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Lower Mississippi River
Strategic Habitat Conservation Plan

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Executive Summary

The Mississippi River system is the largest in North America, draining all or parts of 31 states from Canada to the Gulf of Mexico. It has been an important feature in the development of the United States, including its history, culture, commerce, and folklore. The Lower Mississippi River (LMR) extends 954 river-miles from the confluence of the Mississippi and Ohio Rivers at Cairo, Illinois, to the Gulf of Mexico through an ecologically complex 2.7 million-acre leveed floodplain. The LMR has been modified by civil works projects to provide flood control infrastructure and to facilitate navigation. Over the past five decades, this development has resulted in some negative trends in habitat quantity and quality within the LMR channel, however, the river continues to support a highly diverse and productive riverine ecosystem.

For more than a decade the U.S. Fish and Wildlife Service, the U.S. Army Corps of Engineers, and LMR State conservation agencies have been working together to identify and resolve ecosystem management issues. It has become apparent that the very programs that have most severely affected the river can be important tools in maintaining and enhancing its ecological functions. The partnering agencies have found that early consideration of ecological opportunities can be incorporated into the design, construction, and maintenance (O&M) of channel improvement projects, with little to no effect on flood control, navigation, or project cost. Working together, the agencies have also implemented cost-effective restoration actions unaffiliated with ongoing projects by sharing responsibilities and resources. This strategic habitat conservation plan outlines the mechanism by which the U.S. Fish and Wildlife Service, the U.S. Army Corps of Engineers, and other partners can utilize the Channel Improvement and Channel O&M programs as conservation tools, in addition to their primary purposes, to help maintain and improve habitat values within the LMR channel, and for recovery of endangered and other trust species inhabiting the river channel.

This strategic conservation plan does not obligate any party to undertake specific tasks and may not represent the views nor the official positions or approval of any individuals or agencies involved in developing the plan, other than the U.S. Fish and Wildlife Service.

Background

The Lower Mississippi River (LMR) extends 954 miles from the confluence of the Ohio River to the Gulf of Mexico. Over the past 30 years there has been a gradual but significant loss of secondary channels and in the area of associated seasonally flooded in-channel habitats in the LMR. About 23 secondary channels and roughly 14,000 acres of associated higher elevation habitats (+5 & +10 Low Water Reference Plane (LWRP)) have been lost in the LMR since the 1960's due to natural realignments and/or channel modifications, including closure dikes, conducted under the U.S. Army Corps of Engineers (COE) Mississippi River and Tributaries Project (Williams and Clouse 2003). Dikes constructed along the main channel have resulted in sediment accretion and loss of aquatic surface area during low water periods. Numerous recreational, commercial, and non-game species, including neotropical migrant birds, ducks, shorebirds, reptiles, fishes, and invertebrates, depend upon secondary channel, main channel border, and seasonally flooded channel habitats for shelter, forage, spawning, and/or juvenile recruitment.

The LMR is inhabited by three endangered species: pallid sturgeon, Interior least tern, and fat pocketbook mussel, all of which are dependent upon in-channel and seasonally flooded habitats. Pallid sturgeons require in-channel habitats for movement and foraging, and utilize seasonally flooded gravel and sand bars for spawning, foraging, and recruitment. Interior least terns forage in channel habitats such as dike pools and require seasonally exposed sand and gravel bars and islands for successful nesting and recruitment. Fat pocketbook mussels inhabit select secondary channels of the LMR that are maintained during low discharge stages by bank water seepage from seasonally flooded sand bars.

In 1982 the COE initiated the Lower Mississippi River Environmental Program (LMREP) to develop information on environmental impacts associated with implementation of the Mississippi River and Tributaries Project, and to identify opportunities to integrate beneficial environmental effects into their civil works program (http://www.mvd.usace.army.mil/gis/lmr_environmental_reports/description.htm). LMREP has produced information on historical geomorphology, fisheries, and hydrology and ecology of stone dike systems and secondary channels. LMREP investigations of stone dikes resulted in improved environmental designs that incorporated notches in the dikes to alter sediment deposition and maintain/improve aquatic habitat conditions during low to moderate discharge periods.

Following the 1985 listing of the Interior least tern as endangered, COE initiated annual nesting season tern counts on the LMR between Cairo, IL, and Greenville, MS. The survey reach was extended downstream to Vicksburg, MS in 1988, and to Baton Rouge, LA, in 2001. These counts have documented a persistent increase in the number of terns known to utilize the LMR, from approximately 300 birds in 1985, to over 12,000 in 2011 (Jones 2011).

Historical records of pallid sturgeon in the LMR are extremely rare, and the U.S. Fish and Wildlife Service (FWS) was able to document only 35 observations of the species from the entire Mississippi River (Keenlyne 1989), 28 of these from the LMR. In 2001, COE initiated efforts to develop sampling methods for pallid sturgeon in the LMR, as well as studies on abundance, distribution, demography, and habitat use (e.g., Killgore *et al*. 2007a, 2007b; Hoover *et al*. 2007, etc.). These and other efforts have resulted in

the collection of almost 500 pallid sturgeons at multiple locations between New Orleans, LA, and St. Louis, MO (Killgore *et al*. 2007a, FWS *in litt*. 2012). These data have demonstrated recruitment and low mortality rates of pallid sturgeon in the LMR (Killgore *et al*. 2007b).

There are no historical records of fat pocketbook mussel within the channel of the LMR. This species was first reported from the LMR as fresh dead shells in 1996 (Mississippi Museum of Natural Science mollusk collection). Living animals were observed in 2003 (Hartfield *in litt*. 2003) inhabiting secondary channels modified by dike notches between River Miles 480 and 490. The COE Engineer Research and Development Center (ERDC) has collected scattered shells on sandbars upstream of dikes during low river stages, and in 2011, juvenile fat pocketbook mussels were collected in the interior of a chevron at River Mile 610, below Helena, Arkansas.

Partnerships

In 2001 the COE, Southeastern Region FWS, and Lower Mississippi River Conservation Committee (LMRCC), which consists of 12 state natural resource management and environmental quality agencies, began conducting annual meetings to discuss LMR conservation issues and maintenance and construction projects. Key components of these Partnership meetings include updates on locations and habitat use by endangered species in the LMR channel, the identification and consideration of using environmental engineering principles in the design and construction of river training structures, and improving communication and coordination among partners for the benefit of all trust species in the LMR.

Dike notching and other alternative designs of river training structures are considered to specifically reduce impacts to trust resources and fisheries and when there is minimal effect on the purpose and intent of the authorized project (i.e., navigation/flood risk reduction). Opportunities are also considered to benefit a wide range of recreationally and commercially important species and their habitats. Since this collaboration began, 230 dike notches have been constructed or maintained (nature-made) in the LMR to increase in-channel and seasonally flooded habitat diversity. Almost 30% of the 800 dikes in the LMR have notches and more are being planned.

