width of the dredge, is lowered to the face of the material to be removed. High velocity water jets loosen the material which is then drawn by pump as slurry through the dredge pipe and floating pipeline where the material is deposited outside of the navigation channel. Hopper dredges are also operated where dredged material must be moved greater distances. Hopper dredges stores dredged material onboard and transport it to an approved disposal site. Cutterhead dredges are equipped with a rotating cutter apparatus surrounding the intake end of the suction pipe. Cutterheads can efficiently dig and pump all types of alluvial materials and compacted deposits, such as clay and hardpan. This type of dredge has the capability of pumping dredged material long distances to upland disposal areas.

Over the past ten years, a total of almost 431,000,000 cubic yards of sediment have been dredged from the main channel of the Mississippi River. This represents an average of 43,000,000 ± 12,000,000 cubic yards dredged each year. However, over 75 percent of this dredging occurred downstream from Baton Rouge, under the Mississippi River, Baton Rouge to the Gulf of Mexico deep-draft navigation project. Annual variation in dredging amounts is due to river stage; low water years require more dredging to maintain the navigation channel. From 1948 - 2008, dike construction dramatically reduced the amount of annual dredging requirements above Baton Rouge.

Environmental features: Within-banks or flow-lane dredge disposal provides environmental benefits by maintaining sediment within the channel to build sandbars, reduce erosion, and

provide material to build or replenish island habitats and coastal wetlands. In some cases, dredge material flows through a pipeline to nearby dike fields or other off-channel locations to build or enhance landforms, such as ILT nesting islands.

Conservation Measures

Conservation Measures to minimize harm to listed species which are proposed by the action agency are considered part of the proposed action. The Corps MVD identified conservation strategies and actions in its 2013 Conservation Plan/BA. Actions identified under Strategies 1 and 2 have been incorporated as Standard Operating Procedures and Best Management Practices (hereafter, referred to as BMPs) under the CIP to minimize adverse effects of the CIP, maintain LMR channel habitat quantity and complexity, and to contribute to the conservation of the endangered ILT, PS, and FPM and their habitats. Actions identified under Strategies 3 and 4 provide information and mechanisms to incorporate adaptive management into the CIP through research, monitoring and partnerships.

Strategy 1: Avoid adverse impacts directly associated with CIP engineering practices.

Actions:

a. Comply with seasonal restrictions for construction when appropriate and/or possible. Seasonal restrictions, or "windows," have been or may be established by state and Federal resource agencies to minimize nesting, spawning, or juvenile disturbance during all construction and maintenance activities. Currently, construction is prohibited from 1 April to 1 August annually on the LMR, a 5-month window. As new information is developed, these restrictions may be modified to reduce impacts on construction activities while protecting endangered species and their habitats. However, any changes to these seasonal restrictions could potentially impact the navigation mission of the CIP and will be carefully considered by all agencies involved. (*Construction and maintenance BMP*)

b. Avoid closure of secondary channels. Loss of secondary channel habitat, and decline of endangered species habitat value, has occurred through the construction of secondary channel closure structures under the CIP. In recent years, alternatives such as strategic dike placement, chevrons, etc. have been successfully used in place of closure structures to maintain appropriate depth and width of the navigation channel while maintaining habitat diversity. (*Construction and maintenance BMP, habitat protection BMP*)

c. Avoid impacts of dikes on gravel bars. Gravel bars are typically found at the upstream reach of islands and near crossings where water depth is shallow and dikes are required to maintain the navigation channel. Efforts are underway to identify established gravel bars and avoid construction activities that may result in accretion of sand over well-developed gravel substrates. Notching existing dikes impacting gravel substrates has also been targeted. (*Construction and maintenance BMP, habitat protection BMP*)

Strategy 2: Develop and implement channel construction and maintenance operation

guidelines that conserve and restore LMR habitat for all three species, are subject to adaptive management, and can and will be continued should the species become fully recovered.

Actions:

a. Identify and implement dike construction and maintenance designs that maximize habitat complexity. Dike notching is the primary mechanism to increase habitat complexity. Most ILT colonies on the LMR are associated with dike fields, which create higher sandbars with less exposure to flooding during the summer nesting season. Notches are created by removing rock toward the landward end during maintenance work on an existing dike or by leaving an open, low section when a new dike is built (Guntren *et al*. 2013). Water flowing through the notch scours substrates below the dike increasing bathymetric diversity and allowing flow to isolate nesting sandbars through most of the nesting season. Dike notching and other alternative designs of river training structures (e.g., round points, chevrons, off-bankline revetment, as described by the Corps (2006) and Pokrefke (2012), that increase habitat diversity and/or reduce impacts to endangered species and other native fauna will only be considered when there is minimal effect on the purpose and intent of the authorized project (i.e., navigation/flood risk reduction). (*Construction and maintenance BMP, habitat restoration BMP*)

b. Restore connectivity to the main channel whenever possible. Restoration of secondary channels by notching or removing closure dikes, was identified as one of the top restoration priorities (Boysen *et al*. 2012) and an evaluation procedure has been developed to rank the habitat value of over 50 secondary channels for planning purposes (Killgore *et al*. 2012). In recent years, secondary channel restoration actions have required collaboration of multiple partners, and are expected to continue to do so. (*Habitat restoration BMP*)

c. Utilize chevrons instead of dikes where conditions are appropriate. Dike fields form large, homogenous sandbars that become exposed at moderate to low discharges. Chevrons will be constructed in selected areas to increase hydraulic diversity in homogenous sandbar habitat while maintaining appropriate flow conditions for navigation and bank protection. (*Construction and maintenance BMP*)

d. Continue to create longitudinal grooves in ACM. Armoring riverbanks with ACM to protect the river channel is critical to both flood risk management and navigation. The Corps has designed deep grooves in ACM to increase surface area, reduce surface current speed, and allow greater opportunity for attachment of invertebrates. This practice increases the biomass of invertebrates consumed by PS and by prey species for PS and ILT. (*Construction and maintenance BMP*)

e. Utilize hardpoints in lieu of revetment where conditions allow. In some erosional areas, hardpoints are an alternative to ACM. They function to prevent bank erosion with less impact to natural riverbank. Hardpoints will be considered where practical. (*Construction and maintenance BMP*)

f. Continue to strategically place large woody debris removed from banks during revetment construction or repair into the channel. Large woody debris removed from the bank during construction and maintenance activities will be strategically placed in the channel, to provide habitat for attached macroinvertebrates, as well as shelter for forage fish. (*Construction and maintenance BMP*)

g. Minimize impacts of dredging. Dredging activities will avoid or minimize impacts on gravel bars, tributary mouths, and backwater habitats. The Corps will continue to abide by recommendations provided by the Service, including distance buffers and timing windows. Beneficial placement of dredged material will be utilized where appropriate and authorized. (*Construction and maintenance BMP, habitat restoration BMP*)

Strategy 3: Develop cost-effective monitoring programs, as funding allows, to document habitat and species response to channel operations.

Actions:

a. Collaborate with Service and LMRCC to periodically monitor and measure habitat complexity and channel response to river training structures. Habitat complexity will be measured using existing capabilities including bathymetric surveys, Red Hen geo-referenced video, Lidar, ground truthing including gravel bar surveys, and aerial photography. GIS maps using River and Environmental Engineering GIS will be updated with new habitat information.

b. Utilize ILT and PS as surrogate species to monitor ecosystem response to management. Unless future information suggests otherwise, Corps will utilize these two endangered species as surrogates to document ecosystem function, quality, and response to Corps channel management, regardless of the species' future listing status under the ESA. FPM is not recommended as a surrogate species at this time due to limited data availability.

c. Conduct targeted monitoring and analysis of habitat utilization and preference of the three endangered species. Field surveys and telemetry will be conducted to evaluate habitat use of listed species and their responses to Corps construction and maintenance activities in the LMR.

d. Collaborate with Service to develop and implement a more statistically rigorous monitoring program to track ILT population trends on the LMR. Over the next 1-2 years, the ERDC-EL will be coordinating with the Service, ABC, and the USGS to develop a range-wide monitoring program for the ILT, which will serve to: 1) streamline and standardize existing monitoring techniques, and 2) provide a robust means of assessing range-wide population status into the future. Ideally, the monitoring protocol will rely upon sub-sampling rather than complete counts of adults throughout the range. If the ILT is delisted, monitoring on the LMR will be part of a required range-wide post-delisting monitoring plan.

e. Monitor population size and trends of PS in the LMR. Periodic monitoring of PS populations will continue using standardized collection methodologies. Key population attributes, including young-of-year survival, recruitment, adult survival, and density, will be evaluated using Population Viability Analysis models. Population size and trends will be compared among southern, middle, and upper reaches of the LMR. Information will be shared with partners at annual meetings and used to evaluate and modify conservation actions.

f. Conduct periodic surveys for presence/absence of FPM. Densities of FPM are naturally low in LMR, and there are no historical occurrence records. Therefore, measurements of population size or trends are currently not practical. However, low-water surveys of FPM in proposed or existing construction sites in main and side channel habitats should be conducted to evaluate presence/absence as budget and authority allows.

Strategy 4: Share restoration, research, and monitoring responsibilities and costs by maintaining strong partnerships with other Federal and state agencies and NGOs.

Actions:

a. Continue to sponsor annual meetings with partners to discuss and implement Actions 1 and 2 as part of regular program and project efforts.

b. Continue to work with LMRCC, The Nature Conservancy, and other partners to share restoration and funding responsibilities as budget and authority allow.

c. Promote the Lower Mississippi Resource Assessment as a means to identify and implement conservation and restoration measures.

While the implementation of BMPs is contingent upon opportunity, annual appropriations and other practical constraints, all of the identified actions have been at least partially implemented for more than a decade.

STATUS OF THE SPECIES

This section presents the biological or ecological information relevant to formulating the biological opinion. Appropriate information on the species' life history, their habitats and distributions, and other data on factors necessary to their survival, is included to provide background for analysis in later sections. This analysis documents the effects of all past human and natural activities or events that have led to the current range-wide status of the species. This information is taken from listing documents, recovery plans, five-Year Reviews, the Conservation Plan/Biological Assessment (Corps 2013a), and other sources.

Interior Least Tern

The least tern is the smallest of the North American terns, growing to a length of 21 to 23 cm (8 to 9 in) and a wingspan of 48 to 53 cm (10 to 21 in) (Thompson *et al*. 1997). Their plumage and coloration is similar for both sexes and all ages. ILT are the inland reproductive population of least tern that nests on or adjacent to the major rivers of the Great Plains and the Lower Mississippi Valley. The listed range of ILT is defined as the Mississippi River and tributaries north of Baton Rouge, Louisiana; and all drainages in Texas more than 50 miles inland from the coast (50 FR 21789). This portion of the range is only used for nesting and foraging during the spring/summer reproductive season (May – August). ILT are strong fliers, migrating as far as 2000 miles between their summer nesting habitats and winter habitats in Central and South America (Thompson *et al*. 1997).

Taxonomy and Genetics

Least terns within the Interior Basin of North America were described as *Sterna antillarum athalassos* (Burleigh and Lowery 1942). 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).

Genetic analyses of North American populations of least tern find no evidence of differentiation warranting subspecies recognition (e.g., Whittier 2001; Draheim *et al*. 2010; Draheim *et al*. 2012). Data indicate that genetic exchange between eastern least terns and ILT is occurring at a rate greater than three migrants per generation between populations (Whittier *et al*. 2006).

Whittier *et al*. (2006) noted that the general lack of genetic diversity in least tern and other Charadriiformes (shorebirds, gulls, auks and allies) might be an inherent trait, and not the result of a population bottleneck (evolutionary event where a significant proportion of a species is eliminated; or where a population becomes reproductively isolated) or expansion. However, in a comparison of museum specimen DNA with contemporary specimens, Draheim *et al*. (2012) found a reduction in contemporary genetic diversity in both Eastern and California least terns since the 1960's, potential evidence of a past bottleneck possibly related to overexploitation during the 20th century.

Life Span

ILT are long-lived, with records of recapture more than 20 years following banding (Thompson *et al*. 1997), however, the average life span is probably less. Most begin breeding at two or three years of age, and breed annually throughout their lives (Thompson *et al*. 1997).

Nesting Habitat and Behavior

ILT generally nest on the ground, in open areas, and near appropriate feeding habitat (Lott and Wiley 2011, Lott *et al*. 2013). 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 1991, Stucker 2012). Typical least tern clutch size is reported as two to three eggs (Thompson *et al*. 1997), however clutch size may vary by location and year (e.g., Szell and Woodrey 2003; Jones 2012), especially in

response to varying availability of prey (Massey *et al*. 1992).

Vegetation free sand or gravel islands are preferred for nesting, although, sand banks, point bars, and beaches may also be utilized (Lott *et al*. 2013). Natural nesting habitat features are maintained and influenced by magnitude and timing of riverine flood events (Sidle *et al*. 1992; Renken and Smith 1995; Pavelka *in litt*. 2012). However, flooding was historically, and remains a primary cause of ILT nest failure in both unregulated and regulated river channels (e.g., Szell and Woodrey 2003, Sidle *et al*. 1992).

ILT prefer areas remote from trees or other vegetation that may hide or support predators (Lott *et al*. 2013). Least terns will also nest on anthropogenic sites (Jackson and Jackson 1985; Lott 2006) near water bodies with appropriate fish species and abundance, including industrial sites (Ciuzio *et al*. 2005; Mills 2012), dredged-material deposition sites (Ciuzio *et al*. 2005); sand pits (Smith 2008), created habitats (Stucker 2012), and rooftops (e.g., Boyland 2008, Watterson 2009).

Lott and Wiley (2012) described five physical and biological conditions that are necessary for ILT 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 <30 percent ground vegetation; 4) nesting sites that are >250 ft. from large trees; and, 5) availability of prey fishes to support chick growth until fledging.

Least terns are colonial nesters. Colony size may vary from a few breeding birds to > 1200 (e.g., Jones 2012). Some drainage populations may be limited by annual availability of nesting habitat (e.g., Missouri River; Stucker 2012), while potential nesting habitat is generally abundant and underutilized in others (e.g., Mississippi River; Corps 2008). 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 (e.g., Jones 2012) and/or nesting success (e.g., Smith and Renken 1993; Lott and Wiley 2012). However, least terns may re-nest, or relocate and re-nest if nests or chicks are destroyed early in the season (Massey and Fancher 1989; Thompson *et al*. 1997). Least tern chicks leave their nests within a few days of hatching (semiprecocial), but remain near the nests and are fed by their parents until fledging (Thompson *et al*. 1997).

Food and Foraging Habitat

ILT are primarily opportunistic piscivores, feeding on small fish species or fingerlings of larger species (<52 mm [2 in] total length for adults and <34 mm [1.3 in] total length for young chicks) (Stucker 2012). Surveys of nesting colonies on the lower Mississippi River have identified 21 fish species dropped by foraging terns (Corps 2008). These include native species such as shad (*Dorosoma* spp.), carps and minnows (Cyprinidae), freshwater drum (*Aplodinotus grunniens*), largemouth bass (*Micropterus salmoides*), white bass (*Morone chrysops*), sunfish (*Lepomis* spp.) and top minnows (*Fundulus* spp.); as well as invasive species such as silver and bighead carp (*Hypophthalmichthys* spp.). 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 (Stucker 2012).

