MISSOURI RIVER
SHALLOW WATER HABITAT
REPORT FOR 2004

Executive Summary

The Endangered Species Act (ESA) requires that the U.S. Army Corps of Engineers (Corps), in coordination with the appropriate resources agency, will ensure that any action authorized, funded, or carried out is not likely to jeopardize the continued existence of any federally listed threatened or endangered species or result in the destruction or adverse modification of critical habitat. Formal consultation between the U.S. Fish and Wildlife Service (FWS) and the Corps under Section 7 of the ESA culminated with the "Biological Opinion on the Operation of the Missouri River Main Stem System, Operation and Maintenance of the Missouri River Bank Stabilization and Navigation Project (BSNP), and Operation of the Kansas River Reservoir System" (Opinion), dated November 30, 2000. The Opinion concludes the existing operation of Missouri River Main Stem System (System), the maintenance and operation of the BSNP and operation of the Kansas Reservoir System jeopardizes the existence of the endangered interior least tern and pallid sturgeon and the threatened piping plover. It also concluded an incidental take of bald eagles.

On December 16, 2003, and in response to the Corps' request for the reinitiation of consultation, the FWS issued an amendment to its 2000 Biological Opinion (2003 Amended BiOp). The FWS determined that the 2000 Biological Opinion reasonable and prudent alternative (RPA), modified by the omission of flow changes and the addition of the proposed new RPA elements, will continue to avoid jeopardizing the continued survival and recovery of the Interior least tern and the Northern Great Plains population of piping plovers. With respect to the pallid sturgeon, the FWS determined the Corps' actions continue to appreciably reduce the likelihood of both survival and recovery of the species, thus jeopardizing the continued existence of the pallid sturgeon. The 2003 Amended BiOp includes RPA Section VII.1.a., which calls for a low summer release from the System of 25,000 cubic feet per second (cfs) each year beginning no later than July 1 and lasting for a minimum of 30 days. RPA Section VII.1.b provides that when approximately 1,200 acres of new shallow water habitat has been made available above that which currently exists between Sioux City and Omaha (approximately the amount that would be developed through flow management) the Corps, in consultation with the FWS, may modify flows to take advantage of that habitat and more fully meet project purposes.

Since the receipt of the 2003 Amended BiOp, the Corps has been working with the FWS on plans for near-term SWH development sufficient to implement Section VII.1.b of the 2003 Amended BiOp. In a letter dated February 13, 2004, the Corps provided new information to support a request that the 1,200 acres of new SWH development be applied from Ponca State Park to the mouth of the Osage River, rather than limiting SWH development to the Sioux City to Platte River reach identified in the 2003 Amended BiOp. The FWS evaluated this request and concurred in a letter dated March 5, 2004.

A list of potential sites suitable for SWH development were originally selected by the Corps based on a number of criteria including: meeting the SWH definition in the 2003 Amended BiOp; land ownership; ability to comply with the National Environmental Policy Act, Section 404 of the Clean Water Act, and Section 10 of the Rivers and Harbors Act of 1899; logistics of awarding a contract;

logistics of Corps in-house crews being able to work at the site before July 1; and cost per acre of return on the created habitat. The Corps' original list was vetted with the FWS, the Department of Agriculture's Natural Resource Conservation Service, and the states of Iowa, Kansas, Missouri, and Nebraska in a January, 2004 meeting. The FWS and States also offered additional sites where work might be possible. The list was vetted one final time with the FWS and then within the Corps, particularly with the river engineers to ensure feasibility of the proposed work. It was recognized by both agencies that the list was not necessarily complete, as some sites might be added as opportunities presented themselves and that some sites might drop out. The FWS agreed that the list provided in the March 2, 2004, letter identified a sufficient number of potential sites generally suitable for the purposes of implementing RPA Section VII.1.b.

The FWS March 5, 2004, letter also provided further technical guidance on the characteristics of SWH to assist river engineers and biologists in developing pallid sturgeon habitat. FWS also provided technical guidance for and supported the use of notching dikes as a means to diversify aquatic habitat. This technical guidance was utilized as SWH plans were developed and constructed.

Corps' projects designed to create SWH include bank, dike, and revetment notches, dredging to widen the existing channel and to connect backwater areas, creation of pilot channels and chutes, and major dike modifications. Notching was begun as early as 1975 in an effort to halt the accretion process that was narrowing the topwidth of the river and in an effort to improve the aquatic habitat of the river. The four main types of notches the Corps is using in development of SWH for 2004 include revetment notches, bank notches, dike notches and type B notches. A notch serves to increase the percent time that flow occurs through a particular section of the dike. Most notched dikes have an elevation of between +1 and +3 construction reference plain (CRP). At these elevations the dikes are overtopped approximately 50% to 20% of the time. Thus, 50% to 80% of the time the dike cuts off all flow from upstream to downstream. In order to increase the percent of time of flow through a section of the dike, a notch cut to –4 CRP will have some flow through the notch up to 95% of the time. This effectively creates SWH for a broader range of flows. The length and depth of the notch must take into consideration that too much flow through the notch could reduce the effectiveness of the dike.