In addition, LMRCC brought together multiple stakeholders to identify rehabilitation projects and resource use (e.g., public access points) opportunities in the LMR. Referred to as the Mississippi River Conservation Initiative, state biologists and other stakeholders identified a total of 239 LMR sites in Arkansas, Kentucky, Tennessee, Mississippi, and Louisiana considered important habitats requiring some form of restoration. Potential habitat benefits of these 239 LMRCC restoration projects have been grouped and ranked using a decision support model (Boysen et al 2012). Restoration of secondary channels was identified as the top priority and an evaluation procedure has been developed to rank the habitat value of over 50 secondary channels for planning purposes (Killgore et al. 2012). Dike notching and other floodplain restoration measures were also recommended. To date, these combined efforts have cost-efficiently rehabilitated six secondary channels totaling over 25 miles of in-channel habitat and

enhanced hundreds of acres of seasonally flooded habitats without impacting the COE's primary missions of flood damage reduction and provision of a safe, stable commercial navigation channel.

Data and information on species abundance and demographics, and habitat associations continue to be developed both independently and cooperatively by the LMR partners. For example, knowledge of the location and abundance of pallid sturgeon and fat pocketbook mussels in the LMR has been increased by an order of magnitude during the past decade. The COE has a 25-year record of monitoring interior least tern abundance in the LMR, and a 12-year record of evaluating pallid sturgeon populations. Such biological data and information are essential to monitoring the long-term success of habitat restoration and management within the LMR navigation and flood control programs.

Purpose and Objectives:

The environmental management Partnership and its LMR conservation strategies have evolved to include this Strategic Habitat Conservation (SHC) framework developed by the FWS and U.S. Geological Survey (USGS) in 2008. The purpose of this SHC Plan is to identify a strategic framework for FWS vision, partnership, and involvement in efforts to conserve endangered species, their habitats, and associated species in the LMR. Objectives include identification of:

1. Priority species, their limiting factors, and population trajectories in the LMR;
2. Conservation design that provides cost-effective environmental engineering;
3. Partner agency roles and conservation delivery in the LMR; and,
4. Monitoring and research feedback mechanism for adaptive management.

Available Institutional Resources:

FWS biologists work closely with the COE and state natural resource management and environmental quality agencies to review and develop Federal land and water resource projects that meet critical needs of local communities and conserve the nation's fish and wildlife resources. The Fish and Wildlife Coordination Act (FWCA), National Environmental Policy Act (NEPA), Clean Water Act (CWA), and Endangered Species Act (ESA) provide mechanisms to ensure that fish and wildlife conservation is considered, adverse impacts are addressed, and opportunities to help recover imperiled species are capitalized upon early in Federal civil works project planning by all involved stakeholders.

Corps of Engineers Civil Works projects are authorized by legislation generically referred to as Omnibus Legislation, including those under regulatory purview of various Flood Control Acts, Rivers and Harbor Acts and, since 1974, Water Resources

Development Acts (WRDA). WRDA legislation provides the Corps with authority to study water resource problems, construct projects, and make major modifications to projects. WRDA bills can also contain general provisions and special study authorizations. The Mississippi River and Tributaries (MR&T) Project was authorized by the Flood Control Act of 1928, which has been amended numerous times to provide the current authority. The Channel Improvement Program (CIP) feature of the MR&T project provides for a low-water navigation channel 9 feet deep and 300 feet wide from Baton Rouge, LA, to Cairo, IL, and for stabilization of river banks to protect flood control levees. Actions to accomplish these objectives include the construction of stone dikes to develop a self-maintaining channel, foreshore protection dikes and revetments to arrest bank caving and protect levees and other structures, bend way weir systems to lower river velocities and reduce shoaling, and in limited cases, dredging to reduce shoaling. The project is approximately 90% complete, and is scheduled to be finished in 2020.

In 2002, the COE introduced Environmental Operating Principles (EOP) to provide direction in all aspects of COE activity for improved stewardship of land, water and air. EOP implementation guidelines were subsequently adopted to identify ways COE missions can be integrated into environmental laws, values, and practices (ER 200-1-5). Since 2002, COE has been applying EOPs into CIP, as well as Operation and Maintenance (O&M) activities in the LMR with varying success. Although the CIP is almost complete, remaining components, as well as on-going and future O&M activities provide opportunities to cost-effectively utilize EOPs to improve ecosystem responses to the programs that have affected channel habitat quantity and quality in the LMR.

The COE has developed resources and information vital to strategic management of the LMR ecosystem. They have mapped aquatic and terrestrial habitats within the 2.8 million-acre LMR leveed floodplain ecosystem. Aquatic habitat maps of the river's channel for 1880, 1915, and for ten-year intervals from the 1930s to the 1990s have been completed and are being used to assess historic habitat trends, conduct habitat spatial analyses, and evaluate project effects on federally endangered species as well as other aquatic resources. Terrestrial habitat and land cover maps prepared using 1982 and 1992 data have been used to delineate jurisdictional wetlands, plan levee construction to avoid and minimize adverse environmental impacts, and maximize beneficial conservation effects. In addition, LMREP investigations have been conducted on fish and wildlife populations and habitat values of levee borrow pits, effects of in-channel stone dikes, and articulated concrete mattress revetments.

In 2000 the LMRCC developed an Aquatic Resource Management Plan (ARMP) for the 954 river-mile long LMR reach (http://www.lmrcc.org/ARMPstrategies.pdf). The ARMP provided a 10-year operational plan to address several factors adversely affecting wetland-dependent natural resources in the LMR active floodplain and backwater areas. As mentioned previously, during the period 2001 – 2004 the Partnership conducted the Mississippi River Conservation Initiative (MRCI), which consisted of a series of planning meetings in the six LMRCC-member states (AR, KY, LA, MS, MO, and TN) that were designed to identify specific aquatic habitat restoration and public access opportunities

(http://www.lmrcc.org/MRCI.htm). The MRCI was a landscape-scale effort that ultimately resulted in six state-specific lists consisting of 239 potential projects. In 2006 the LMRCC, under the auspices of the Partnership, began compiling the MRCI projects into a landscape-scale plan – Restoring America's Greatest River (RAGR). The RAGR plan comprises the implementation phase of the Partnership's five-year planning effort to rehabilitate the LMR leveed floodplain ecosystem (http://www.lmrcc.org/). Working cooperatively with the Partnership, the LMRCC has developed a comprehensive Geographic Information System comprised of spatial databases covering the Lower Mississippi River Ecosystem and the Mississippi Alluvial Valley to support the implementation of the MRCI. Data holdings include vector files of roads, hydrology, river training features (dikes, revetments, levees, ports, etc.), public lands boundaries, satellite imagery, digital orthophotos, low water video, and raster data including soils, land cover/land use, DEMs and bathymetry.