Least tern will also occasionally feed on aquatic or marine invertebrates (Thompson *et al*. 1997). Riverine foraging habitats and fish abundance may be influenced by stochastic hydrological conditions and events (i.e., flow, and flood timing and magnitude), and geomorphic modification (Schramm 2004).

In the Missouri River drainage, ILT have been documented foraging for fish in shallow water habitats <12 km (7 mi) from colony sites (Stucker 2012). In the Lower Mississippi River, foraging terns have been observed feeding in a variety of habitats within 3 km (2 mi) of colony sites (Jones 2012).

Migration and Winter Habitat

Fall ILT migrants are believed to generally follow major river basins to their confluence with the Mississippi River and then south to the Gulf of Mexico, however, late summer observations of least terns >150 km (93 mi) from major river drainages suggests some birds migrate cross-country (Thompson *et al*. 1997). ILT exhibit distinct migration staging in August prior to migration. Once they reach the Gulf Coast, they cannot be distinguished from other least tern populations en route to, or within their winter habitats (i.e., Gulf of Mexico, Caribbean islands, Central and South America), therefore the limited information on migration and winter habitat is inclusive of other populations (i.e., Caribbean, Gulf Coast, East Coast). Least terns appear to migrate in small, loose groups along or near shore, feeding in shallows and resting onshore (Thompson *et al*. 1997). Very little is known of least tern winter habitats, other than the birds are primarily observed along marine coasts, in bays and estuaries, and at the mouths of rivers (Thompson *et al*. 1997). Atwood and Casioppo (2011) summarized known information about the distribution of wintering least terns; none of the approximately 50 recoveries of banded birds (through 2004) obtained south of the United States were from ILT breeding colonies.

Breeding/Natal Site Fidelity and Dispersal

Breeding-site fidelity for least terns appears to vary in different populations and breeding areas. Thompson *et al*. (1997) summarized reports of return rates of banded adults to sites where banded as 36 to 86 percent in California colonies, 42 percent on the Mississippi River, 28 percent on the central Platte River, Nebraska, and 81 percent 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 5 percent on the Mississippi River, to 82 percent in Kansas and Oklahoma (Thompson *et al*. 1997).

Site fidelity in least tern 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 percent turnover rate in nesting colony sites, primarily due to changes in habitat condition or disturbance. Where the physical characteristics of nesting sites are relatively stable from year-to-year (e.g., California), least terns exhibit higher levels of site fidelity than in areas where nesting sites may be annually reconfigured by the impacts of winter storms (e.g., Massachusetts).

Lott *et al*. (2013) used data from published mark/recapture studies (e.g., Atwood and Massey 1988, Akçakaya *et al*. 2003) and a large number of unpublished band recovery records to assess least tern dispersal and site fidelity. Their analysis found that 50 to 90 percent of reported recaptures occurred <26 km (16 mi) from the original banding sites, while >90 percent dispersed <96 km (59 mi). 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 (Lott *et al*. 2013). Long distance dispersal (up to 1,000 km) has been documented (e.g., Renken and Smith 1995; Boyd and Sexson 2004, Lott *et al*. 2013), and may not be uncommon (Boyd and Thompson 1985).

Predation

ILT eggs, chicks and adults are prey for a variety of mammal and bird predators. Reported predators include fish crow (*Corvus ossifragus*), American crow (*C. brachyrhynchos*), common raven (*C. corax*), boat-tailed grackle (*Quiscalus major*), gulls (*Larus* spp.), great blue heron (*Ardea herodias*), black-crowned night heron (*Nycticorax nycticorax*), ruddy turnstone (*Arenaria interpres*), sanderling (*Calidris alba*), great horned owl (*Bubo virginianus*), peregrine falcon (*Falco peregrinus*) , American kestrel (*F. sparverius*), northern harrier (*Circus cyaneus*), loggerhead shrike (*Lanius ludovicianus*), red fox (*Vulpes vulpes*), coyote (*Canis latrans*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), opossum (*Didelphis virginiana*), feral hog (Sus scrofa), catfish (Ictalurus sp.), and domesticated and feral dogs and cats (Thompson *et al*. 1997). 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).

Location and size of nesting colonies also has a significant influence on degree of predation. In several studies, ILT reproductive success has been higher on island colonies v. connected sandbar colonies, and when water levels maintained isolation of islands and nesting bars from mammal predators (e.g., Smith and Renken 1993; Szell and Woodrey 2003). Burger (1984) found significantly higher rates of predation in larger colonies compared to smaller least tern colonies in New Jersey.

Historical Distribution and Abundance

The historical distribution and abundance of ILT is poorly documented. Hardy (1957) provided the first information on least tern distribution on large, interior rivers, documenting scattered records of occurrence and nesting in the Mississippi, Ohio, Missouri, Arkansas, and Red river drainages. Downing (1980) published results from a rapid aerial/ground survey of a subset of the rivers, identifying additional nesting populations within the range, and estimated the interior population at ~1,250 adult birds. Ducey (1981) doubled the number of known nesting sites including areas between the scattered observations reported in Hardy (1957). He also extended the northern distribution of ILT to include the Missouri River below Garrison Dam in North Dakota and Fort Peck dam in Montana. These three publications (Hardy 1957, Downing 1980,

Ducey 1981) provide the primary historical sources of information about ILT geographic range, and were used to quantify a range-wide population size of 1,400 to 1,800 adults in the listing rule (50 FR 21789).

Sidle *et al*. (1985) reported on observations from a number of extensive, regional tern surveys, and increased the range-wide minimum population estimate to ~4,500 adults. This reference, along with the previous summaries, provided the background for regional recovery goals presented in the recovery plan for ILT (U.S. Fish and Wildlife Service 1990). Hill (1992, 1993) subsequently reported extensive observations of ILT from the Southern Plains, particularly from the Arkansas, Cimarron, Canadian, and Red Rivers.

Current Distribution and Abundance

The current documented east to west distribution of summer nesting ILT encompasses >18 degrees of longitude (>1,440 km (900 mi)) from the lower Ohio River in Indiana/Kentucky, west to the Upper Missouri River, Montana. The north to south distribution encompasses >21 degrees of latitude (>2300 km (1,450 mi)) from Montana to southern Texas. ILT currently nest along >4,600 km (2,858 mi) of river channels across the Great Plains and the Lower Mississippi Valley (Lott *et al*. 2013).

In 2005, Lott (2006) coordinated the only simultaneous survey to date of the geographic range of ILT during a two-week window of the breeding season. Summarized counts from this survey indicated a minimum adult population size of ~17,500, with nesting occurring in >480 colonies spread across 18 states (Lott 2006). Lott (2006) also provided counts for 21 populations or population segments unknown at the time of listing, which collectively supported over 2,000 ILT. Lott (2006) 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 ILT colonies were not surveyed.

Productivity

Productivity (generally measured as fledgling success per breeding adult pair) considered necessary to maintain stable or increasing populations of ILT has been estimated at 0.51 fledglings/pair or higher (Kirsch and Sidle 1999). However, estimates of productivity have been highly variable within and between ILT drainage populations (Kirsch and Sidle 1999; Dugger *et al*. 2000), and do not appear sufficient to support observed increases in local or range-wide populations (Kirsch and Sidle 1999).

Discrepancies between productivity and population trends have also been observed for California least terns. The California Least Tern Recovery Plan identified productivity levels averaging at least 1.0 fledglings/pair as necessary to maintain a stable or growing population of terns (Service 1985). However, California least terns have experienced an overall positive population trend even when productivity levels have been substantially lower (e.g., 0.23 to 0.36 fledglings/pair; Service 2006a)

There is strong evidence that ILT productivity naturally varies dramatically by year, and among

sites within years (e.g., Sidle *et al*. 1992; Dugger *et al*. 2000). Factors other than fledgling success affecting long-term productivity include post-fledging juvenile survival, adult annual survival, longevity, and/or emigration and immigration (Kirsch and Sidle 1999), all of which are poorly documented for least terns. Models developed by Whittier (2001) found that ILT breeding populations at Salt Plains National Wildlife Refuge, Oklahoma, and Quivira National Wildlife Refuge, Kansas would persist despite low productivity. In these models, longevity and periodic high recruitment counteracted low productivity estimates. However, this was not the case for the Missouri River population, due to low overall productivity, and no peaks in productivity during the monitoring record analyzed (1991-1998, Whittier 2001). Since that time, however, higher fledgling ratios (>1.0) have been occasionally observed in the Missouri River, likely as a result of habitat increases that developed following 1996-97 high flow years (Pavelka *in litt*. 2012).

Dispersal of individuals between populations is an important factor in the persistence of unstable peripheral populations (e.g., Taylor 1990). In such cases immigration of individuals into the population can reduce the magnitude of population fluctuations and even prevent extirpation of the population (Taylor 1990). Dispersal between ILT populations has been poorly documented, but it appears to be an important factor in maintenance of peripheral populations such as the upper Missouri River (Lott *et al*. 2013).

Population Trends

The listed population of ILT has demonstrated a positive observed population trend, increasing by almost an order of magnitude since listing. Kirsch and Sidle (1999) reported a range-wide population increase from <2,000 in 1985 to >8,800 adult birds in 1995, and found that 29 of 31 ILT locations with multi-year monitoring data were either increasing or stable. Lott (2006) reported an increase to >17,500 adult birds in 2005, forming 489 colonies in 68 distinct geographic sites.

Lott (2006) conceptualized the ILT functioning as a large meta-population (a group of spatially separated populations of the same species which interact at some level), which might also include least terns on the Gulf Coast. Using available information on dispersal of least tern, Lott *et al*. (2013) defined 16 discrete breeding populations of ILT, with four major geographical breeding populations, two in the Missouri River drainage, and two in the Lower Mississippi River drainage. These four populations account for >95 percent of all adult birds and nesting sites throughout the range. Below, we consider overall population trends by drainage since listing.

Missouri River Drainage: The Missouri River drainage supports ~10 percent of the ILT population. Management programs have been successfully implemented in portions of the Missouri River drainage (i.e., Missouri, Loup, and Platte rivers). ILT numbers in the Missouri River drainage have increased from 740 birds when listed (1985) to an average of approximately 1,500 birds/year over the past decade.

Mississippi/Ohio River: The Mississippi/Ohio River drainage supports ~65 percent of the ILT population. An informal management program for ILT was initiated on the LMR

immediately after listing by the CORPS-MVD. Under this management scenario, ILT numbers increased from <1,000 birds in 1985, to ~6000 birds in 2000. In 2001, the CIP channel design approach considered in this consultation was incorporated into the Corps-MVD channel construction and maintenance. ILT counts have since increased to ~10,000 birds/year over the past decade; however, data is insufficient to link the increase directly to changes in channel design.

ILT from the LMR have also expanded into the Ohio River drainage. The 1986 colonization by a nesting pair of ILT at an industrial site adjacent to the Wabash River, Gibson County, Indiana, led to increasing numbers of terns, and expansion of nesting colonies to multiple sites on public and private properties (Hayes and Pike 2011). At last count (2012) these sites supported more than 200 birds.

In 2002, observation of ILT attempting to nest on dredged material deposited in the lower Ohio River led the Corps Louisville District to develop and initiate a dredged-material disposal methodology that constructs sandbars conducive to nesting ILT (e.g., Van Hoff 2007, Fischer and Van Hoff 2009, Fischer 2011). Disposal islands now support 120 to 160 adult ILT during the nesting season (Fischer 2012).

Southern Plains Rivers: Red and Arkansas River drainages: The Red/Arkansas River drainages ~22 percent of the ILT population. Management guidelines have been developed and implemented by the Corps' Southwest Division (Corps-SWD) in reaches of the Red and Arkansas rivers (Corps 2002, Corps 2012). ILT population trends in both the Red and Arkansas River drainages have been positive since the species was listed. Red River ILT counts have increased from <80 adult birds (1985), to >700 birds/year over the past decade. Arkansas River counts have increased from 610 adult birds (1985) to >1,000 birds/year over the past decade.

Others: Approximately 3 percent of ILT nest in drainages other than the above. These are primarily associated with anthropogenic sites, including reservoirs, mines, and industrial sites.

Summary

ILT continues to be represented throughout most of its historical latitudinal summer nesting range. The species has demonstrated resilience, expanding its longitudinal summer nesting range by colonizing reservoirs constructed in drainages where this species in not known to have historically occurred, and by adapting to a variety of other suitable anthropogenic habitats. Range-wide numerical recovery criteria have been met and exceeded for more than a decade. ILT regional and range-wide population persistence and increases in numbers of birds and nesting colonies demonstrate successful protection and management of its habitat (Service 2013a).

While some portions of the potential historical range may have become periodically or permanently unsuitable for ILT nesting, the species has increased in abundance and nesting colonies in geographical areas where habitat conditions are more accommodating. Threats and sources of threats to ILT are primarily localized (e.g., predation, vegetation of habitat, human

disturbance, reservoir releases), regional (e.g., water table and flow declines), and/or stochastic (e.g., floods and droughts), and are not significant to the range-wide status of the species. ILT has expanded in population size, number of breeding colonies, and range, showing resilience to these threats, and response to local management. Based upon improvements in range-wide status and successful protection and management of its habitats, the Service has recommended delisting the ILT due to recovery (Service 2013a).

Pallid Sturgeon

The PS is a benthic, riverine fish that occupies the Mississippi River Basin, including the Mississippi River, Missouri River, and their major tributaries (i.e. Platte, Yellowstone, and Atchafalaya rivers) (Service 1990). In 1990, the PS was listed as an endangered species under the Act (Service 1990). Its decline was attributed to several anthropogenic impacts, including habitat modification and commercial harvest of the fish (Service 1990). More recent studies have added water contamination, entrainment, and hybridization to the list of impacts (Divers *et al*. 2009; Service 1993, 2009; Blevins 2011; Schrey *et al*. 2011). The shovelnose sturgeon ((SS: *S. platorynchus*) is a sibling species to the PS and shares much of its range. The two species are morphologically similar, although the SS is more abundant than the PS (Kallemeyn 1983; Killgore *et al*. 2007). To further protect the PS, the SS was listed as a threatened species under the Similarity-of-Appearance Provisions of the Act in 2010 (Service 2010). This listing bans the commercial harvest of SS in areas where PS are known to occur (Service 2010).

Taxonomy and Genetics

PS was described from the Mississippi River by Forbes and Richardson (1905) as *Parascaphirhynchus albus*. In a comparison with shovelnose sturgeon (SS, *S. platorynchus*), they reported that the new species differed in size, color, head length, eye size, mouth width, barbel length ratios, ossification, gill raker morphology, number of ribs, and size of the air bladder (Forbes and Richardson 1905). Berg (1911) later placed the pallid sturgeon within the genus *Scaphirhynchus* (i.e., *S. albus*) along with the more common and widely distributed SS.

During the five decades following the original description of PS, it remained one of the least known North American freshwater fish, and at least some contemporary ichthyologists doubted its validity. However, during mid-century, the accumulation of specimens from the Missouri River allowed a comparison of the two species of *Scaphirhynchus* in greater detail (Bailey and Cross 1954).