The following discussion describes in more detail the types of projects the Corps is constructing to develop a minimum of 1200 acres of SWH for the benefit of pallid sturgeon. The suitability of this newly created SWH will be maximized with releases equal to or higher than full service. Accordingly the Corps is proposing to operate consistent with the 2004 AOP dated March 19, 2004, based on meeting the provisions of Section VII.1.b. of the 2003 Amended Biological Opinion.

BANK NOTCHES. These are 75' wide notches excavated to –5 construction reference plain (CRP) constructed entirely landward of the high bank. These notches are constructed in straight out dikes or L-head dikes using land-based equipment. Bank notches have numerous immediate and long-term benefits for the pallid sturgeon.

The immediate benefits include the creation of a secondary channel adjacent to the high bank. Water enters from the upstream notch and flows along the bank through the downstream bank notches. Deposition will occur riverward of the secondary channel resulting in sandbar formation and shallowing of the area between the dikes. The resulting habitat has greater depth and velocity variation than the pre-notch condition. In addition, the excavated overbank will erode and create a more dynamic alluvial process within the dike field. Also, the cleared vegetation disposed of in the river

during construction, along with trees falling into the river as the bank erodes, will provide structure for benthic organisms.

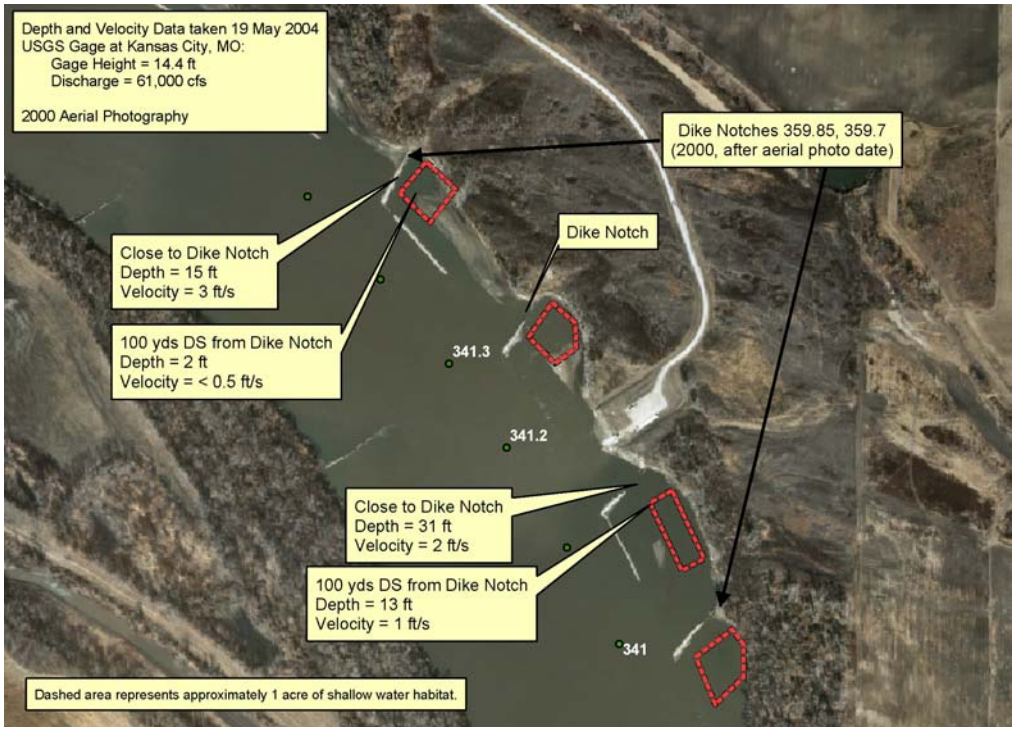
The long-term benefits are fairly rapid erosion of the high bank and widening of the top-width of the river. As the river widens, the total amount of aquatic habitat available is increased and sandbar formation within the dike field increases in a riverward direction. The following figure illustrates the erosion that will occur downstream of a bank notch.

Based on analysis of past and current bank notching efforts, one bank notch will create between 4 and 6 acres of diverse shallow water habitat. The Corps will construct 75 bank notches creating between 300 and 450 acres of diverse shallow water habitat. Fifty notches are completed and an estimated 25 notches will be constructed between June 7 and June 30.

DIKE NOTCHES. These notches range in width between 50' to 100' and are excavated to either –4 or –5 CRP. These notches are excavated along the river portion of the dike between the high bank and no more than half-way out on the dike.

As with a bank notch, dike notches have immediate benefits. These notches improve the depth and velocity diversity upstream and downstream of the dike by allowing a portion of the river flow to flow within the dike field. As the flow spreads out downstream and riverward of a notch, the velocity slows down creating a high degree of velocity variability. In addition to the increased velocity diversity, a deep scour hole will form immediately downstream of a notch and deposition will generally occur further downstream and riverward from the notch increasing the depth diversity. The result is an area with a high degree of depth and velocity diversity upstream and downstream of the notch.