Since 2005, COE has collaborated with LMRCC and other partners to: 1) conduct synoptic studies of pallid sturgeon population status and habitat restoration benefits; 2) obtain geo-referenced video during low water periods to evaluate status of river training structures, and to determine habitat quality in secondary channels and other areas of the LMR; 3) quantify long-term changes in depth, volume, and status of secondary channels in the LMR; 4) begin studies of gravel bars used by sturgeon and other riverine species as spawning sites; and 5) continue planning restoration projects. Information derived from these efforts is shared annually at the lower basin pallid sturgeon recovery meeting and the channel improvement meetings sponsored by the Memphis, Vicksburg, and New Orleans Districts. Most recently, the COE is working with partners to execute the Lower Mississippi River Resource Assessment.

The Lower Mississippi River Resource Assessment (LMRRA) was authorized in WRDA 2000, Sec. 402, and funding was initiated in FY09. The reconnaissance level report was approved 5 March 2010. The purpose of the study is to develop recommendations for: 1) the collection, availability, and use of information needed for river-related management; 2) the planning, construction, and evaluation of potential restoration, protection, and enhancement measures to meet identified habitat needs; and 3) potential projects to meet identified river access and recreation needs. The Nature Conservancy (TNC), along with LMRCC and other partners, including National Audubon Society, Delta F.A.R.M., and the American Land Conservancy, have joined this effort as cost-share partners on a feasibility level watershed study with the signing of the COE – TNC cost share on 11 January 2012.

Priority Species

As noted previously, numerous species that utilize LMR habitats may be adversely affected by river channel modifications. The pallid sturgeon, Interior least tern, and fat pocketbook mussel have been selected as priority species for the LMR SHC Plan. Selection of an endangered fish, bird and mussel as priority species ensures attention to

and protection of habitat values for a majority of river-dependent species guilds. Additionally, this SHC can be expanded to address future habitat and species needs.

The Partnership's objectives for all three species are to identify, stabilize and improve their habitats in the LMR leveed floodplain ecosystem; document population sizes and trends of the priority species; and to achieve population and recruitment levels that reflect improvement in status and lead to recovery under the ESA within this portion of their ranges.

Pallid Sturgeon

Pallid Sturgeon – Milliken Bend, Warren Co., MS

Recovery Criteria: The 1993 criteria to down list pallid sturgeon from endangered to threatened include a population structure with at least 10% sexually mature females, and sufficient numbers in the wild to maintain population stability. Recovery criteria for pallid sturgeon are currently being revised by FWS Region 6. There is significant information on genetic structure through the range and delisting of the species by management area is under consideration.

Current status in the LMR: When listed in 1990, there were only 28 recognized records of pallid sturgeon from the Mississippi River and none from the Atchafalaya River (Keenlyne 1989). Pallid sturgeon population size has not been quantitatively defined within the LMR; however, collection efforts over the past decade show the species is widespread and not uncommon. Efforts to collect river sturgeon in the LMR have been relatively limited over the past decade, particularly considering the scope and scale of the available habitat. However, these collections have shown that pallid sturgeon occur throughout most of the 950 mile reach of the LMR (Bettoli et al. 2008, Killgore et

al. 2007a, Kuntz and Schramm 2012, Hartfield, pers. obsv. 2001-2010), and the 200 mile reach of the Atchafalaya River (Constant et al. 1997, Dean in litt. 2005-2009, Herrala and Schramm 2010). Collections of pallid sturgeon in the LMR include almost 500 individuals collected between the mouth of the Ohio River and Head of Passes (Killgore et al. 2007a; Hartfield, in litt. 2001-2010; Kuntz and Schramm 2012), ranging from 0 – 21 years of age (50 to >800 mm fork length (FL)) (Killgore et al. 2007b, Hartfield pers. obsv. 2010). Over 600 pallid sturgeon ranging from 400 to >1000 mm FL have been collected from the Atchafalaya River distributary of the LMR (U.S. Fish and Wildlife Service 2007, Dean pers. comm. 2009).

Although pallid sturgeon 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 pallid sturgeon comprised 2.2% of fish captured on winter set trotlines, and ranked 5th in frequency of capture out of 22 species collected. Recaptures of pallid sturgeon are also rare in the LMR. Killgore et al. (2007a) reported only 5 pallid sturgeon recaptures over 7 years. In another study that conducted 2 years of pallid sturgeon collection and telemetry efforts in a 30-mi reach of the Mississippi River, only a single pallid recapture occurred out of >60 pallid collected, tagged, and released, even though telemetry results indicate most pallid sturgeon remained within the sample reach (Kuntz and Schramm 2012).

There is also evidence that the LMR pallid sturgeon population can sustain removal of substantial numbers of individuals from the population. Bettoli et al. (2009) conservatively estimated that 2% of the commercially harvested sturgeons in the Tennessee reach of the LMR were pallid sturgeon (169 females over two seasons). Commercial harvest for sturgeon caviar has occurred annually in the Tennessee and Missouri reaches of the LMR for more than two decades. While baseline data on LMR pallid populations is lacking, the persistence of the species following more than two decades of harvest pressure on mature pallid sturgeon females, suggests the population is relatively robust. Additional evidence of population size has recently been developed in association with evidence of persistent and periodic entrainment losses of LMR pallid sturgeon. During an emergency opening of the Bonnet Carre Spillway during 2008, the COE and FWS estimated up to 92 pallid sturgeon were injured or killed due to entrainment (U.S. Fish and Wildlife Service 2009). Bonnet Carre has been opened four times since the species was listed (1994, 1997, 2008, 2011). Other diversion structures that have been operating for one to five decades (Old River Control Complex, Davis Pond) are also known to entrain pallid sturgeon. While episodes of commercial harvest or entrainment constitute substantial periodic or continuous localized loss of individuals to the pallid sturgeon population within the specific 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; Kuntz and Schramm 2012).

LMR pallid sturgeon population demographics have been poorly defined but recruitment has been documented by capture of multiple age classes (Figure 1, Killgore et al. 2007a) and capture of larval pallid sturgeon at several locations between the confluence of the Ohio River and Vicksburg, MS. Adult pallid sturgeon annual mortality

is low (<12%) in the LMR, compared to the Middle Mississippi River (>35%) where commercial fishing was just recently banned (Killgore et al. 2007b). There are latitudinal morphometric variation and length-at-age differences across the range (Murphy et al. 2007), suggesting that management goals should be reach-specific. Specific spawning and rearing habitats are poorly known but surmised to include gravel bars (spawning), and secondary channels and flooded sand islands (juvenile recruitment). Telemetry studies in the LMR have shown use of multiple channel habitats by larger size classes of pallid sturgeon, including point bars, secondary channels, crossovers, wing dikes, island tips, natural banks, and revetted banks (Kuntz and Schramm 2012).