Bailey and Cross (1954) examined 16 SS and 15 PS, most of which had been recently collected from the middle and upper Missouri River. Their analysis confirmed most of the diagnostic characters that were identified by Forbes and Richardson (1905), and defined several new diagnostic characters, including barbel arrangement and position, barbel structure (i.e., diameter and papillae), and fin ray counts. They also developed a suite of diagnostic measurement ratios intended to eliminate the effects of individual and, possibly, geographic variation. Bailey and Cross also attempted to describe and account for allometric changes in measurement ratios for juvenile PS. However, Bailey and Cross (1954) recognized a major limitation to their analysis was the small number of specimens examined, given the geographic range of both species.

In the 30 years following Bailey and Cross (1954), most new observations and records of pallid sturgeon continued to originate from the middle and upper Missouri River drainage (Kallemeyn 1983, Keenlyne 1989), supporting the diagnostic features identified by Bailey and Cross (1954), however, PS specimens from the Mississippi River remained rare. A range-wide status review for pallid sturgeon assembled in 1983 found only 31 of 250 historical and recent observations from the Mississippi River (Kallemeyn 1983). This review attributed rarity of the species in the Mississipi River, at least in part, to lack of sampling efforts and inefficiency of sampling methods in large river habitats (Kallemeyn 1983). In a response to a petition to list pallid sturgeon as an endangered species, Keenlyne (1989) re-surveyed collection records, literature, and active collectors, documenting 35 observations of the species from the Mississippi River, 2 from the lower 150 miles of the Missouri River, 38 in the lower 810 miles of the Missouri, and 765 pallid sturgeon observations from the Missouri River between Fort Peck and Gavins Point Dams (Keenlyne 1989, Appendix 2).

The first rigorous attempt to scientifically collect and quantify river sturgeon (*Scaphirhynchus* spp.) in the Mississippi and lower Missouri rivers was conducted in Missouri during 1978-1979 (Carlson *et al*. 1985). Out of 4355 river sturgeon collected, 11 were identified as pallid sturgeon, based on the Bailey and Cross (1954) analysis, but an additional 12 river sturgeon were found to have one or more characters that appeared to be intermediate between SS and PS. Noting that specimens with intermediate characters had not been reported by Bailey and Cross, Carlson *et al*. (1985) attributed these fish to a recent hybridization event between shovelnose and pallid sturgeons that had likely been precipitated by engineering modifications in the Missouri and Mississippi rivers. An additional occurrence of morphological intermediate or hybrid river sturgeon in the Mississippi River, Kentucky, was subsequently reported by Warren *et al*. (1986). In the 1990 Federal Register publication listing the pallid sturgeon as an endangered species, hybridization between PS and SS was identified as a factor in the endangered status of the species (U.S. Fish and Wildlife Service 1990). The listing publication also noted that the age of the purported hybrid fish suggested that recent habitat alteration on the Missouri River was likely responsible for the significant amount of hybridization noted by Carlson *et al*. (1985).

Keenlyne *et al*. (1994) later reported a high incidence of hybridization between PS and SS in the Mississippi and Atchafalaya rivers, along with a report of a hybrid from an impounded Missouri River reach. They also concluded that their finding of individual sturgeon demonstrating a wide range of morphometric characteristics, where Bailey and Cross (1954) found mutual exclusivity between the species 40 years earlier, suggested that the hybridization was a fairly recent event initiated by habitat modification. Keenlyne *et al*. (1994) also noted that the wide range of morphological variation observed indicated fertile hybrids and genetic introgression (Keenlyne *et al*. 1994).

While Carlson *et al*. (1985) and Keenlyne *et al* (1994) used a suite of counts and measurement proportionalities taken from Bailey and Cross (1954) to confirm their sturgeon field identifications and to demonstrate hybridization, later workers developed character indices based upon the Bailey and Cross proportionalities (e.g., Sheehan *et al*. 1999, Service 2000, Wills *et al*. 2002), or on hatchery reared specimens from the Upper Missouri River (Kuhajda and Mayden 2001). These indices have since been used to demonstrate that a significant proportion of *Scaphirhynchus* sturgeon in the Mississippi and Atchafalaya rivers are hybrids between the

species, and to support the hypothesis that hybridization is a recent threat.

Murphy *et al*. (2007) examined morphometric variation within 41 pallid and shovelnose sturgeons collected in the Mississippi River, compared identifications using character indices with results from a sheared principal components analysis (PCA), and found complete separation of PS and SS using PCA, while the character indices indicated significant overlap. They concluded that morphological variation in PS could be explained as latitudinal morphometric variation and allometric growth differences between populations at the extremities of the range (i.e., upper Missouri River and Lower Mississippi/Atchafalaya River). Murphy *et al*. (2007) also proposed that allometric growth, temperature-dependent development, and regionally comparable growth rates may explain both intraspecific variability and interspecific similarity between pallid and shovelnose sturgeons in the Mississippi River. Various other studies have also identified allometric growth of pallid sturgeon as a source of morphological variation in the species, especially in young individuals and at smaller sizes (e.g., Bailey and Cross 1954, Carlson *et al*. 1985, Kuhajda *et al*. 2007).

Genetic studies have also provided supporting evidence that hybridization between PS and SS is occurring in the Mississippi and Atchafalaya rivers (Campton *et al*. 2000, Tranah *et al*. 2001, 2004; Schrey and Heist 2007). However, there is emerging evidence that introgression may have been occurring over multiple generations (Schrey *et al*. 2011), and may be natural (Hartfield and Kuhajda 2009, Hartfield *et al*. 2013).

Genetic data indicate that genetic structuring exists within the pallid sturgeon's range consisting of two distinct groups at the extremes of the species' range with an intermediate group in the middle Missouri River (Campton *et al*. 2000; Tranah *et al*. 2001; Schrey and Heist 2007). These data suggest a pattern of isolation by distance, with gene flow more likely to occur between adjacent groups than among geographically distant groups, and thus, genetic differences increase with geographical distance. Additionally, data indicate that these genetic differences translate into biological differences (i.e., differences in growth rates, metabolic rates, and consumption rates) indicative of local adaptations (Meyer 2011).

Habitat

PS occupy the benthos of large, turbid rivers in North America, particularly the main channel (Kallemeyn 1983). PS are thought to occupy the sandy main channel in the Mississippi, Missouri, and Yellowstone rivers most commonly, but also are collected over gravel substrates (Servcie 1993; Bramblett & White 2001; Hurley *et al*. 2004; Garvey *et al*. 2009; Koch *et al*. 2012). Several studies have documented PS near islands and dikes, and these habitats are thought to provide a break in water velocity and an increased area of depositional substrates for foraging (Garvey *et al*. 2009; Koch *et al*. 2012). Increased use of side channel and main channel islands has been noted in spring, and it is hypothesized that these habitats may be used as refugia during periods of increased flow (Garvey *et al*. 2009; Koch *et al*. 2012). Recent telemetry monitoring of PS in the LMR indicate use of most channel habitats, including dikes, revetment, islands, secondary channels, etc. (Kroboth *et al*. 2013).

PS occur within a variety of flow regimes (Garvey *et al*. 2009). In their upper range, adult PS are

collected in depths that vary between 1.97-47.57 ft with bottom water velocities ranging from 2.20 ft/s and 2.62 ft/s (Service 1993; Bramblett & White 2001; Gerrity 2005). PS in the LMR have been collected at depths greater than 65 ft with a mean value of 32.81 ft, and water velocities greater than 5.91 ft/s with a mean value of 2.30 ft/s (ERDC unpublished data). Turbidity is thought to be an important factor in habitat selection by PS, which have a tendency to occupy more turbid habitats than shovelnose sturgeon (Blevins 2011). In the LMR, PS have been collected in turbidities up to 340 NTU's with a mean value of 90 NTU's (ERDC unpublished data).

Much of the natural habitat throughout the range of PS has been altered by humans, and this is thought to have had a negative impact on this species (Service 1993). Habitats were once very diverse, and provided a variety of substrates and flow conditions (Baker *et al*. 1991; Service 1993). Extensive modification of the Missouri and Mississippi rivers over the last 100 years has drastically changed the form and function of the river (Baker *et al*. 1991; Prato 2003). Today, habitats are reduced and fragmented and much of the Mississippi River basin has been channelized to aid in navigation and flood control (Baker *et al*. 1991). The impact of habitat alteration on PS throughout its range is unknown, but recent studies have shown that in the unimpounded reaches (i.e., LMR), suitable habitat is available and supports a diverse aquatic community (Service 2007).

Movement

Like other sturgeon, PS is a migratory fish species and move upstream annually to spawn (Koch *et al*. 2012). Movements are thought to be triggered by increased water temperature and flow in spring months (Garvey *et al*. 2009; Blevins 2011). Garvey *et al*. (2009) suggested that PS remain sedentary, or remain in one area for much of the year, and then move either upstream or downstream during spring. It is possible that because movement in large, swift rivers requires a great amount of energy, this relatively inactive period may be a means to conserve energy (Garvey *et al*. 2009). Most active periods of movement in the upper Missouri River (RPMA2) were between 20 March and 20 June (Bramblett & White 2001). In one study, individual fish traveled an average of 3.73 mi/day and one individual traveled over 9.94 mi/day (Garvey *et al*. 2009). PS in the Missouri River have been reported as traveling up to 5.90 mi/hour and 13.30 mi/day during active periods (Bramblett & White 2001). PS may undertake long-distance, multi-year upstream movements, based on recaptures of shovelnose sturgeon in the Missouri River originally tagged in the LMR. Upstream distances approaching 1245 mi have been recorded (ERDC unpublished data) and similar distances have been recorded for downstream movements (Service unpublished data).

Aggregations of PS have been reported in several locations in the middle Mississippi River, particularly around gravel bars, including one annual aggregation at the Chain of Rocks Dam, thought to be related to spawning activities (Garvey *et al*. 2009). Aggregations of PS in the lower 8.70 mi of the Yellowstone River are also believed related to spawning activities of sturgeon from the Missouri River (Bramblett & White 2001). PS have been found to have active movement patterns during both the day and night, but move mostly during the day (Bramblett & White 2001).

Feeding

Sturgeon are benthic feeders and are well adapted morphologically (ventral positioning of the mouth, laterally compressed body) for the benthic lifestyle (Service 1993; Findels 1997). Adult PS are primarily piscivorous (but still consume invertebrates), and are thought to switch to piscivory around age 5 or 6 (Kallemeyn 1983; Carlson *et al*. 1985; Hoover *et al*. 2007; Grohs *et al*. 2009). In a study of PS in the middle and lower Mississippi River, fish were a common dietary component and were represented primarily by Cyprinidae, Sciaenidae, and Clupeidae (Hoover *et al*. 2007). Other important dietary items for PS in the Mississippi River were larval Hydropsychidae (Insecta: Trichoptera), Ephemeridae (Insecta: Ephemeroptera), and Chironomidae (Insecta: Diptera) (Hoover *et al*. 2007). PS diet varies depending on season and location, and these differences probably are related to prey availability (Hoover *et al*. 2007). In a Mississippi River dietary study, Trichoptera and Ephemeroptera were consumed in greater quantities in winter months in the lower Mississippi River, while the opposite trend was observed in the middle Mississippi River (Hoover *et al*. 2007). Hoover *et al*. (2007) also found that in both the middle Mississippi River and the lower Mississippi River, dietary richness is greatest in winter months.

Spawning

Freshwater sturgeon travel upstream to spawn between the spring equinox and summer solstice, and it is possible that either a second spawn or an extended spawning period may occur in the fall in southern portions of the range (i.e., Mississippi River) (Service 2007; Wildhaber *et al*. 2007). These spawning migrations are thought to be triggered by several cues, including water temperature, water velocity, photoperiod, presence of a mate, and prey availability (Keenlyne 1997; DeLonay *et al*. 2007; DeLonay *et al*. 2009; Blevins 2011). Gamete development is completed during the upstream migration and sturgeon are thought to spawn near the apex of their migration (Bemis & Kynard 1997). Data suggests that female *Scaphirhynchus* spp. do not reach sexual maturity until ages 6-17 and spawn every 2-3 years, and that males do not reach sexual maturity until ages 4-9 (Keenlyne & Jenkins 1993; Colombo *et al*. 2007; Stahl 2008; Divers *et al*. 2009). PS and shovelnose sturgeon at lower latitudes (e.g., lower Mississippi River) may begin spawning at an earlier age than those in upper portions of the range (e.g., Upper and Middle Mississippi and Missouri Rivers) because they are thought to have shorter lifespans and smaller sizes (George *et al*. 2012). Also, LMR PS may be more highly fecund than those in northern portions of their range (George *et al*. 2012). It is thought that PS, like shovelnose sturgeon spawn over gravel substrates, but spawning has never been observed in this species (Service 1993; DeLonay *et al*. 2007; DeLonay *et al*. 2009).

Rearing

PS hatch when they reach a total length of approximately ¼-inch TL. Larvae feed on yolk reserves and drift downstream for 11-17 days, until yolk reserves are depleted (Snyder 2002; Braaten *et al*. 2008; DeLonay *et al*. 2009). Length of drift and rate of yolk depletion are dependent on several factors, including water temperature, photoperiod, and water velocity (Snyder 2002; DeLonay *et al*. 2009). Larval drift is not completely understood and the impacts of artificial structures, as well as the role of eddies, are unknown (Kynard *et al*. 2007; Braaten *et*

al. 2008). During drift, sturgeon repeat a "swim up and drift" pattern, in which they swim up in the water column from the bottom (<10 in) and then drift downstream (Kynard *et al*. 2002; Kynard *et al*. 2007). A hatchery series of shovelnose sturgeon from Louisiana (J. Dean, Natchitoches National Fish Hatchery, unpublished data) reports complete yolk sac absorption at days 8-9 post-hatch, which is several days sooner than shovelnose sturgeon from Gavins Point National Fish Hatchery in South Dakota, so there could be a latitudinal difference in yolk absorption and larval maturation rates throughout the range of PS (Snyder 2002). Exogenous feeding begins when yolk reserves are depleted and drifting has ceased, and timing can differ latitudinally (DeLonay *et al*. 2009). The switch from endogenous to exogenous feeding is known as the "critical period", because mortality is likely if sturgeon do not find adequate food (Kynard *et al*. 2002; DeLonay *et al*. 2009). PS begin exogenous feeding around 11-12 days post-hatch in upper portions of their range, but exogenous feeding was observed in fish as small as 17.82 mm TL in the lower Mississippi River (Harrison *et al*., unpublished data), which could be as young as 6-8 days (based on unpublished age and growth data from Natchitoches National Fish Hatchery) post-hatch (Braaten *et al*. 2007). The diets of young of year and juvenile PS and shovelnose sturgeon in upper portions of their ranges are much like those of the adult shovelnose sturgeon, and are primarily composed of aquatic insects and other benthic macroinvertebrates (Braaten *et al*. 2007; Wanner *et al*. 2007; Grohs, Klumb *et al*. 2009). Young of year and juvenile PS in the LMR feed primarily on Chironomidae over sand in channel habitats (Harrison *et al*. 2012, unpublished data). Juvenile PS are thought to switch to piscivory around ages 5-6 (Kallemeyn 1983; Carlson *et al*. 1985; Hoover *et al*. 2007; Grohs *et al*. 2009).