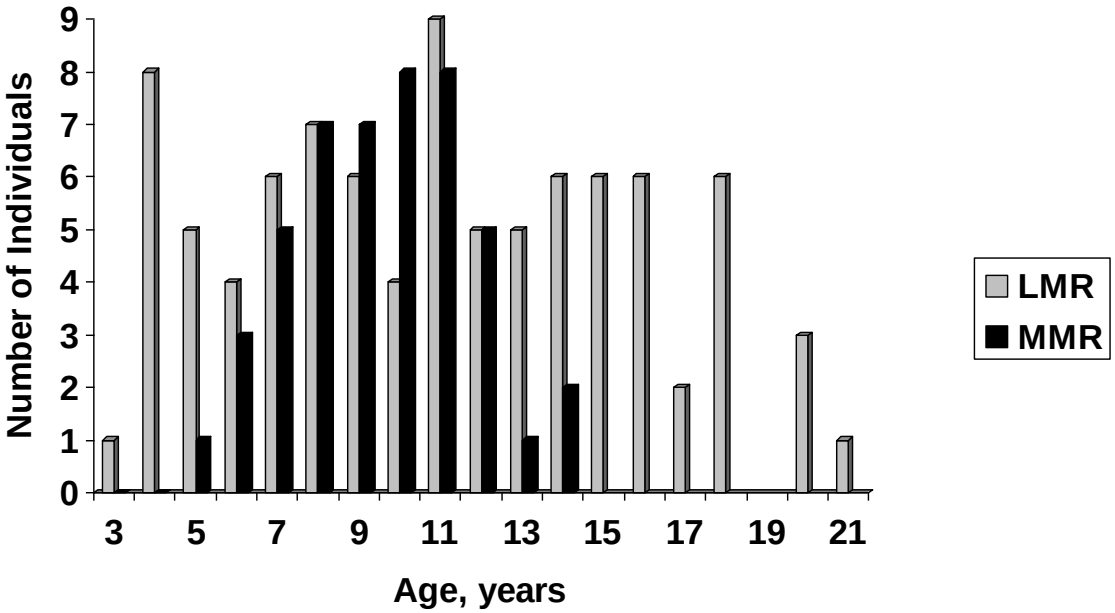

Figure 1: Age distribution of pallid sturgeon captured in the Lower (LMR) and Middle (MMR) Mississippi River (Killgore et al. 2007b).

On-going Research: Methods to develop population size estimates are being investigated by COE and FWS, and the COE is developing a Population Viability Analysis. FWS and the USGS Mississippi Cooperative Fish and Wildlife program are conducting telemetry studies of pallid sturgeon in the LMR and Atchafalaya River. The COE is considering habitat associations identified by the telemetry studies during annual review of LMR channel improvement projects. FWS and partners are conducting a morphological and genetic analysis of LMR river sturgeon (*Scaphirynchus* spp.) to improve taxonomic understanding and identification. FWS, Region 6, is currently revising the Pallid Sturgeon Recovery Plan.

Interior Least Tern

Interior Least Tern – Willow Cut-Off, East Carroll Parish, LA

Recovery Criteria: The 1990 delisting recovery criteria for Interior least tern specifies protection and management of essential breeding habitats, a range-wide population of 7,000 birds, and population targets for five river drainages - Missouri, Mississippi, Arkansas, Red, and Rio Grande Rivers. The recovery population target for the LMR was identified as 2,200 – 2,500 terns. Recovery population levels are to be maintained for a 10-year period. FWS is currently in process of conducting a 5-year status review for the species.

Current status in the LMR:

The Interior least tern range-wide numerical recovery criterion (7,000 birds) (USFWS 1990) has been met or exceeded each of the past 17 years (1994 – 2011). Using range-wide seasonal count data of adult Interior least terns from 1984 (722 terns) to 1995 (8,859 terns), Kirsch and Sidle (1999) demonstrated achievement of the numerical recovery criterion, and a positive range-wide population growth trend. They noted, however, that most of the Interior least tern increase had occurred on the LMR, observed that population increases were not supported by available fledgling success estimates, and hypothesized that Interior least tern increases were possibly due to immigration surges from a more abundant Eastern least tern Gulf Coast population.

Range-wide Interior least tern counts have doubled since 1995 (e.g., Lott 2006: 17,591 adult terns range-wide). The majority of birds continue to be reported from the Lower Mississippi River (Lott 2006: 62% of the 2005 range-wide count from the LMR), and Interior least tern counts now equal or exceed population estimates for least tern along the U.S. Gulf Coast (Lott 2006). Lott (2006) noted marked declines in Gulf Coast

least tern populations in recent years, hypothesized a wider least tern metapopulation which includes Gulf Coast and Interior least tern subpopulations, and the potential for significant immigration from the Gulf Coast inland due to high human disturbance along the coast and presence of better nesting conditions on the LMR. However, there are no data or observations directly supporting either the Kirsch and Sidle (1999) or Lott (2006) immigration hypotheses as a factor in the 20+ year increase in Interior least tern counts, either in the LMR or range-wide. Recent studies, however, have shown high genetic connectivity among groups of Interior least tern inhabiting different drainage basins, as well as between interior and coastal populations (Draheim et al. 2010).

Some proportion of the increase in adult Interior least tern numbers has been attributed to improved survey efforts and efficiency, such as extending surveys over wider geographical areas, and/or discovery of new subpopulations (Lott 2006). Examples include the LMR where changes in survey methods, and extending survey reaches correspond to some degree with higher Interior least tern counts (Figure 2). The occurrence of large numbers of Interior least tern within the LMR un-impounded navigation system has also been attributed, in part, to higher elevation sand and gravel bars associated with channel training dikes (Lott 2012).

When listed in 1985, fewer than 400 Interior least terns were known to inhabit less than 200 miles of the LMR. Nesting colonies have been monitored in the LMR for 25 years (Figure 2) and data have shown a significant increase in Interior least tern numbers since initiation of the LMREP in 1982. Interior least terns 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.

On-going Research: COE analyses indicate that habitat quantity has remained relatively stable and underutilized by breeding/nesting Interior least tern for the past two decades (Corps of Engineers 1999, 2008). COE is finalizing a habitat trend analysis for the LMR (Keevin in progress). FWS, COE, USGS, and American Bird Conservancy are collaborating to develop a range-wide metapopulation model designed to synthesize the bulk of scientific research conducted on the species, and to assist in answering questions about management alternative effects on local, regional, and range-wide population status. This collaborative group is also planning to design a metapopulation based monitoring program. FWS, Region 4, is in the process of conducting a range-wide 5-year status review.

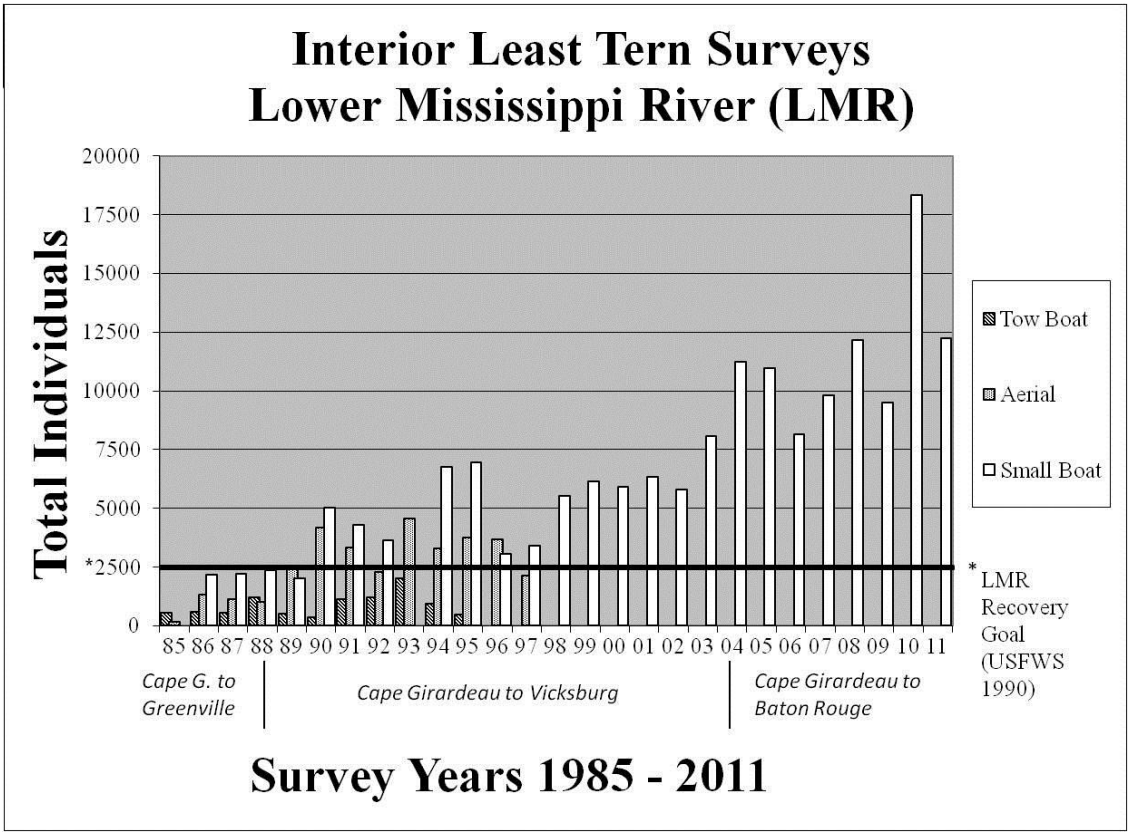

Figure 2: Interior Least Tern Population Survey Results in the Lower Mississippi River, 1985-2011 (Mike Thron, USACOE).

Fat Pocketbook Mussel

Fat Pocketbook Mussel – Ajax Bar, Issaquena Co., MS

Recovery Criteria: The 1989 recovery criteria to downlist the fat pocketbook mussel from endangered to threatened is the protection of the St. Francis River population and the discovery or establishment of two additional viable populations outside of that river system. Delisting criteria have not been identified.

Current status in the LMR:

The fat pocketbook mussel population in the St. Francis River has been successfully protected under the ESA for more than 30 years. Since the species was listed fat pocketbook mussel populations have also been discovered in the Ohio and Lower Mississippi Rivers. Based on the presence of juvenile and sub-adult specimens, both of these recently discovered populations are likely viable.

The fat pocketbook mussel was first reported from Mississippi River channel habitats in 2003. Although efforts to determine range and population size of the fat pocketbook mussel in the Mississippi River and adjacent habitats have been limited, collections of live adult mussels have been made at multiple sites between RM 346 (south of Natchez, Mississippi) and RM 670 (north of Helena, Arkansas). Collections are localized in small areas of relatively stable secondary channels and side channels. Population densities are extremely low in the secondary channel habitats where they are found; however, recruitment appears to be occurring based on the occurrence of young individuals (P. Hartfield, pers. obsv. 2003-2007). Locations of fat pocketbook mussels in the LMR are highly correlated with secondary channels in which water flow is maintained by dike notches.

On-going Research: FWS has conducted limited surveys and documented fat pocketbook occurrences between RM 336 – 670. The Corps has considered conducting low water surveys in the LMR for mussels at locations scheduled for maintenance or new construction; however, opportunities have been limited during the past few years due to high water. COE has documented recruitment near modified channel training structures (Killgore in litt. 2012).

Factors Affecting Priority Species

Several concerns have been identified for the priority species in the LMR (US Fish and Wildlife Service 1989, 2007, 2012). These include: habitat loss and modification for all three priority species, nest disturbance of Interior least tern, commercial harvest of pallid sturgeon, dredge entrainment of pallid sturgeon, sand and gravel mining entrainment and spawning habitat degradation, entrainment of pallid sturgeon through water control structures, effects of pollution and contaminants on all three species, and hybridization of pallid sturgeon with shovelnose sturgeon. Ongoing and proposed actions required to fully assess these factors are identified below.

Habitat Loss and Modification: While it is likely that habitat modification has the potential to seriously affect all three priority species, there is little evidence of direct impacts in the LMR, i.e., knowledge and numbers of pallid sturgeon and Interior least tern have increased relative to historical pre-modification conditions, and the occurrence of fat pocketbook mussel was first documented from the LMR post-modification.

Appropriate habitat for pallid sturgeon 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 characteristics are common in the LMR throughout nearly all of its length. 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 widespread gravel bars suitable for spawning. However, the location and complexity of channel habitats has been modified over time by river engineering, the effects of which on pallid sturgeon recruitment are poorly documented or understood.

As noted previously, potential LMR nesting habitat for Interior least tern currently exceeds use by the species. Actions such as notch construction in dikes may be increasing or enhancing Interior least tern breeding habitats in the LMR by severing land-based routes used by terrestrial predators to access Interior least tern nesting colonies.

Fat pocketbook mussels are associated with secondary channels in the LMR where flows are maintained by dike notches. Their presence may result from recent exploitation of developing habitat conditions created within COE dike fields, however, this is poorly documented and understood.