Kynard *et al*. (2002), found larval PS to be photopositive and showed little preference to substrate color, except for a slight preference for light substrates when exogenous feeding began. It is thought that PS become increasingly photonegative starting around day 11 post-hatch (Kynard *et al*. 2002). In this same study, larval sturgeon swam in open habitats, seeking no cover under rocks in the swimming tube, and aggregated in small groups around days 3-5 post-hatching (Kynard *et al*. 2002). The black tail phenotype of these young sturgeon is thought to aid in recognition and aggregation (Kynard *et al*. 2002). PS have been observed swimming and drifting at a wide range (2-118 in) above the bottom depending on water velocities (although most fish are thought to stay in the lower 20 in of the water column), and drift velocities are thought to range from 0.98-2.29 ft/s (Kynard *et al*. 2002; Kynard *et al*. 2007; Braaten *et al*. 2008). Drift distance of larval sturgeon is thought to be between 85.75-329.33 mi (Kynard *et al*. 2007; Braaten *et al*. 2008). Juvenile PS have been found in water depths ranging from an average of 7.58-8.14 ft in the upper Missouri River (Gerrity 2005). Maximum critical swimming speeds for juvenile PS range from 0.32 ft/s to 0.82 ft/s, depending on size, with larger juveniles (6-8 in TL) able to withstand higher water velocities than their smaller counterparts (5-6 in TL) (Adams *et al*. 1999).

Distribution and Abundance

PS occur in parts of the Mississippi River Basin, including the Mississippi River south of the Missouri River, and the Missouri, Atchafalaya, Yellowstone, and Platte rivers, where it is adapted to pre-modification habitats of these systems (Kallemeyn 1983; Killgore *et al*. 2007a). Recovery efforts have divided the extensive range of PS into four management units (Servcie 2013b). These areas were selected as areas of high importance for recovery task implementation

based on population variation (i.e., morphological, genetic) and habitat differences (i.e., physiographic regions, impounded, unimpounded reaches) throughout the extensive range of the PS (Service 2013b).

Great Plains Management Unit (GPMU): The GPMU extends from Great Falls of the Missouri River, Montana, to Fort Randall Dam, South Dakota, and includes the major tributaries thereof (Yellowstone, Marias, Milk Rivers). The most recent available estimates suggest there are approximately 45 wild adult PS remaining in the most upstream portion of the GPMU (previously RPMA 1), which includes the Missouri River from the confluence of the Marias River to the headwaters of Fort Peck Reservoir, Montana; all are thought to be older adults (Service 2007). Natural recruitment is not believed to have occurred in this area over the last 20 years (Gerrity *et al*. 2008). Stocking of juveniles and larvae began in 1997 and continues today (Service 2007). PS are hatchery-reared from broodstock captured in the management unit and stocked at age-1 (Gerrity *et al*. 2008). Recent collection data reveal that stocking efforts are working to alleviate extirpation of the species from the GPMU (Service 2007). Although historical population demographics from pre-altered habitats are unknown, the PS population from downstream of Fort Peck Dam to the headwaters of Lake Sakakawea, North Dakota, and from the Yellowstone River below the confluence of the Tongue River, Montana (Previously RPMA 2), is thought to have declined by 40 percent-58 percent since the 1960s (Keenlyne 1989; Service 2007; Braaten *et al*. 2009). Latest estimates suggest that there are around 160 wild sturgeon remaining in this section of the GPMU, and that there is little to no natural recruitment (Klungle & Baxter 2005; Service 2007). Population estimates and forecasts suggest that natural populations in this section of the GPMU will be extirpated between 2016 and 2018 (Kapuscinski 2002; Klungle & Baxter 2005). However, stocking efforts are currently in place and hatchery-reared juvenile PS are being released in efforts to achieve a population size of 1,700 individuals (Braaten *et al*. 2009).

Central Lowlands Management Unit (CLMU): The CLMU includes the Missouri River from Fort Randall Dam, South Dakota, to the confluence of the Grand River, Missouri, and includes the major tributaries thereof (lower Platte, lower Kansas Rivers). There are no naturally occurring wild PS remaining in the most upstream portion of the CLMU, i.e., the Missouri River downstream of Fort Randall Dam to Lewis and Clark Lake (formerly RPMA 3). The entire population within this reach of the CLMU consists of hatchery-reared fish and translocated wild PS (Service 2007). Stocking in this region began in 1997, and sturgeon sampling efforts have collected five out of six age classes that were stocked in the area (Shuman *et al*. 2005).

A recent PS study conducted in a 50-mile reach of the lower Missouri River downstream from the confluence of the Platte River estimated a population size much higher than those in the GPMU (Steffensen *et al*. 2012). In this reach, 492 individuals (38 were recaptures) were collected between 2008 and 2010 (Steffensen *et al*. 2012). Of those, 93 were wild PS, and 399 were hatchery-reared PS (Steffensen *et al*. 2012). Between 1990 and 2005, 117 unique wild PS were reported from the Missouri River below Gavins Point Dam to the confluence of the Mississippi River (formerly RPMA 4) (Service 2007). It is currently unclear whether or not natural recruitment occurs in this portion of the GPMU (Service 2007).

Interior Highlands Management Unit (IHMU): The IHMU includes the Missouri River from the confluence of the Grand River, Missouri, to the confluence of the Mississippi River, Missouri, and the Mississippi River from Keokuk, Iowa, to the confluence of the Ohio River, Illinois. It is unclear if there is any natural recruitment in the lower Missouri River, from Gavins Point Dam to the confluence of the Mississippi River (Steffensen *et al*. 2010; Service 2007). Between 1994 and 2008, nearly 80,000 hatchery-reared PS were released into the lower Missouri River, and as of 2008, only 1 percent had been recaptured (Steffensen *et al*. 2010). Wild PS are more frequently captured in the MMR, which extends from the confluence of the Missouri River to the confluence of the Ohio River, than in the GPMU and CLMU. In a collaborative sampling effort between 2002 and 2005, researchers from the Corps, Missouri Department of Conservation, and Southern Illinois University, captured 148 PS, with only 12 fish of hatchery origin (Service 2007). In the MMR, pallid to shovelnose sturgeon capture ratio range from 1:36 to 1:77 pallid:shovelnose (Killgore *et al*. 2007a). Age-0 PS have been collected in the MMR, although it is unknown where spawning occurs (Hrabik *et al*. 2007).

Coastal Plain Management Unit (CPMU*)*: The CPMU includes the LMR from the confluence of the Ohio River, Illinois, to the Gulf of Mexico, Louisiana (the action area of this consultation), and the Atchafalaya River distributary system, Louisiana. To date, >1,100 PS have been captured in the CPMU since listing (>500 PS from the LMR, and >600 from the Atchafalaya River) (Killgore *et al*. 2007a, SERVICE database 2013), exceeding capture numbers from all other management units, combined. Pallid to shovelnose ratios range between 1:6 to 1:30 in the LMR, depending upon river reach, and 1:6 in the Atchafalaya River (Killgore *et al*. 2007a; SERVICE 2007). Age-0 PS have been captured in both the LMR and the Atchafalaya, although it is unclear exactly where and when spawning occurs (ERDC, unpublished data; Hartfield *et al*. 2013). Age-0 and immature PS are difficult to distinguish from SS (Hartfield *et al*. 2013), however, capture data indicates annual recruitment of immature PS since 1991 (SERVICE database 2013).

Summary

The immediate risk of local extirpation in the Missouri River has been reduced by implementation of an artificial propagation program. New information on habitat extent and conditions, population size, potential recruitment in the Mississippi River, and new information on population size in the Atchafalaya River has improved understanding of the species in these areas. Numbers of wild pallid sturgeon are higher in the Mississippi and Atchafalaya Rivers than initially believed, and recruitment has been documented.

Fat Pocketbook Mussel

The FPM (*Potamilus capax*) is a freshwater pearly mussel native to portions of the Ohio and Mississippi River drainages (Watters *et al*. 2009). FPM belong to the family Unionidae, which is one of two families of pearly mussels that occur in North America (Watters *et al*. 2009). This species was originally described as *Unio capax* by Green (1832), but was later placed in the genus *Potamilus* Rafinesque (Watters *et al*. 2009). The shell is highly inflated and obovate (MMNS 2001; Watters *et al*. 2009). This species is relatively large, with adults sometimes

reaching over 5-inches in length (Service 1989).

The FPM was listed as endangered in 1976 (Service 1976). The decline of the FPM has been attributed to anthropogenic impacts, including water contamination and habitat modifications for river navigation and flood control (Service 1989). Because its shell is too thin for use, this species is of no commercial value (Harris & Gordon 1990).

Habitat

FPM occupy depositional areas of large, slow moving rivers, and museum records suggest that it requires flowing water and stable substrates (Service 1989; Watters *et al*. 2009). This species is typically found in sand and silt substrates, but has also been collected in mud, clay, and fine gravel substrates in depths ranging from a few inches to ten feet (Baker 1928; Parmalee 1967; Harris & Gordon 1987; Service 1989; Harris & Gordon 1990; Service 2012). The FPM is able to survive in deep depositional areas of silt, and it has been suggested that prior to anthropogenic habitat alteration, this species was probably common in oxbows and sloughs (Miller & Payne 2005). In the lower Mississippi River, FPM have been found in sand in secondary channels and in a mixture of sand, silt, and mud in side channels (Service 2012).

Movement

Freshwater mussels generally follow two movement patterns, vertical and horizontal, and movement is thought to be seasonal and/or related to reproduction or habitat suitability (Peck 2010). Relocation has been used to move FPM populations threatened by habitat modification (e.g., dredging, channel maintenance, road/bridge construction) to more suitable habitats (Peck 2010). After relocation, this species has a tendency to move less than do non-relocated individuals (Peck *et al*. 2007). FPM have an average range of 21.36 yds, but some individuals have been noted to move >165 yds (Peck *et al*. 2007). A 25 month study of the movement patterns of the FPM in Arkansas using telemetry demonstrated that the average home range of this species is 117.0 yds2, and most movements are downstream in unimpounded reaches (Peck 2010).

Feeding

Like other freshwater mussels, the FPM feeds by circulating water through its gills, removing particulate organic matter (Miller & Payne 2005; EPA 2007). It has been demonstrated that different bivalve species filter different sized particulate matter, although the specific diet of this species is unknown (Silverman *et al*. 1995).

Reproduction

Gravid FPM have been found between June and December and this species is likely bradytictic (Baker 1928; Oesch 1984; Service 1989; Roe *et al*. 1997; Watters *et al*. 2009). Fertilization occurs in spring after sperm are released upstream of female and are siphoned into the gills (Baldridge *et al*. 2007; Service 2012 (b)). The posterior portion of the outer gills is the marsupial region in this species (Watters *et al*. 2009). Glochidia are packaged in white, fragile

conglutinates (Utterback 1916). Glochidia are axe-head or hatchet-shaped with hooks along the lateral margin of the ventral flange and measure 0.105 x 0.185 mm (Utterback 1916; Oesch 1984). The only known host species for FPM is freshwater drum *Aplodinotus grunniens* Rafinesque, but the method of glochidial attachment remains unknown (Watters *et al*. 2009; Service 2012). It has been suggested that glochidial attachment may occur upon ingestion of the gravid adult by the molluscivorous host (Dillon 2000; Barnhart *et al*. 2009). FPM less than 5 years in age have been collected in the St. Francis, Arkansas, Ohio, and Lower Mississippi rivers, indicating successful reproduction and recruitment (W.T. Slack, pers. comm.; Service 2012).

Distribution and Abundance

Historically, the FPM occurred in the upper Mississippi and Ohio rivers and the major tributaries thereof, but this range has declined by >70 percent (Harris & Gordon 1987; NatureServe 2012). There are museum records of FPM from the upper Mississippi River from the confluence of the Minnesota and St. Croix rivers to the White River, but this species is thought to have been extirpated from many of those historical sites of occurrence (EPA 2007; NatureServe 2012; Service 2012). At the time of listing, the FPM was only known from one locality, the St. Francis Floodway, Arkansas; in 1989, an updated recovery plan was published with additional records from the St. Francis River and several small drainage ditches and tributaries (Service 1989). Since 1989, additional FPM populations have been found in the St. Francis River system, as well as in the LMR, White, Ohio, Wabash, lower Tennessee, and Cumberland rivers (Service 2012).

Summary:

The status of the fat pocketbook has improved significantly over the past two decades (Service 2012). The range of the species in the St. Francis and Lower Ohio River systems has expanded, a population has been discovered in a significant portion of the Lower Mississippi River, and there is evidence that most populations are recruiting and are naturally sustainable. Taxonomic uncertainty of the Ohio River population has been addressed through genetic and morphological studies completed in 2011.

ENVIRONMENTAL BASELINE

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, their habitats, and ecosystem within the action area. The purpose is to describe the current status of the species within the action area and those factors that have contributed to this state.

Status of the Species in the Action Area

Interior Least Tern

The historical distribution and abundance of ILT in the LMR is poorly documented. Hardy (1957) reported the few documented ILT historical records of occurrence and nesting on the LMR, but surmised that the birds nested at many localities along the river. Downing (1980) reported 300 birds in 11 colonies during an aerial survey of the Mississippi River, and noted the

greatest concentration of birds occurred between Osceola, Arkansas, and Cairo, Illinois. These primary historical sources of information were used to quantify a 1985 estimated population size of 350 to 400 adult ILT in the listing rule (50 FR 21789). The 1990 Recovery Plan utilized data from Sidle *et al*. (1985) and increased the minimum LMR population estimate to ~2,300 adults (Service 1990).

Nesting colonies in the LMR have been annually monitored since 1985. ILT are currently distributed along an 800 mile reach of the LMR between the confluence of the Ohio River and Baton Rouge, LA. The population level has ranged from 8,000 – 18,000 birds over the past 9 years, and the drainage basin recovery goal has been exceeded for more than 20 years (Figure 1). Some proportion of the increase in adult ILT numbers has been attributed to improved survey efforts and efficiency (Lott 2006); for example, changes in survey methods utilized in the LMR, and extending survey reaches correspond to some degree with higher ILT counts. However, the large numbers of ILT within the LMR un-impounded navigation system has also been attributed to higher elevation sand and gravel bars associated with the construction of channel training dikes (Lott 2012).

In the LMR, tern nest colonies are typically located on an unattached (surrounded by water) sand and/or gravel bar usually associated with a dike field and secondary channel. Those colonies that occur on sand or gravel bars connected with the bank are on very large, remote point bars, ½ to 1 mile in width, and often 2 to 4 miles in length (Jones 2012). The Corps analyses indicate that habitat quantity has remained relatively stable and underutilized by breeding/nesting ILT for the past two decades (Corps 1999, 2008) and habitat quantity and quality does not appear to be a limiting factor for the species in the LMR. Based upon improvements in range-wide status and successful protection and management of its habitats, the Service has recommended delisting the ILT due to recovery (Service 2013a).

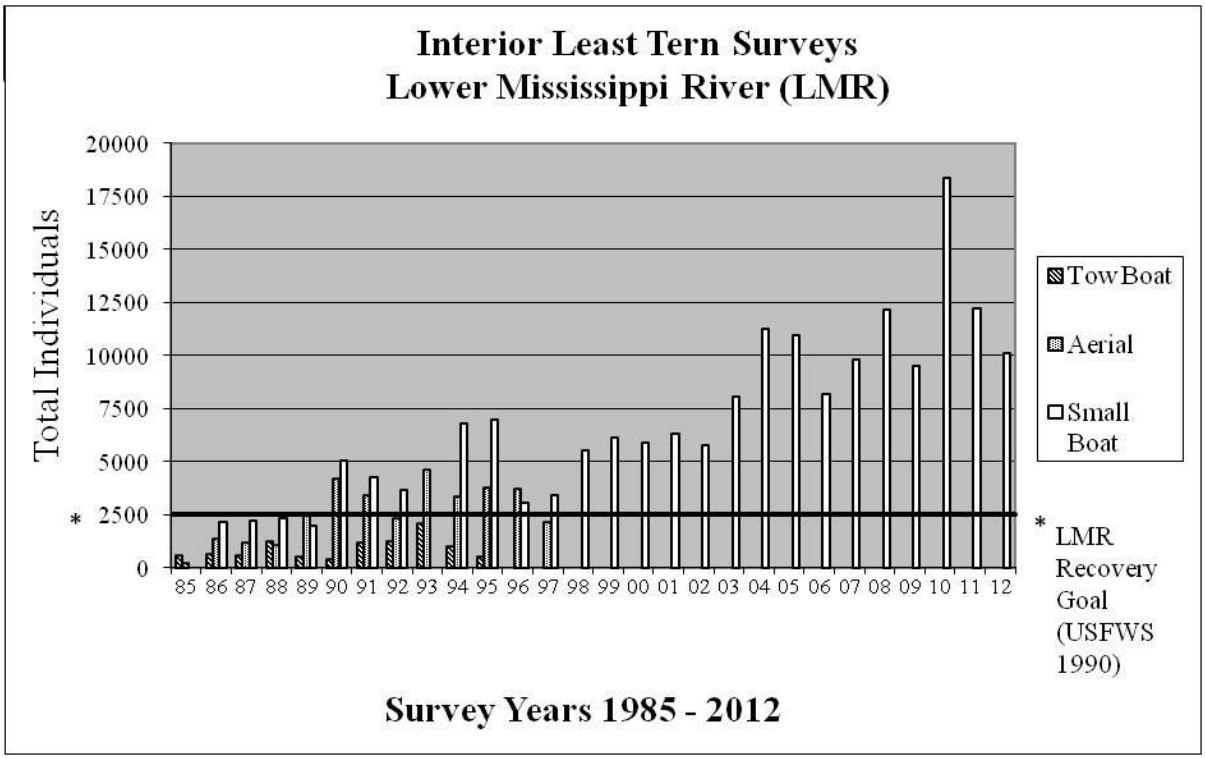

Figure 1: ILT Population Survey Results in the Lower Mississippi River, 1985-2012 (Mike Thron, Corps).

Pallid Sturgeon

The PS historical baseline in the LMR is undocumented. Prior to listing, collection records of PS in the LMR were extremely rare, and the Service was able to document only 35 observations of the species from the entire Mississippi River (Keenlyne 1989), 28 of these from the LMR and none from the Atchafalaya River. PS population size has not been quantitatively defined within the LMR, particularly considering the scope and scale of the available habitat to sampled areas.

In 2001, the Corps initiated efforts to develop sampling methods for PS in the LMR, as well as studies on abundance, distribution, demography, and habitat use (e.g., Killgore *et al*. 2007a,b; Hoover *et al*. 2007, etc.). These and other collections, as well as telemetry monitoring of sonic tagged individuals have shown that PS occur throughout most of the 950 mile reach of the LMR (Bettoli *et al*. 2008, Killgore *et al*. 2007a, Kroboth *et al*. 2013, Service database 2013), and the 200 mile reach of the Atchafalaya River (Constant *et al*. 1997, Dean *in litt*. 2005-2009, Herrala and Schramm 2011, Service database 2013) (Figure 2). Collections of PS in the LMR include almost 500 individuals collected between the mouth of the Ohio River and New Orleans, LA (Killgore *et al*. 2007a; Service database 2013), ranging in age from 0 – 21 years (50 to >1,000 mm fork length (FL)) (Killgore *et al*. 2007b, Service database 2013). No PS or shovelnose sturgeon have been collected below RM 95.5 (Killgore *et al*. 2007a) Over 600 PS ranging from 400 to >1000 mm FL have been collected from the Atchafalaya River distributary of the LMR (Service database 2013).

Although PS population size in the LMR has not been quantified, available data suggest a substantial population when compared to fishing effort and fish species composition. Killgore *et al*. (2007a) found that PS comprised 2.2 percent of fish captured on winter set trotlines, and ranked 5th in relative abundance out of 22 species collected. During two years of trotline sampling at Vicksburg and Tunica, Mississippi, PS comprised 2.4 and 2.5 percent, respectively, of fish collected at both locations, and ranked 4th in relative abundance out of 11 species collected (Aycock *et al*. 2012).

Rarity of recaptures of marked PS in the LMR also indicates the species is more common than previously believed. Killgore *et al*. (2007a) reported only five PS recaptures over seven years. In another study that conducted two years of monthly PS collection and telemetry efforts in a 30-mi reach of the Mississippi River, only a single PS recapture occurred out of >60 PS collected, tagged, and released, even though telemetry results indicated that many PS remained within the sample reach (Kroboth *et al*. 2013 2012).

There is also evidence that the LMR PS population can sustain removal of substantial numbers of individuals from the population. Bettoli *et al*. (2009) conservatively estimated that 2 percent of the commercially harvested sturgeons in the Tennessee reach of the LMR were PS (169 females over two seasons). Utilizing the same methodology and data as Bettoli *et al*. (2009), the proportion of all PS captures (N=18; 16 released) to sturgeon study harvest (N=114) during the 2006-2007 Tennessee sturgeon fishery was 16 percent; total 2006-2007 commercial sturgeon harvest (TH) = 4,052 sturgeon; therefore, a conservative estimate of 648 (TH x 0.16) PS were commercially collected (most were presumably released) from a 113 mi reach of the LMR in

Tennessee, over a 7 month season. Commercial harvest for sturgeon caviar occurred annually in the Tennessee and Missouri reaches of the LMR for more than two decades before shovelnose sturgeon were listed under the Act (Service 2010). The high numbers of PS captured in TN, including the persistence of the species following decades of harvest pressure on mature PS females, suggests PS is not uncommon in this reach.

Additional evidence of population size has recently been developed in association with persistent and periodic entrainment losses of LMR PS. During an emergency opening of the Bonnet Carre Spillway during 2008, the Corps and the Service estimated up to 92 PS were injured or killed due to entrainment (Service 2009). Other diversion structures that have been operating for one to five decades (Old River Control Complex, Davis Pond) are also known to entrain PS. The most downstream collection of pallid sturgeon has been at RM 95.5. Two juvenile shovelnose sturgeon were collected opposite the Caernarvon Diversion at RM 81, which is the most downstream collection of *Scaphirynchus*. These data indicate a low risk of entraining pallid sturgeon below New Orleans because of their rarity or absence in the lower 100 miles of the LMR. While decades of commercial harvest and entrainment constitute substantial periodic or continuous localized loss of individuals to the PS population within specific LMR stream reaches, scientific collection efforts indicate the species has persisted within the commercially harvested and diversion reaches of the LMR (e.g., Killgore *et al*. 2007 a,b; Kroboth *et al*. 2013 2012).

LMR PS population demographics have been poorly defined but recruitment has been documented by capture of multiple age classes (Killgore *et al*. 2007a) (Figure 3) and capture of larval PS at several locations between the confluence of the Ohio River and Vicksburg, Mississippi (Hrabik *et al*. 2007, Hartfield *et al*. 2013, Killgore *et al*. in prep.). Adult PS annual mortality is low (<12 percent) in the LMR, compared to the Middle Mississippi River (>35 percent) (Killgore *et al*. 2007b) where commercial fishing was recently banned (Service 2010).

Specific spawning and rearing habitats for PS are poorly known but surmised to include gravel bars (spawning), and secondary channels and flooded sand islands (larval and juvenile recruitment), all of which are common to abundant habitats on the LMR. Most sturgeon larval collections in the LMR have been associated with island tips and secondary channels (P. Hartfield, SERVICE, pers. obsv., 2007-2011; Jack Killgore, Corps, pers. comm. 2013). Telemetry studies in the LMR have shown use of multiple channel habitats by larger size classes of PS such as point bars, secondary channels, crossovers, island tips, and natural banks, and including river engineering structures such as wing dikes and revetted banks (Kroboth *et al*. 2013).

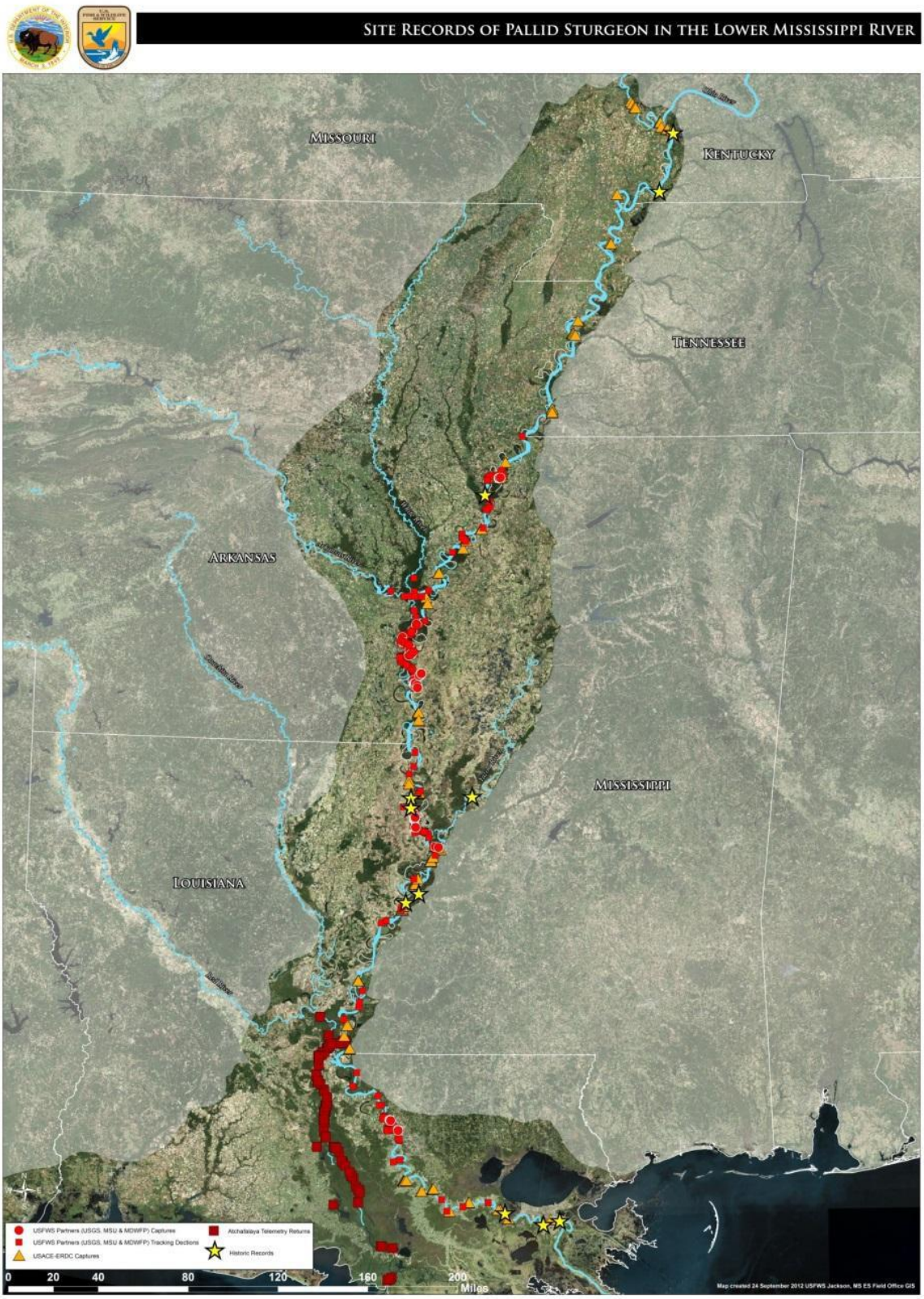

Figure 2: Capture and telemetry locations of PS in the LMR and Atchafalaya Rivers. Collection and telemetry records by ERDC, USGS, and Service. Map developed by Mississippi Field Office, U.S.

Fish and Wildlife Service.

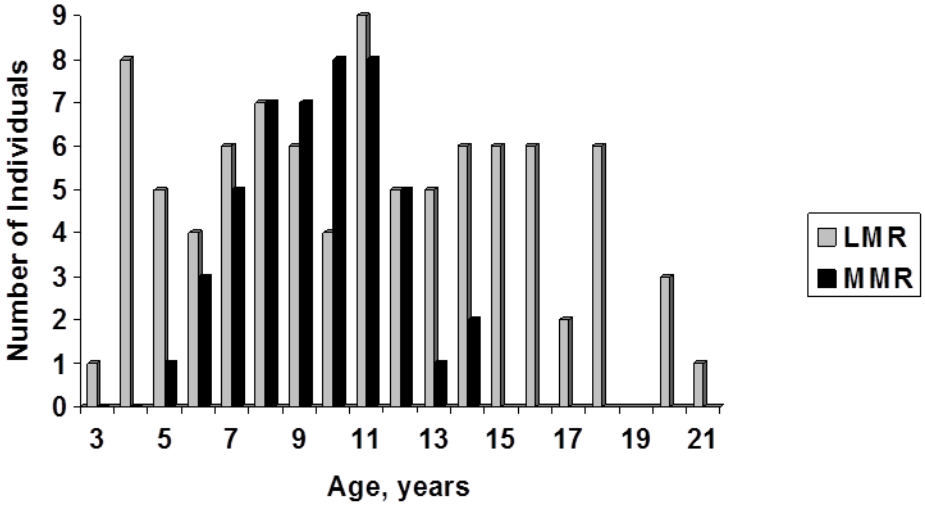

Figure 3. Age distribution of PS captured in the Lower (LMR) and Middle (MMR) Mississippi River (Killgore et al. 2007b).

Fat Pocketbook Mussel

There are no historical records of FPM from, or adjacent to, the LMR channel. Most recent LMR collection records of FPM are from secondary and side channels along the river (Service 2012). Live and fresh dead specimens have been collected from secondary channels between River Miles 410 – 800 that are stabilized by dike fields and maintain hydrologic connectivity with the main channel. A single young individual has been collected in a trawl sample below a chevron dike, Bolivar County, Mississippi (W.T. Slack, Corps-ERDC pers. comm.). Recent collections of FPM from the LMR indicate a widespread population, but more sampling is needed to assess abundance and trends.

Factors Affecting the Species in the Action Area

Several concerns have been identified for the priority species in the LMR (Service 2012). These include: habitat loss and modification for all three priority species, human disturbance to ILT nests and chicks, commercial harvest of PS, dredge entrainment of PS, sand and gravel mining entrainment and spawning habitat degradation, entrainment of PS through water control structures, effects of pollution and contaminants on all three species, and hybridization of PS with shovelnose sturgeon.