Potential effects of annual channel maintenance activities to pallid sturgeon, Interior least tern, and fat pocketbook mussel habitats, along with potential avoidance and minimization actions, are discussed and considered during annual Partnership meetings hosted by COE Districts. Channel maintenance and restoration programs 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. Priority species and their LMR habitats will continue to be quantified and monitored by COE and other participating agencies. The data will be used to determine the extent and significance of habitat modification to the priority species, quantify habitat benefits of creative engineering, project future habitat trends, identify habitat improvement opportunities, modify channel management programs as necessary, and monitor long-term habitat trends and responses.

Commercial Harvest of Pallid Sturgeon: Commercial harvest of shovelnose sturgeon has occurred to various degrees in the LMR since the 1800s. Harvest has been closed for over two decades in the Arkansas, Mississippi, and Louisiana reaches of the LMR; however, harvest of shovelnose sturgeon for caviar had increased in the LMR reaches of Tennessee and Missouri, and migrating pallid sturgeon were subject to harvest in Kentucky and Illinois. Based on data that indicated significant numbers of mature female pallid sturgeon 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), FWS listed the shovelnose sturgeon within the sympatric range of pallid sturgeon as threatened due to similarity of appearance (US Fish and Wildlife Service 2010). This action effectively eliminated the loss of pallid sturgeon to commercial caviar harvest in the LMR and Middle Mississippi River.

Dredge Entrainment: Maintenance dredging of the navigation channel is required in the LMR navigation channel, particularly within crossovers and harbors at low river stages. Dredging has been shown to take shovelnose sturgeon in the Middle Mississippi River (MMR), suggesting some level of take of pallid sturgeon may be occurring through dredge entrainment in the LMR. However, risk may be reduced due to the larger channel and complexity of the LMR compared to the MMR. Furthermore, entrainment risk varies depending on type of dredge (cutter head, hopper, mechanical), the habitat being dredged, and size-dependent swimming capability of sturgeon (Hoover et al. 2009; Hoover et al. 2011).

Channel maintenance dredging locations are mapped by the COE and are considered relative to all locations where priority species occur and their seasonal habitat use. Spawning and early rearing habitats of sturgeon are protected by seasonal restrictions of dredging. Telemetry monitoring of sonic-tagged pallid sturgeon in the LMR by FWS/USGS has shown occasional seasonal use of crossovers by large size classes of pallid sturgeon, however, pallid sturgeon telemetry relocations are also most

frequently associated with water depths greater than six meters (18 ft), well below the authorized depth of the CIP (Kuntz and Schramm 2012).

Although mussels can be subject to dredge entrainment, habitats where fat pocketbook mussels have been found in the LMR are not subject to dredging, and dredge entrainment is not considered a threat to fat pocketbook in this system.

Dredging near nesting sandbars can disrupt Interior least tern nesting activities. The COE maps Interior least tern nesting sites and maintains 1500 foot buffers between dredge sites and nesting sandbars during nesting season.

Sand and Gravel Mining: Regulatory branches of the COE issue permits for sand and gravel mining dredging in the LMR. The FWS has expressed concerns that permitted commercial mining dredges in the Mississippi River can entrain endangered pallid sturgeon and degrade gravel bars where sturgeon spawn. Following concerns expressed by FWS, the COE agreed to monitor location, frequency, and size and quantity of material extracted under these permits. In addition, ERDC conducted multiple studies on sturgeon susceptibility to sand and gravel dredges (ERDC-EL 2009) and provided the following information:

1) A chronology of sturgeon life history stages was compiled by sampling the temporal occurrence of larvae, juvenile, and adults using Missouri trawls. Application of these data can establish operating windows when dredges would have minimal impacts on spawning adults and young-of-year.
2) Entrainment of sturgeon was directly assessed during dredging operations by sampling dredged material and overflow, and field sampling for sturgeon in the vicinity of an active dredge. No sturgeons were collected.
3) Measurements of swimming performance by different size-classes of sturgeon were conducted and compared to suction velocities created by dredges. Data provided quantitative assessment of risk for young-of-year sturgeon of different sizes.

An initial survey of gravel bars in the LMR was conducted by ERDC (D. Biedenharn and M. Corcoran) and maps developed of their locations. Further potomological studies are necessary to fully evaluate effects of sand and gravel dredging on priority species. Currently, special conditions are applied to the permits to avoid potential impacts to the priority species and can be modified as new information becomes available.

Control Structure Entrainment: Entrainment of pallid sturgeon 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. The COE has consulted with the FWS 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 pallid sturgeon at the two planned structures (U.S. Fish and Wildlife Service 2009a, 2009b, 2010). Emergency consultations for Morganza and New Madrid floodways that were operated during the 2011 flood were also completed

(U.S. Fish and Wildlife Service in litt. 2011). The COE and FWS need to complete formal consultations over entrainment of this species at Davis Pond, Caernarvon, ORCC, and other proposed structures. Entrainment studies at lower Mississippi River diversions, excluding ORCC but including Bonnet Carre and Davis Pond, have been completed by ERDC. The final report will document sturgeon entrained through existing diversions, document sturgeon occurring in the Mississippi River near the vicinity of existing diversions, and present population viability models for risk analysis. Results of these studies will be used to quantify entrainment of pallid and shovelnose sturgeon at diversions over the project life. Localized entrainment losses must be weighed against population size and recruitment levels of pallid sturgeon throughout the LMR. COE is working to identify engineering designs to minimize entrainment losses through water control structures and will consider a rescue and recovery effort to minimize population impacts of floodway operations.

Pollution and Contaminants: Pesticides and heavy metals have been detected in the tissues of sturgeon throughout the United States and could potentially affect all three priority species to varying degrees. These contaminants cause reproductive failure and population declines, and pose potential health risks to consumers of sturgeon meat and caviar. 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 and Keenlyne 1993), suggesting that contaminants could impact pallid sturgeon to some degree. Historical and recent water quality data for the LMR needs to be analyzed to determine the significance and trends of pollution and contaminants in the LMR.

Hydrokinetics: Applications have been made to utilize the LMR for power generation using hydrokinetic technology. Effects of hydrokinetic turbines on pallid sturgeon are currently undefined; however, there is potential of injury or mortality from turbine blade strikes, as well as potential behavioral effects due to electromagnetic fields and noise. COE Mississippi River fishery data, as well as FWS/USGS telemetry data are being used by hydrokinetic developers to identify potential impacts to pallid sturgeon and other fish resources. Interior least tern and fat pocketbook mussels are unlikely to be directly affected by hydrokinetic turbines, however, infrastructure siting has the potential to affect these species or their habitats.