Habitat Loss and Modification

Information relative to ILT, PS, and FPM population sizes, distributions, and their status in the LMR has increased significantly in recent years, relative to knowledge of historical

pre-modification or pre-listing distribution and abundance of the species. While it is likely that habitat modification has the potential to seriously affect all three endangered species and is a factor in their current range-wide distributions and status, there is little evidence of direct negative impacts in the LMR.

Appropriate habitat for PS is generally characterized as large, deep, turbid, fast, and free-flowing rivers, with spawning migration and success linked to seasonal high flow events common to a natural hydrograph. These habitat characteristics are common in the LMR throughout nearly all of its length. As noted under **Status of the Species in the Action Area**, above, sturgeon spawning is believed associated with gravel bars, and larval collections are associated with islands and secondary channels. The LMR appears to contain the most extensive and possibly the best quality habitat within the species' range, including complex channel habitats, numerous secondary channels and islands, and large gravel bars apparently suitable for spawning, all of which are maintained by a natural hydrograph. While, the location and complexity of main and secondary channel habitats has been modified over time by river engineering under the CIP, any potential adverse effects on PS recruitment are un-documented and speculative. There are currently no data to indicate that habitat quantity or quality is a limiting factor to PS in the LMR.

Available data indicate that habitat loss and modification is not a factor affecting ILT in the LMR. This is reflected in the sustained growth of the LMR ILT population since the species was listed. Although terrestrialization of sandbars associated with dikes was identified as a potential threat to ILT (Smith and Stuckey 1988), available LMR nesting habitat for ILT continues to exceed use by the species (CORPS 2008).

There are no historical records of FPM from the LMR. The expansion of the FPM range into LMR appears to be related to more stable habitat conditions created within Corps dike fields associated with secondary channels (see **Status of the Species in the Action Area**, above).

Maintenance Dredging

Maintenance dredging of the navigation channel has been conducted for more than a century in the LMR and continues to be required in the LMR navigation channel, particularly within crossovers and harbors at low river stages. Construction of river engineering structures has dramatically reduced the amount of annual dredging requirements, particularly above Baton Rouge, Louisiana, the primary range of all three species in the LMR.

Dredging has been shown to take shovelnose sturgeon in the MMR, suggesting some level of take of PS may be occurring through dredge entrainment in the LMR. Dredging near nesting sandbars also has the potential to disrupt ILT nesting activities. Dredging windows are currently utilized by the Corps to minimize effects to endangered species in the LMR.

Although mussels can be subject to dredge entrainment, habitats where FPM have been

found in the LMR are not subject to dredging, therefore, dredge entrainment is not considered a factor affecting FPM in this system.

Water Diversion Entrainment

Entrainment of PS through water control and floodway structures (i.e., Bonnet Carre floodway, Davis Pond, and the Old River Control Complex (ORCC)) is known to occur in the LMR. Water control and floodway structures are separate issues from the CIP, and are not covered under this Biological Opinion. However, the CORPS has consulted with the SERVICE over the 2008 spillway operation of Bonnet Carre and the proposed construction of two new diversion structures, White Ditch and Covenant/Blind River. Biological Opinions have authorized take resulting from the emergency operation of Bonnet Carre, as well as possible future take of PS at the two planned structures (SERVICE 2009a, 2009b, 2010a). Emergency consultations for Morganza and New Madrid floodways that were operated during the 2011 flood were also completed. A consultation on the 2011 opening of the Bonnet Carre is ongoing pending results of Corps studies. Entrainment studies at LMR diversions, excluding ORCC but including Bonnet Carre and Davis Pond, have been completed by ERDC (report in preparation). The Corps is working to identify engineering designs to minimize entrainment losses through water control structures and conducts rescue and recovery efforts to minimize PS population impacts due to floodway operations.

Entrainment is not an issue with ILT or FPM in the LMR.

Sand and Gravel Mining

Regulatory branches of the Corps' Districts issue permits for sand and gravel mining dredging in the LMR. Regulatory issues are not directly related to the CIP and are not addressed under this Biological Opinion. The Service has expressed concerns that permitted commercial mining dredges in the Mississippi River have the potential to adversely affect the three endangered species in the LMR. The Corps addressed these concerns by establishing permit conditions protective of habitats utilized by the species, and restricting mining during times when the species are most vulnerable. The Corps conducted studies on sturgeon susceptibility to sand and gravel dredging, and has mapped important gravel areas in the LMR. The Corps has also committed to monitoring locations of sand and gravel mining, as well as the quantity and size of materials removed from the river (Service *in litt*.).

Commercial Harvest of Pallid Sturgeon

Commercial harvest of sturgeon for caviar and smoked flesh has occurred to various degrees in the LMR since the 1800s. Harvest for shovelnose sturgeon has been closed for at least three decades in the Arkansas, Mississippi, and Louisiana reaches of the LMR south of the Tennessee state line; however, harvest of shovelnose sturgeon for caviar had increased in the LMR reaches of Tennessee, Kentucky, Missouri, and Illinois. Based on data that indicated significant numbers of mature female PS were being taken during

commercial harvest of shovelnose sturgeon in the Tennessee reach of the LMR (Bettoli *et al*. 2010), and high mortality of pallids in reaches where commercial harvesting was still legal (Killgore *et al*. 2007b), Service listed the shovelnose sturgeon within the sympatric range of PS as threatened due to similarity of appearance (Service 2010). This action, coupled with previous State regulations, has effectively eliminated commercial harvest of sturgeon in the LMR.

Pollution and Contaminants

Pesticides and heavy metals could potentially affect all three priority species to varying degrees. Sampling for contaminants in ILT has been concentrated in the Missouri River drainage, where sub-lethal amounts of arsenic, mercury, chlorinated hydrocarbon, selenium, and PCBs have been documented in the species (Fannin and Esmoil 1993, Ruelle 1993, Allen et al. 1998), however, no incidences of death or decreased fitness of ILT due to contaminants have been reported to date. Shovelnose sturgeon in the Mississippi and Missouri Rivers have been found with high levels of DDT and chlordane, and hermaphroditic individuals have been observed (Ruelle & Keenlyne 1993), suggesting that contaminants may impact PS to some degree. There is no information on effects of contaminants to FPM, however, some contaminants are known to have detrimental effects to different life stages of freshwater mussels (e.g., Cope *et al*. 2008).

Water quality has improved in the LMR since implementation of the CWA, and recent water quality data generally meets EPA guidelines. Analysis of main channel LMR water and sediment has found that suspected contaminants (e.g., PCB's chloradane, dieldrin and DDE) occur below detection levels (Goolsby and Pereira 1995). Concentrations of toxic heavy metals dissolved in LMR water are below USEPA guidelines for drinking water and water that supports aquatic life; however, heavy metals associated with suspended sediments may exceed the pollution guidelines at some locations (Rostad *et al*. 1995).

Pollution and contaminants are not directly related to the CIP, although under some conditions contaminants may be re-suspended by dredging activities in contaminated sediments. However, the LMR is a dynamic channel constantly moving and mixing large quantities of sediment through the system, and the concentrations of contaminants have apparently been homogenized due to repeated deposition and re-suspension (Rostad *et al*. 1995). Crossovers are particularly dynamic, thus the need for regular dredging under the CIP, and there is no data that sediments within frequently dredged LMR crossovers contain contaminant levels above those considered safe by EPA.

Hydrokinetics

Applications have been made to utilize the LMR for power generation using hydrokinetic technology. Effects of hydrokinetic turbines on PS are currently undefined; there is potential of injury or mortality from turbine blade strikes, as well as potential behavioral effects due to electromagnetic fields and noise. ILT and FPM are unlikely to be directly affected by hydrokinetic turbines; however, infrastructure siting has the potential to affect

these species or their habitats. Hydrokinetic turbines are not part of CIP, and their potential effects are the responsibility of the applicant. Most pending FERC hydrokinetic permit applications in the LMR were recently surrendered due to economic uncertainty (D. Lissner, Free-Flow Power Company, *in litt*. 2013).

Hybridization of Pallid and Shovelnose Sturgeon

Hybridization with shovelnose sturgeon has been identified as a threat to PS in the LMR. This hybridization was initially believed to be caused by a loss of species isolating mechanisms due to river engineering and modifications to essential habitat features. However, neither the mechanisms nor the essential habitat features have been identified (Hartfield and Kuhajda 2009). There is morphological evidence that some proportion of individuals identified as "hybrids" are morphological variants of both species, and have been misidentified due to allometric growth of PS (e.g., Murphy *et al*. 2007, Hartfield *et al*. 2013). There is also evidence that morphological and genetic variation interpreted as hybridization existed in LMR sturgeon populations prior to, and therefore may be unrelated to, modification of the LMR (Hartfield and Kuhajda 2009, Schrey *et al*. 2011, Hartfield *et al*. 2013). Genetic and morphological studies are in progress to improve and standardize identification of river sturgeon in the LMR, and determine the significance and possible trends of hybridization as a factor to PS in the LMR (Service *in litt*. 2011).

Authorized Take

Biological Opinions which allow the take of listed species also represent a factor that should be considered when examining factors that could have an influence on a listed population. No Biological Opinions have been issued for ILT on the LMR. A single consultation has been conducted for FPM, which authorized the lethal take of 20 individuals during repair of dikes where the species was known to occur. Most consultations conducted for PS have concerned research and recovery efforts, however, three consultations have authorized lethal take for flow diversions, and one is currently in progress. Table 2, below, presents all take of ILT, PS, and FPM authorized by Biological Opinions completed for the Lower Mississippi River.

TABLE 2: OPINIONS	ISSUE	AUTHORIZED TAKE	TAKE REPORTED	Critical Habitat
INTERIOR LEAST TERN				
0		0	0	NA
PALLID STURGEON				
2003	Biological Opinion on Natchitoches National Fish Hatchery's Collection of Endangered Pallid Sturgeon from Louisiana Waters for Propagation and Research	90 adults/season for 5 season (harassment) 8 adults/season for 5 seasons (death) potential	23 harassment (2003)	NA
2004	Modification to **revise** 2003 IT estimates for BO (4-7-3-702) on Natchitoches National Fish Hatchery's Activities	120 adults/season for 5 season (harassment) 14 adults/season for 5 seasons (death) potential	329 (Atchafalaya) harassment (through 2010) 7 dead (2004)	NA
2004	Programmatic Biological Opinion Addressing Effects of the Southeast Region's Section 10(a)(1)(A) Permitting on the Pallid Sturgeon (5-years)	28 adults in captive propagation/year (death) 2,500 to 15,000 captive year-class 90 days old or older (one-time loss-death)[2] 200 larval/juvenile/year sampling (death) 3, 5-inch or greater fish/year netting (death or injury) 3 fish/year external tagging (death or injury) 1 fish/year transport (death) 5 fish/year radio-tracking (death or injury)	461 (LMR) harassment (through 2012) 1 dead (2006) 2 dead (2007) 1 dead (2009)	NA
2005	Modification of Programmatic BO-adding new forms of take to the 2004 revised IT for the 2003 Biological Opinion on Natchitoches National Fish Hatchery's Activities	14 wild pallid sturgeon/season (death) potential 15,000 hatchery-reared pallid sturgeon/season (death)[2] potential	NA	NA
2009	Biological Opinion on 2008 Emergency opening of Bonnet Carre Spillway, CORPS	14 adults (harassment) 92 adults (death)	14 adult harassment Unknown deaths	NA
2010	Biological Opinion on Medium White Ditch Diversion	23 adults/year (death) potential	0	NA
2010	Biological Opinion on Small diversion at Convent/ Blind River	7 adults/year (death) potential	0	NA
2010	Taxonomic ID study	100 adults (death)	76	NA
2013	Mod-Programmatic BO	21 adults/year (death) potential	0	
PALLID STURGEON TOTAL		120 adults/yr (harassment) 192 adults (death) 14-28/year (potential death) 200 larval fish/year (potential death) 2,500-15,000 year-class 90 days old or older (one-time loss-death)[2]	827 adult harassment 87 adult known dead Unknown <200/year larvae collected	NA
FAT POCKETBOOK MUSSEL				
2004	Biological Opinion on maintenance of two existing dikes at Ben Lomand Dike Field	20 (death) potential	Unknown	NA

[1] Biological opinions within the action area; [2] Hatchery propagation was terminated in Region 4 in 2005.

EFFECTS OF THE ACTION

Bendway cutoffs constructed between 1929 and 1960 under the MR&T Program shortened the river by >150 mi (Winkley 1977). Since 1960, channel engineering conducted under the CIP has resulted in a loss of secondary channels and associated habitats (Baker *et. al* 1988, Williams and Clouse 2003, Guntren *et al*. 2013, Killgore *et al*. 2012). Therefore, the primary environmental effects of the MR&T Program and CIP have been the physical loss of LMR channel habitat quantity, a growing disconnect with the relict floodplain during low to moderate river stages, and a general loss of riverine habitat complexity (i.e., diversity). ILT, PS, and FPM abundance and distribution in the LMR are all strongly tied to secondary channel condition and distribution (see **Status of the Species in the Action Area**, above). The responses of ILT, PS, and FPM to the effects of the CIP are evaluated below.

Effects to the Species in the Action Area

Interior Least Tern

There are currently no data that indicate habitat modification due to the CIP has adversely affected the status of ILT in the LMR. In fact, the data suggests that overall the ILT response to the conditions resulting from the CIP has been positive since the species was protected under the Act. ILT population size in the LMR has increased from a historical (1985) listing baseline of fewer than 500 birds, to a current baseline of ~10,000 or more breeding birds per season. Direct causes of the population increase are not fully understood; however, they may be related at least in part to: 1) More inclusive survey efforts and methods; 2) Earlier and extended breeding potential due to more efficient movement of flood flows through the system (including effects of tributary impoundment and engineering) (e.g., Schramm 2004); 3) Higher sandbars associated with dike fields (e.g., Lott 2006); 4) Dike notching and avoidance work windows implemented by the Corps; and/or, 5) Immigration of coastal least terns due to better nesting and forage conditions along the LMR (e.g., Lott 2006).

Construction activities near nesting sandbars can disrupt ILT nesting activities. The Corps maps ILT nesting sites and maintains 1,500 ft buffers between CIP construction and dredging activities and nesting sandbars during the nesting season. This distance exceeds most recommendations for buffers between waterbirds and human activities (Valente & Fischer 2011).

Terrestrialization of islands and sandbars associated with dike fields has been identified as a negative factor affecting ILT. However, actions such as dike notch construction under the CIP, are being utilized where feasible and practical to sever land-based routes used by ATV recreationists and terrestrial predators to access ILT nesting colonies.

While habitat quantity and condition is not currently known to be negatively limiting ILT in the LMR, Corps-MVD and Districts have been actively working with partners to restore degraded secondary channels and their associated islands and bars. These activities are protecting, and enhancing ILT habitat quantity and quality throughout the LMR.

Pallid Sturgeon

There are currently no data that directly indicate habitat modification due to the CIP has adversely affected the status of PS in the LMR. As noted under **Status of the Species in the Action Area**, above, the historical population baseline of PS in the LMR is unknown; however, PS records continue to increase proportionately with collecting efforts, they have been collected in all reaches of the LMR sampled (Killgore *et al*. 2007), and sonic detections of tagged PS show extensive use of multiple habitats (Kroboth *et al*. 2013). While we cannot directly determine PS response to habitat changes induced by the CIP, current information indicates that the PS is widely distributed throughout the LMR, habitat is abundant and of high quality, the species is reproducing and recruiting, and CIP actions have been designed to minimize adverse effects to the species and habitats known or suspected to be important to reproduction and recruitment (see **Status of the Species in the Action Area**, above).