Hybridization of Pallid and Shovelnose Sturgeon: Hybridization with shovelnose sturgeon has been identified as a threat to pallid sturgeon in the LMR. This hybridization was initially believed to be caused by a loss of species isolating mechanisms due to river engineering and habitat modifications. However, neither the mechanisms nor the essential habitat features have been identified. There is morphological and genetic evidence that some proportion of these "hybrids" are morphological variants of both species and have been misidentified due to allometric growth of pallid sturgeon (Murphy et al. 2007). There is also evidence that morphological variation interpreted as hybridization existed in LMR sturgeon populations prior to, and may be unrelated to, significant regulation of the LMR (Hartfield and Kuhajda 2009). Ongoing genetic and morphological studies are designed to improve and standardize identification of river

sturgeon in the LMR, and determine the significance and possible trends of hybridization as a threat to pallid sturgeon in the LMR (U.S. Fish and Wildlife Service *in litt*. 2011).

Habitat Model

"Terrestrialization" of habitat (i.e., loss of secondary channels and seasonally flooded habitats) is considered to be a primary threat to pallid sturgeon, least tern, and fat pocketbook mussel populations. An analysis of habitat quantity, quality, and trends is required under the ESA (Factor A) to determine whether a species may require protection. A similar analysis is required to determine whether a species' status has improved or declined. The Factor A listing analyses for pallid sturgeon and least tern in the LMR lacked this consideration, primarily because few historical records of the species existed for this portion of their range at the time of listing. The LMR was not considered under the Factor A analysis for the fat pocketbook mussel because the species was not historically known to occur in this river.

COE has since conducted an analysis of sandbar habitat available to Interior least tern in the LMR (COE 1999, 2008), and is in the process of quantifying changes in shallow water habitat depth complexity, and changes in secondary channel over time (Keevin in progress). A detailed analysis, incorporating information about habitat use by pallid sturgeon, Interior least tern, and fat pocketbook mussel in the LMR will be developed to identify management strategies and to track and forecast habitat trends and species responses to management. ERDC and the COE Mississippi Valley Division and its Districts have developed a GIS mapping system that identifies sturgeon and fat pocketbook mussel collection localities, and Interior least tern nesting areas relative to bathymetry and channel control structures. This technology is currently used to avoid or minimize potential impact from channel maintenance and other river regulation activities. As more data are acquired, habitat use information and known habitat areas will also be used to define a suite of habitat use indicators (i.e., islands, secondary channels, seasonally inundated shallow water, and depth, frequency, or duration of flow) that can be sensed remotely or generated through hydrologic modeling. Maps, aerial photography, and/or hydrological data will be used to determine extent of habitat indicators by reach and through time. A detailed analysis of historical and current habitat information and knowledge of habitat use by pallid sturgeon, Interior least tern, and fat pocketbook mussel in the LMR will be periodically conducted by FWS. The results will be used to track the status of these three priority species in the LMR, identify and help implement habitat management strategies, and forecast habitat trends and species responses to management.

Conservation Design

Development of the Mississippi River for year around navigation and flood protection has resulted in a general decrease of channel habitat complexity in the LMR (e.g.,

Williams and Clouse 2004). Long-term conservation of the three priority species, as well as other components of the channel ecosystem, requires a multi-partner and multi-faceted scientific approach utilizing water and sediment to maintain and enhance aquatic habitat complexity, particularly associated with secondary channels and seasonally flooded habitats. Under the CIP, water and sediments are manipulated through channel engineering in order to maintain flood protection and a safe and efficient 9' x 300' navigation channel in the LMR from Cairo, Illinois, to Baton Rouge, Louisiana. Channel engineering, including channel structure maintenance, therefore, provides opportunities to utilize flows and sediments to improve or restore in-stream habitats outside of the navigation channel at little to no extra cost, and without impacting navigation activities or flood control. For example, more than 200 dike notches and 200 hard points (an alternative to bank paving) have been constructed in the LMR since 2000. Several restoration projects unrelated to navigation, have been designed by the COE, funded by state and federal partners, and constructed by private contractors. Restoration projects constructed in recent years include weirs to prevent dewatering of floodplain oxbow lakes and channels, and retrofitted dike notches to restore flow through more than 20 miles of secondary channel habitat. This collaborative approach to using the CIP and O&M as primary tools to manage and conserve the LMR ecosystem by the COE, FWS, and LMRCC, along with a better understanding, mapping, and avoidance of important habitat areas has resulted in significantly improved habitat for the pallid sturgeon, Interior least tern, fat pocketbook mussel, as well as numerous other wetland-dependent species.

Decision support tools: The LMRCC MRCI conducted state-level planning meetings to identify ~220 potential aquatic habitat restoration projects within the LMR leveed floodplain. The ERDC has developed a Decision Support Model (DSM) that prioritizes these projects based on their ecological significance, as defined by habitat scarcity and rarity, degree of connectivity, and benefits to priority species. This tool is used to identify areas where aquatic habitat restoration projects with a high ecological benefit can be cost-effectively constructed. The recently initiated LMRRA watershed feasibility study will add to our body of knowledge and help support future decisions.

Priority areas: Natural backwaters and secondary channels have been identified as priority areas. Twenty eight maps have been developed showing ~220 priority restoration opportunities in the LMR (LMRCC 2005). An index was developed to rank the habitat value of secondary channels that could be targeted for restoration and identify select secondary channels that are minimally disturbed and suitable for conservation (Killgore et al. 2012). Maps of gravel bars have been produced as a first step to avoid and minimize impacts to these important sturgeon spawning habitats. Further investigations are needed to determine the quality and stability of gravel bars in the LMR.

Habitat objectives: Rehabilitate secondary channels and their associated islands and natural backwater areas including the provision of depth and water velocity heterogeneity by notching closing dikes; restore in-channel and channel border habitat diversity by notching dikes, constructing hardpoints to preserve natural bank vegetation, and constructing chevrons to increase hydraulic diversity in homogenous sandbar habitat; increase habitat value, availability, and connectivity for priority species.

Conservation Delivery

There is little funding available for direct habitat restoration work or species monitoring in the LMR. Therefore, existing programs are being used to identify appropriate conservation actions and new partnerships are formed to implement those actions. These include:

COE Channel Improvement (CIP), Operation and &Maintenance (O&M)Programs: Annually the COE invites State and Federal natural resource biologists familiar with river-dependent species, multiple-use management of the LMR, and commercial navigation to meet and review proposed CIP and O&M actions for the year as well as out years, and identify conservation actions that can be incorporated into COE channel maintenance activities. COE has developed and periodically updates a Mississippi River Channel Improvement Master Plan which shows constructed and proposed channel training features, as well as environmental improvement features, and priority species locations.