Fat Pocketbook Mussel

There are currently no data that indicate habitat modification due to the CIP has adversely affected the status of FPM in the LMR. The FPM was not historically known to survive in the active channel of the LMR. Recent collections of live individuals and fresh dead shells are primarily associated with secondary channels stabilized by notched dike fields, and it is likely that the dike fields created conditions appropriate to the survival of FPM. Therefore, it appears that FPM has responded positively to the effects of the CIP.

Minimization and Mitigation Components of the CIP

Corps MVD and Districts have developed and incorporated minimization and mitigation strategies and actions (BMPs) for endangered species into the CIP (see **Conservation Measures**, above). Potential effects of annual CIP channel construction and maintenance activities to PS, ILT, and FPM habitats, along with potential avoidance and minimization actions, are discussed and considered during annual Partnership meetings hosted by Corps Districts. BMPs developed under the CIP are currently focused on maintaining and enhancing overall channel habitat complexity through dike design and notching, restoration of secondary channels, and use of value engineering techniques such as hard points and chevrons that provide river training and habitat benefits simultaneously. The endangered species and their LMR habitats are being quantified and monitored by the Corps and other participating agencies. These data are used to determine the extent and significance of habitat modification to the species, quantify habitat benefits of creative engineering, project future habitat trends, identify habitat improvement opportunities, modify channel management actions as appropriate, and monitor long-term habitat and endangered species population trends and responses.

Direct Effects

The primary engineering actions affecting flow and habitat dynamics in the LMR channel occurred more than 50 years ago (e.g., bendway cutoffs, 1932 – 1960; pre-1960 construction of large impoundments in the Missouri, Ohio, and Upper Mississippi rivers). Activities now

conducted under the CIP (i.e., construction and maintenance of channel engineering structures, dredging) have also been on-going for the past 60-70 years. Even though the LMR baselines of the ILT, PS, and FPM have expanded under these conditions over the past two decades, CIP activities may have direct adverse effects to individuals of all three species. These are addressed below.

Maintenance of the 9-Foot Channel

Maintenance of the 9-Foot navigation channel consists of channel maintenance dredging and disposal, maintenance of existing channel training structures and construction of new channel training structures. These activities have the potential to locally disrupt the reproductive cycles and behavior of ILT and PS, and to cause injury or death to individuals of all three species; however, CIP activities may also be used to directly benefit the species.

Dredging/Disposal

Periodic dredging is necessary to maintain navigation depths during low flow seasons or events, primarily in channel crossings (crossovers). There is some potential of local disturbance of nesting ILT, as well as some unknown potential for entrainment of PS during such events. There are also concerns that dredging LMR sediments may re-suspend contaminants associated with sediments.

The amount of material dredged in the LMR has been significantly reduced over the past few decades due to construction of dikes and revetments (Corps 2013a). The Corps has implemented seasonal dredging restrictions and windows to avoid impacts to ILT and PS (FPM is not likely to occur within the active navigation channel). Occasionally, Corps requests local waiver of these restrictions during infrequent early and mid-summer low flow events in order to maintain navigation. In general, distance buffers can usually be maintained from ILT colonies. Data indicates that crossovers are too dynamic for PS larvae and juveniles, as these life stages avoid high velocities and shifting substrates typical of crossovers and would not likely reside at these locations for long periods.

There is some potential of entrainment of PS by navigation dredging. While a few sonic tagged (adult) PS have been detected in crossovers during high river stages, they prefer greater depths than those requiring dredging (Kroboth *et al*. 2013), and they have not been detected in crossovers at low river stages when dredging is occurring (USGS tracking data, *in litt*., 2007-2013).

Efforts to quantify take of PS incidental to dredge operations in the Middle Mississippi River (MMR) (Service 2005) have utilized estimates of shovelnose sturgeon density at a dredge site, relative to PS: shovelnose ratios, to estimate numbers of PS subject to entrainment in the action area. This approach is not reasonable in the LMR for several reasons: 1) the action area includes ~200 sites over almost 700 miles of large river channel; 2) sturgeon capture data is localized within the action area; 3) capture localities rarely include areas subject to dredging; and, 4)

this limited data indicates that sturgeon densities, as well as PS: shovelnose ratios, vary considerably by locality and river reach (e.g., Killgore *et al*. 2007). Additionally, other data suggests that the potential of dredge entrainment in the LMR is not comparable to the potential in the MMR: 1) PS captures and telemetry detections in the LMR indicate the species prefers depths >21 ft (7 m) (e.g., Kroboth *et al*. 2013), well below the authorized 9 ft (3 m) navigation channel depth; 2) the depth and width of the LMR, and therefore habitat options, are considerably greater than the MMR; 3) telemetry monitoring of more than 200 sonic tagged LMR sturgeon have resulted in no detections in shallow crossovers or active dredge reaches during low flow events (USGS tracking data, *in litt*., 2007-2013,); and, 4) the potential of PS take by dredge entrainment is also likely to be minimized or offset by CIP dredge BMPs (i.e., inchannel disposal).

There have been concerns that some contaminants may be re-suspended by dredging activities in in the Mississippi River (SERVICE 2000). However, the LMR is a dynamic channel constantly moving and mixing large quantities of sediment through the system, and concentrations of historical contaminants have apparently been homogenized due to repeated deposition and re-suspension of contaminated silts (Rostad *et al*. 1995). Crossovers are particularly dynamic, thus the need for regular dredging, and there is no data that sediments within frequently dredged LMR crossovers contain contaminant levels above those considered safe by EPA.

In a recent Louisiana Department of Environmental Quality tissue analyses, fish from the Mississippi River were analyzed for over 100 toxic chemicals, most which (95 percent) were undetected (Caffey *et al*. 2002). Samples with detectable toxins were at relatively low concentrations, falling below the U.S. Food and Drug Administrations (FDA) standard for edible fish.

Beneficial uses of dredge material include disposal within open channel dike fields to create or enhance ILT nesting sites (Corps 2013a).

Channel Training Structures

Dikes

Sandbars associated with dikes have higher elevations than naturally formed bars, providing ILT with earlier and extended nesting opportunities. PS are also strongly associated with dikes (Kroboth *et al*. 2013), apparently due to presence of current velocity shelters and foraging opportunities. However, new dike construction may have detrimental effects on ILT by precipitating erosion of nesting islands, or connection of nesting islands with the main bank, and on PS by closure of secondary channels. In the past, dikes were purposefully used to block and close secondary channels in the LMR. Construction of closing structures is now avoided, and Corps (2013) is opportunistically utilizing CIP dike maintenance and collaborative efforts with the LMRCC to restore flows in secondary channels through retrofitting closing dikes with notches (Corps 2013a). Corps also considers the potential effects of dike

construction and maintenance relative to endangered species and their habitats, and may modify design and/or location in order to reduce detrimental effects, or to provide beneficial effects (Corps 2013a).

FPM are strongly associated with secondary channel dike fields in the LMR, and live individuals are occasionally observed above and near notched dikes (P. Hartfield, pers. obsv. 2003-2007). Dike maintenance within secondary channels is infrequent, and while placement of new stone during secondary channel dike maintenance has the potential to kill or injure FPM adjacent to dikes, only a single live individual has been collected near the base of a dike.

Bendway Weirs

Bendway weirs have been considered to adversely affect ILT through: 1) local reductions in the area of bare sandbar nesting habitat; 2) local reduction in foraging habitat availability; and 3) local reduction in the abundance of forage fish (Service 2000). However, in the LMR, sandbar nesting habitat quantity is not a limiting factor (Corps 2013a), the effects of bendway weir construction are localized, and the bed material forming the bars is generally redistributed down-river with little loss of overall habitat quantity. Additionally, bendway weirs may also reduce channel degradation and maintain flows in nearby side channels, important nursery areas for ILT forage species, mitigating any local effects (Service 2000).

Bendway weirs may have local benefits to PS by providing current velocity shelters behind each weir, as well as by increased fish forage potential associated with their construction. FPM do not inhabit the areas where bendway weirs are constructed, but may benefit from their potential to reduce channel degradation and maintain flows in nearby side channels (SERVICE 2000).

Chevron Dikes

Chevron dikes create habitat heterogeneity which increases invertebrate and forage fish abundance and diversity, providing benefits for ILT and PS. Effects to FPM are currently poorly known, however, a juvenile FPM has been recently collected behind a chevron dike (T. Slack, CORPS, pers. comm.). CORPS considers utilization of chevron dikes in lieu of traditional dikes, wherever practical.

Revetments

Bankline revetments prohibit bank erosion and lateral channel migration. Off-Bankline revetments are an environmental enhancement alternative, providing slack water habitat compared to traditional On-Bankline revetments. Notches are typically left in the Off-Bankline revetment to allow fish to access the slack water areas.

When completed, revetments will cover approximately 50 percent of the banks of the Lower Mississippi River (Baker *et al*. 1988). Revetment construction, as well as

periodic maintenance, requires bank grading and clearing of top of bank vegetation. Revetment construction may result in some changes in composition and abundance of forage species for both ILT and PS (Baker *et al*. 1988, Pennington *et al*. 1985). However, these are generally temporary (Pennington *et al*. 1985), or are offset by BMPs currently in use (Baker *et al*. 1988, Corps 2013a). For example, longitudinal grooves constructed into revetment blocks provide surface area and increase abundance of attached aquatic invertebrates, while habitat continues to be available for burrowing species between and beneath the revetment mats (Baker *et al*. 1988). Spaces between blocks and folds of the mat also provide velocity shelters for forage fish species. Corps also strategically places woody debris removed from the bank during revetment construction and maintenance activities back into the channel, providing habitat for attached macroinvertebrates, as well as shelter for forage fish (CORPS 2013a).

Revetments are constructed on the actively eroding banks of the river, remote from sand deposition areas where ILT nest; the location, as well as construction timing windows and buffers implemented by Corps, generally prevents any impact to nesting ILT (Corps 2013a). Sonic tagged PS have been documented on revetted banks, particularly during lower river stages (Kroboth *et al*. 2013), apparently utilizing the velocity shelters and forage opportunities provided. FPM are not known to occur on naturally eroding or revetted LMR banks.

Hybridization

It has been surmised that channel training structures have contributed to PS hybridization with shovelnose sturgeon by altering/eliminating spawning habitat and potentially limiting the movement of sturgeon species to spawning habitats (Service 2000). However, habitat quantity and sturgeon movement are not limited by channel training structures in the LMR. There is morphological evidence that some proportion of individuals identified as “hybrids” are morphological variants of both species that have been misidentified due to allometric growth of PS (e.g., Murphy *et al*. 2007, Hartfield *et al*. 2013). There is also evidence that morphological and genetic variation interpreted as hybridization existed in LMR sturgeon populations prior to, and therefore may be unrelated to, modification of the LMR (Hartfield and Kuhajda 2009, Schrey *et al*. 2011, Hartfield *et al*. 2013).

Indirect Effects

Commercial Navigation Traffic

There is currently no data that commercial navigation traffic in the LMR is a limiting factor to ILT nesting or foraging, or has any effect on known populations of FPM, which are remote from the navigation channel. Commercial navigation is believed to occasionally entrain PS in the Upper Mississippi River (UMR) and MMR (Service 2005), resulting in potential injury or mortality of sturgeon larvae and adults. This is based upon known instances and estimates of propeller entrainment of shovelnose sturgeon in that portion of the range (Killgore *et al*. 2001, Killgore *et al*. 2011, Miranda and Killgore 2013). Nothing is known of rates or effects

of navigation traffic entrainment of PS or shovelnose sturgeon in the LMR, and evidence from the UMR and MMR is not directly transferable, since the LMR is significantly wider and deeper. For example, with the exception of crossovers, navigation channel depths equal or exceed 30 ft (10 m) in the LMR, even during the lowest flows. Additionally, PS captures and telemetry relocations indicate that the species prefers depths >21 ft (7m), with most occurring at depths greater than 30 ft (10 m) (Kroboth *et al*. 2013). Since PS are epibenthic in nature, they are believed to be less susceptible to propeller entrainment in the wider and deeper channel of the LMR.

Fleeting

Fleeting areas are generally remote from ILT and FPM habitats. Fleeting does not appear to disrupt habitat use by PS, as sonic tagged fish have been documented under fleeting barges at multiple sites in the LMR (J.T. Young, Mississippi State University, *in litt*. 2013). Fleeting also uses smaller boats with smaller propellers operating at lower RPM's, which reduces the potential of propeller strikes (J. Killgore, Corps-ERDC, pers. comm. 2013).

Port Facilities

Existing port facilities on the LMR are usually generally off-channel above Baton Rouge, Louisiana. PS is a channel-dwelling species, and avoids ports since most are located off-channel in slackwater. Facilities constructed within the channel are associated with banks where channel depth is maintained by the river currents, and which are remote from ILT and FPM habitats.

Exotic Species

Silver carp are now found throughout the LMR, and are abundant. Juvenile silver carp have become a regular prey item for ILT, and may be displacing shad as the major forage species for ILT (Jones 2012). Effects of the increasing abundance of silver carp to PS or FPM are unknown.

Spills

Spills of small quantities of oil and/or diesel are regularly reported in the LMR, and barges occasionally sink. Any direct or chronic effects of spills on ILT, PS, and FPM are largely undocumented and unknown.

Recreation

PS are occasionally caught by recreational anglers in the LMR (Service, *in litt*.), and State and Federal regulations require their immediate release. ILT nesting areas may be disturbed by off road vehicle (ORV) use when low flows allow access to some nesting areas. There is no record of recreational impacts to FPM on the LMR. Recreation activity in the LMR is not affected by the CIP, however, Corps BMPs of dike notching and restoring flows to secondary channels is reducing ORV access to some ILT nesting sandbars during low river stages.

Interrelated and Interdependent Effects

USCG Buoy Tending

USCG buoy tending activities are not known to affect ILT, PS, or FPM.

Water and Sediment Diversion Structures

As noted previously, water and sediment diversion structures are known to entrain PS, whether passively, or actively. The construction and operation of diversion structures are a separate Federal action, and are not considered under this consultation.

Water and sediment diversion structures are not known to affect ILT or FPM.

Cumulative Effects

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation under section 7 of the Act.

The Service is unaware of any future State, tribal, local or private actions within the LMR channel that are reasonably certain to occur in the action area that may affect ILT, PS, or FPM.

Summary of Effects

CIP activities to maintain flood control and navigation efficiency and safety in the LMR may result in occasional temporary habitat displacement, as well as harassment or harm to individual ILT, PS, or FPM. The Corps Conservation Plan/BA incorporates engineering designs, construction strategies, applied research, and management actions into the CIP (identified under **Habitat Conservation Measures**, above) to minimize the potential of adverse effects to individual ILT, PS, or FPM from CIP activities, and to promote conservation of the species and their habitats in the LMR. The administrative record upon which the CIP Conservation Program is based includes >50 years of habitat data, 28 years of monitoring data for ILT, 13 years for PS, and 10 years for FPM. The species monitoring data demonstrate significant overall improvement in range, abundance, and status of ILT, PS, and FPM in the LMR following decades of exposure to CIP activities, even prior to incorporation of program BMPs (see, **Status of the Species in the Action Area**, above), suggesting any negative impacts to individuals by CIP activities have been offset by gains in their LMR populations.