Endangered Species Act: COE and FWS conduct formal and informal consultations under the ESA on COE LMR projects and identify conservation opportunities that can be cost-effectively incorporated into channel improvement or maintenance projects.

Lower Mississippi River Conservation Committee (LMRCC): The LMRCC develops site-specific partnerships comprised of the COE, FWS, state natural resource conservation agencies, and non-governmental and philanthropic organizations to construct high priority aquatic habitat rehabilitation projects (e.g., secondary channel restoration). For example, potential habitat enhancement projects unrelated to maintenance of the commercial navigation channel are identified by LMRCC; designed by the COE engineers; funded by a coalition of Federal, state, philanthropic, and nongovernmental (NGO) partners; and, constructed by private contractors. These projects raise the habitat and environmental base-line of priority species, offsetting and mitigating actions which may be essential to flood control and the maintenance and safety of the LMR commercial navigation channel.

Mississippi River Conservation Initiative: Under this program LMRCC brings together multiple stakeholders to identify rehabilitation projects and resource use (e.g., public access points) opportunities in the LMR.

Mississippi Interstate Cooperative Resource Association (MICRA): MICRA's Paddlefish/Sturgeon Committee was formed in 1992 to address the needs of paddlefish and sturgeon species inhabiting the Mississippi River Basin, and to provide guidance for their future management. The specific goals of MICRA relating to sturgeon include developing a basin-wide information management system and facilitating basin-wide conservation, protection, and restoration of paddlefish and sturgeon habitats.

Lower Mississippi River Resource Assessment (LMRRA): A LMRRA feasibility study is underway to compile river-related data and information and identify restoration measures collaboratively with federal, state, and non-governmental agencies.

Monitoring and Research

The success of LMR SHC depends upon interagency coordination, cooperation, and funding, as well as private sector and NGO partnerships. Although current funding levels are insufficient to monitor immediate responses to channel engineering, long-term habitat and species responses and trends will become apparent through channel bathymetry monitoring and on-going/proposed biological studies. Monitoring and research actions and needs include:

Targeted research: Limited research on pallid sturgeon and fat pocketbook mussel is on-going. ERDC, utilizing funding supplied by the COE Districts and Mississippi Valley Division, has been conducting studies on pallid sturgeon in the LMR for more than ten years. FWS has conducted cursory surveys for fat pocketbook mussel during low water stages. These efforts have shown that the these two species are more widely distributed in the LMR than previously believed; there are differences in size and abundance of pallid sturgeon between discrete reaches of the LMR; the pallid sturgeon population is recruiting in the LMR; and, the population is experiencing low mortality rates. These results are supported, in part, by collections from the Atchafalaya River (Louisiana Department of Wildlife and Fisheries, FWS) and the Arkansas reach of the LMR (Arkansas Game and Fish Commission, USGS, Mississippi State University (MSU)) that indicate the LMR pallid population is relatively young and recruitment is occurring. A 5-year telemetry study funded by Louisiana Hydroelectric, FWS, and USGS is being conducted in the Atchafalaya and Mississippi Rivers to determine seasonal movements and habitat associations. ERDC is conducting research and compiling data to develop a Population Viability Analysis of pallid sturgeon in the lower reach of the LMR, as well as evaluating chronology and habitat use of young-of-year sturgeon, monitoring benefits of secondary channel restoration, and completing a three-year study of pallid sturgeon entrainment through water control structures. The FWS is funding/coordinating research efforts to: 1) improve identification of sturgeon in the LMR; 2) provide information on sturgeon hybridization levels and trends; and 3) determine the range of the fat pocketbook mussel in the LMR.

Targeted research needs include: quantification of pallid sturgeon and fat pocketbook mussel population demographics and recruitment; identification of seasonal movements and habitat use by pallid sturgeon including utilization of restored habitats (secondary channels, dike fields with notches, chevrons, hard points, bend way weirs); entrainment studies of pallid sturgeon at the ORCC and other water and sediment diversion structures in the LMR; characterization of fat pocketbook mussel habitat in the LMR; nesting success of Interior least tern; development of a metapopulation model and a statistic based monitoring program for Interior least tern and pallid sturgeon; and habitat and threat trend analyses in the LMR for all three species.

Monitoring: The COE Memphis District and Mississippi Valley Division have been monitoring least tern nesting areas for more than two decades. Sufficient population data to monitor pallid sturgeon and fat pocketbook mussel response to management do not yet exist. Monitoring needs for these species include: development of a statistically sound range-wide survey design for Interior least tern; development of methodology to monitor population trends of pallid sturgeon and fat pocketbook mussel; and, development and implementation of methodology to monitor habitat response to conservation-related channel engineering activities (e.g., site specific bathymetric surveys). Monitoring programs must be developed collaboratively by river partners to ensure standardization of data collection for wide applicability and evaluation of recovery criteria for eventual down- or de-listing of the species if appropriate.

Feedback Loop: Information gathered through channel monitoring and priority species research and monitoring will be used to adapt/improve river engineering and other river regulation activities to avoid or minimize impacts to listed species and improve their habitat and population base-lines in the LMR. Information generated by research and monitoring of priority species population abundance, demographics, habitat associations, and behavior will be incorporated into species base-lines during annual partnership meetings, as well as during formal and informal consultations between COE and FWS. For example, 1) large gravel bars have been assigned a high priority for research and protection because pallid sturgeon larvae have been consistently collected below them and they are assumed to function as spawning substrates; 2) identification of entrainment of pallid sturgeon through water control structures has led to collaborative efforts to quantify entrainment, formal consultations permitting potential take, the development of conservation measures to reduce the potential for entrainment, and recovery efforts at Bonnet Carre; 3) telemetry results have been used to provide insight into the possible effects of timing and location of channel maintenance activities on pallid sturgeon habitat use; 4) least tern nesting survey data have been used in the dike maintenance program to protect and improve nesting sites; and 5) identification of secondary channels occupied by fat pocketbook mussel has been used to modify in-channel and levee construction projects and improve methods to avoid/reduce impact to the species. New information is considered during annual meetings between all cooperating partners and agencies and data gaps/needs are collaboratively identified and prioritized.

This collaborative approach to management and conservation of the LMR has significantly improved the scientific knowledge base of the three priority species; improved habitats for them and numerous other game and nongame species; provided substantial savings of conservation and channel maintenance funding, and converted the primary threats identified for all three species into tools to conserve the species. Continued interagency trust and cooperation are integral to fully implementing the LMR Strategic Habitat Conservation Plan and to ultimately achieve the conservation goals of all agencies involved in the Partnership.

This strategic conservation plan does not obligate any party to undertake specific tasks and may not represent the views nor the official positions or approval of any individuals or agencies involved in developing the plan, other than the U.S. Fish and Wildlife Service.

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