ILT, PS, and FPM ecology, abundance, and distribution in the LMR are all strongly tied to secondary channel condition and distribution. For example, ILT nesting islands are associated with seasonal or permanent islands maintained by secondary channels; islands and associated

secondary channels are the primary habitats where developing larval sturgeon are commonly collected following the PS spawning season; and all live collections of FPM and most fresh dead shell collections are associated with secondary channels.

Historically, the Mississippi River meandered across the alluvial floodplain forming cut-offs and secondary channels. Prior to river regulation, secondary channels were gained and lost as the river formed new courses to the Gulf of Mexico, however, levees and CIP construction of revetment and dikes stabilized the river and floodplain, reducing or even eliminating formation of new secondary channels (Williams and Clouse 2003, Killgore *et al*. 2012, Guntren *et al*. 2013). While habitat data clearly show that CIP actions have affected the entire length of the LMR through the loss of channel habitat complexity (manifested by secondary channel condition, abundance, and channel depth diversity) (Williams and Clouse 2003, Guntren *et al*. 2013), numerous functioning secondary channels continue to persist throughout the LMR (93 secondary channels were documented by Williams and Clouse 2003; ~102 by Guntren *et al*. 2013). This habitat data, considered in context with the ILT and PS population data, indicates that habitat quantity or quality has not yet become a limiting factor for ILT or PS in the LMR. Considering changes within secondary channels in context with FPM historical and current data, indicates that the CIP may have created conditions suitable for FPM to expand into LMR secondary channel habitats.

Through measures defined in the Corps Conservation Plan/BA, a primary objective of the CIP is to avoid secondary channel loss as well as to mitigate losses through the restoration of secondary channel function (see *Environmental Features* under **River Engineering Structures**, and **Habitat Conservation Measures**, above). These have proven effective, and over the past decade, 13 secondary channel restoration projects have been completed, restoring or enhancing flows in >50 miles of secondary channels (LMRCC in litt. 2013). The Corps has also established an Index of Habitat Quality to rank secondary channel restoration efforts relative to conservation benefits and cost (Killgore et al. 2012).

Interior Least Tern

Nesting ILT may occasionally be disturbed by CIP construction or maintenance activities within, or adjacent to active nesting colonies, resulting in stress to ILT adults and chicks (see **Direct Effects**, above). CIP activities are designed and conducted to avoid or reduce any adverse modification of ILT nesting habitats, whether or not the birds are present, as well as to avoid construction and maintenance activities near colonies during nesting season (seasonal restrictions). If construction or maintenance activities during the restricted season are essential to maintain flood control and/or safe navigation, distance buffers are utilized to avoid disturbance to nesting ILT (see construction and maintenance BMPs under **Habitat Conservation Measures**, above). Due to river stages or other factors beyond the Corps' control, CIP activities may occasionally be conducted during restricted seasons or within avoidance buffers (i.e., deviations from construction and maintenance BMPs). The CIP mitigates for occasional site BMP deviations through habitat protection and restoration BMPs (see **Habitat Conservation Measures**, above).

Local or long-term effects of the CIP to individual ILT or colonies on the LMR are extremely

difficult to document or quantify. This is due to the delayed nature of potential effects to the birds, the ecology of the birds (i.e., 2-3 years delay between hatching to maturity; immigration, emigration; winter range factors, etc.), the ephemeral suitability of nesting bars controlled by climate and hydrology, and "masking" of long-term demographic effects by the rising baseline of the ILT in the LMR. The increase in range and abundance of LMR ILT over the past several decades, however, indicates that neither the CIP nor occasional deviations from construction and maintenance BMPs have resulted in significant net negative impacts to this sub-population or its habitats. Additionally, as noted above, Corps actions have been, and are being conducted under the CIP to mitigate for potential past and future project effects to ILT by protecting and restoring nesting islands and secondary channel habitat integrity (habitat protection and restoration BMPs). Based in large part on ILT increases in the LMR, and development and implementation of the CIP Conservation Plan, the Service has recommended delisting the species due to recovery (Service 2013a).

Pallid Sturgeon

There is some potential of disturbance to spawning PS and harm to larval sturgeon during dike construction or maintenance activities, as well as some potential of PS larvae, juvenile, and/or adult entrainment during dredging activities within the active channel (see Direct Effects, above). CIP activities are designed and conducted to avoid or minimize any potential of disturbance, or harm to PS life stages through incorporating seasonal work restrictions, and to avoid modification of important habitats (see construction and maintenance BMPs under **Habitat Conservation Measures,** above). Due to river stages or other factors beyond the Corps' control, CIP activities may occasionally be conducted during restricted seasons (i.e., deviations from construction and maintenance BMPs). There is some potential of PS larval, subadult, and adult entrainment, and injury or death during main channel dredging operations, even with implementation of BMPs; however, there is no data documenting PS dredge entrainment in the LMR, and the habits and habitats of PS indicate that it would be unlikely (see discussion in Dredging/Disposal under **Direct Effects**, above) . The CIP mitigates for potential effects to PS through habitat protection and restoration BMPs (see **Habitat Conservation Measures**, above).

The detection and quantification of local or long-term effects to PS due to CIP activities is extremely difficult to detect or monitor. This is partially due to the cryptic habitats and habits of PS (see **Pallid Sturgeon**, *Habitats and Movement*, under **STATUS OF THE SPECIES**, above). Conditions within the action area also make sampling difficult and dangerous, and the location of habitats and fish naturally change by river stage, season, and from year to year. Additionally, any long-term demographic effects that might result from CIP actions and activities are masked by the continual rise in the LMR PS status baseline. This continual increase in knowledge of PS distribution, demographics, and population size in the LMR since the species was listed, provide no indication that either the CIP or occasional deviations from construction and maintenance BMPs have resulted in any significant net negative impacts to LMR PS or its habitats, relative to the listing baseline. Additionally, as noted above, Corps actions have been, and are being conducted under the CIP to mitigate for potential past and future project effects to LMR habitats by protecting potential PS spawning habitats, and protecting and restoring secondary channel habitat integrity (habitat protection and restoration BMPs).

Fat Pocketbook Mussel

There are no historical collections of FPM from the LMR, and most recent collection efforts and records date from the past decade (see **Fat Pocketbook Mussel**, **Distribution and Abundance**, under **STATUS OF THE SPECIES**, and **Status of the Species in the Action Area**, Fat Pocketbook Mussel, under **ENVIRONMENTAL BASELINE**, above). While the overall distribution and density of the species in the LMR remains poorly known, all recent live collections and all but a few fresh dead shell collections are associated with secondary channel dike fields that maintain hydrological connectivity with the main channel throughout all or most of the year (Service Jackson, Mississippi, in litt. 2009, Davidson in litt. 2012). Maintenance activities within secondary channel dike fields that maintain hydrological connectivity and are known to support FPM are rare, and only one dike field known to support FPM has been subject to maintenance activity over the past decade (Service 2004).

The detection and quantification of FPM density or distribution within secondary channels, and local or long-term effects to the species due to CIP activities is extremely difficult to detect or monitor. This is partially due to the cryptic benthic habitats, low local density of FPM in the LMR, as well as conditions within the action area that make sampling difficult and dangerous. Therefore, while there is a potential that FPM may be harmed or killed by stone placement during secondary channel dike maintenance, the apparent low density of FPM adjacent to dikes and the infrequency of maintenance activities within functioning secondary channel dike fields, indicates that potential take of FPM by CIP maintenance activities is very low (see **Direct Effects**, above). Additionally, the data suggests that the range extension of FPM into the LMR may be related wholly, or in part, to conditions created by CIP actions within dike fields (i.e., construction of dike fields in secondary channels). Therefore, Corps' BMPs and projects to restore hydrological connectivity within degraded secondary channels is likely to expand LMR FPM populations and mitigate for any potential dike maintenance impacts to the species.

CONCLUSION

After reviewing the current status of the ILT, PS, and FPM, the environmental baseline for the action area, the effects of continued operation and maintenance of the CIP, the cumulative effects, and the CORPS section 7(a)(1) CIP conservation program, it is the Service's biological opinion that the CIP is not likely to jeopardize the continued existence of the ILT, PS, and FPM. No critical habitat has been designated for these species; therefore, none will be affected.

INCIDENTAL TAKE STATEMENT

Section 9 of the Endangered Species Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or

sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act, provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

Amount or Extent of Take Anticipated

As noted under the Summary of Effects, above, the administrative record demonstrates that ILT and PS have not only survived under CIP conditions for decades, but have expanded their ranges and numbers throughout the LMR over the past two decades. FPM has expanded its range into the LMR through colonization of secondary channel habitats stabilized by dike fields constructed under the CIP. The Corps has developed and implemented a CIP Conservation Program for these three endangered species under the authority of section 7(a)(1) of the Act. Under this program, Corps, in consultation with the Service, has identified and implemented conservation measures to minimize harassment or harm that might potentially result to individual ILT, PS, and FPM from CIP activities.

Our regulations (§ 402.14(i)(1)(i)) require us to express the impact of incidental taking of the species in terms of amount or extent. While harassment and harm to individuals of ILT, PS, and FPM may occasionally occur due to CIP activities, for reasons noted under the **Summary of Effects**, above, it is not practical or possible to express the amount or extent of anticipated take in terms of individuals of ILT, PS, or FPM, or to monitor take-related impacts that might occur under the CIP. However, our regulations also allow us to express take in terms of the extent of area that may be affected (i.e., as a surrogate for take), if there is a link between the surrogate and take of the species. As noted in the **Summary of Effects**, above, there is a direct and strong link between LMR secondary channels and the recruitment and survival of ILT, PS, and FPM. A decline in the availability of these habitats to the species as a result of CIP modification of functional secondary channels would detrimentally affect their survival and recruitment, and would result in take of the species. Over the life of the CIP, the number of LMR secondary channels has declined (Williams and Clouse 2003, Killgore *et al*. 2012, Guntren *et al*. 2013). In recognition of this important component of habitat complexity to the conservation of ILT, PS, FPM, and other species, the current CIP is oriented toward maintaining existing secondary channel function, and restoring or improving hydrological connectivity in degraded secondary channels. Additionally, status and trends of secondary channels are measurable through the Corps' riverine survey component of the CIP. Therefore, the Service will utilize secondary channel abundance and condition in the LMR as a surrogate for take of all three species, and as a measure to reinitiate consultation. Herein, for the purposes of this Biological Opinion, the Service authorizes take of ILT, PS, and FPM, incidental to CIP activities and the modification of secondary channels in the LMR.

The Corps recognizes two primary sources of information for secondary channel trends in the LMR (Table 3). Using aerial photography and bathymetric data, Williams and Clouse (2003)

identified a mean of 106 secondary channels over a 40-year span of the CIP between the 1960s and the1990s. Guntren *et al*. (2013) included new data and software analysis to update the previous study, identifying a mean of 102 secondary channels per decade between the 1960s and 00s. Herein, we use the most recent source of information (Guntren et al. 2013) which includes a combination of aerial photography and bathymetry, spans a greater number of years, and applies new and rigorous analytical methods to the Williams and Clouse (2003) data, to establish a target of maintaining a mean of 102 functional secondary channels within the LMR.

TABLE 3: Mean Number of LMR Secondary Channels at +10 LWRP per Decade (n=5) Over the Life of the CIP (CORPS 2013b)

Information Source	Mean	Standard Deviation	90% CI Min	90% CI Max	Range Min	Range Max
Williams & Clouse (2003)						
Number	106	11	93	119		
Area, acres	n/a					
Guntren *et al*. (2013)						
Number	102	18	85	119	76	125
Area, acres	35,598	7,996	27,974	43,222	23,120	41,910

The Service recognizes that while CIP engineering can be, and has been utilized to maintain or restore secondary channel function, their loss or gain may also be influenced by natural hydrogeomorphic processes unrelated to Corps activities. Therefore, for the purposes of this Biological Opinion, we authorize no net loss (0) below 84 functional secondary channels (mean number of secondary channels (102) minus one standard deviation (18); see Table 3, above). A functioning secondary channel is defined as one bordering either vegetated or non-vegetated islands and maintaining hydrological connectivity with the main channel (i.e., measurable inundated channel areas and volumes) at ten feet above the Low Water Reference Plane (+10 LWRP).

Effect of Take

In the accompanying Biological Opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the ILT, PS, or FPM.

Reasonable and Prudent Measures

The Service believes the following reasonable and prudent measures are necessary and appropriate to further minimize take of ILT, PS, and FPM:

1. The Corps will notify the Service of the loss, the potential for loss, or gain of any secondary channels within the LMR.

2. During annual partner meetings, the Corps will summarize the potential for BMP deviations under projected construction and maintenance actions, and possible effects to the ILT, PS, and/or FPM.

3. The Corps may conduct no more than10 actions/year that deviate from construction and maintenance BMPs (e.g., seasonal construction activity restrictions for PS; seasonal distance buffers for ILT) without prior written approval by the Service.

4. The Corps will annually consider any new biological or ecological information relative to minimizing effects of CIP activities through modification of construction and maintenance BMPs.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the CORPS must comply with the following terms and conditions, which implement the reasonable and prudent measures, described above, and outline reporting requirements. These terms and conditions are non-discretionary.

1. During annual partner meetings, CORPS will summarize and consider the potential for new construction and maintenance project effects to secondary channels, and associated effects to the ILT, PS, and/or FPM.

2. The Corps will utilize actions identified under **Conservation Measures**, **Strategy 3**, Action a, above, to monitor number and condition of LMR secondary channels, and report findings during annual partner meetings.

3. During annual partner meetings, the Corps will summarize and consider any new biological or ecological information relative to minimizing effects of CIP activities through modification of construction and maintenance BMPs.

4. The Corps will provide relevant data and analysis prior to modification of any BMPs to the Service, and will obtain the Services written concurrence prior to implementing modified BMPs.

Conservation Recommendations

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out 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. The Corps-MVD (2013) has

developed a comprehensive conservation plan for the ILT, PS, and FPM, in consultation with the Service, and is actively implementing that plan. We encourage the Corps to continue to implement the following conservation measures as resources and opportunities allow:

1. Conduct surveys/scientific investigations on population sizes, ecology, and habitat uses of ILT, PS, and FPM in the LMR.

2. Develop and implement monitoring protocols for ILT, PS, and FPM on the LMR.

3. Utilize sentinel receivers to monitor sonic tagged sturgeon around dredging and revetment construction activities.

4. Work with partners to develop a comprehensive Geographical Information System of LMR habitat features and endangered species associations.

5. Continue to work with partners to maintain/restore side channel and batture connectivity.

In order 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.

REINITIATION NOTICE

This concludes formal consultation on the proposed action. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the number of functional secondary channels in the LMR falls below 84; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take shall cease pending reinitiation.

The Service appreciates the cooperation of the Corps during this consultation. If you have any questions about this biological opinion, please contact Paul Hartfield of the Mississippi Field Office at 601-321-1125.

12/12/13

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