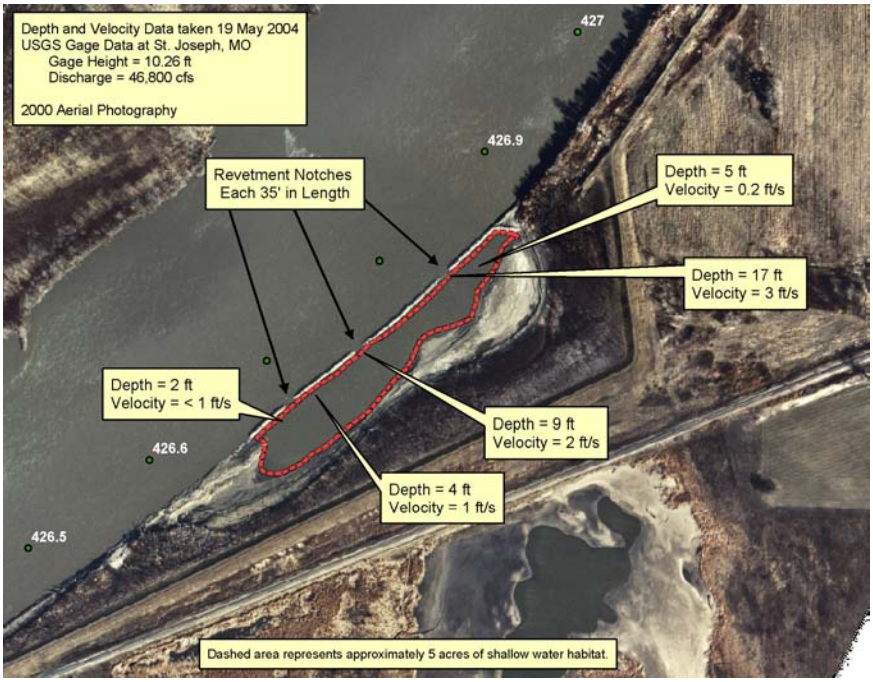
The following figure illustrates the depth and velocity diversity resulting from a series of notches constructed in dikes by Cooley Lake. Depth and velocity data was collected May 2004 at low navigation stages. Red squares represent one acre of shallow water habitat.



Based on analysis of past and current notching, a 50' dike notch will create one acre of diverse shallow water habitat and a 100' notch will create two acres of diverse shallow water habitat. The Corps will construct 427 dike notches ranging from 50' to 100' wide resulting in approximately 492 acres of SWH. Currently 313 dike notches are completed and an estimated 114 notches will be constructed by June 30, 2004.

REVETMENT NOTCHES: These notches are cut in stone fill revetments at locations where a slack water pool is separated from the main channel by a stone fill revetment. Without notches in the revetment, these aquatic areas are poorly connected to the main channel at normal summer flows, and therefore, have little to no flow and no velocity diversity. These notches range in width between 50' to 100' and were excavated to either –4 or –5 CRP. In most cases notches were cut at the upstream and downstream end of the pool to maximize the effects of the notches.

A revetment notch increases the connectivity of the slack water pool with the main channel. The increased connectivity increases the flow in the slack water area, which increases the velocity diversity and increases the depth diversity of the area. The following figure illustrates the increased connectivity and depth and velocity diversity that results from revetment notches. Depth and velocity data were collected during May 2004 at low navigation stages.



Based on analysis of past and current revetment notching efforts, a 50' revetment notch will create one acre of diverse shallow water habitat and a 100' revetment notch will create two acres of diverse shallow water habitat. There are 91 revetment notches ranging from 50' to 100' that are estimated to create 118 SWH acres. Currently 82 of these notches are completed and an estimated 9 notches will be constructed by June 30, 2004.

TYPE B NOTCH. Type B notches were constructed in the reach from Sioux City, Iowa to Rulo, Nebraska (BiOp Segments 12 and 13). Type B notches were constructed in a total of 48 dikes (6 bends) in Segment 12, and a total of 75 dikes (6 bends) in Segment 13. Type B notches were monitored both qualitatively and quantitatively.

During these inspections erosion was observed, trapping of large woody debris was noted and the change in surface flow patterns between modified and unmodified dikes was readily seen. The extent of the effect ranged from one notch width to several notch widths in the downstream direction, depending on the length of the exposed dike and the angle of the dike to the direction of flow. Quantitative assessments were made using pre-and post construction surveys. Depth diversity and bankline irregularity were increased over an area of roughly two acres per notch. It is important to note that the diversity changes extended to the limits of the survey, so it is reasonable to assume that the changes extend beyond the surveyed area. The following figure shows typical depth diversity in the vicinity of a type B notch. Considering the above information, and information contained in the 2003 Amended Biological it is likely that each type B notch would provide 1-2 acres of SWH. There are a total of 124 type B notches that are estimated to result in 124 to 248 SWH acres.

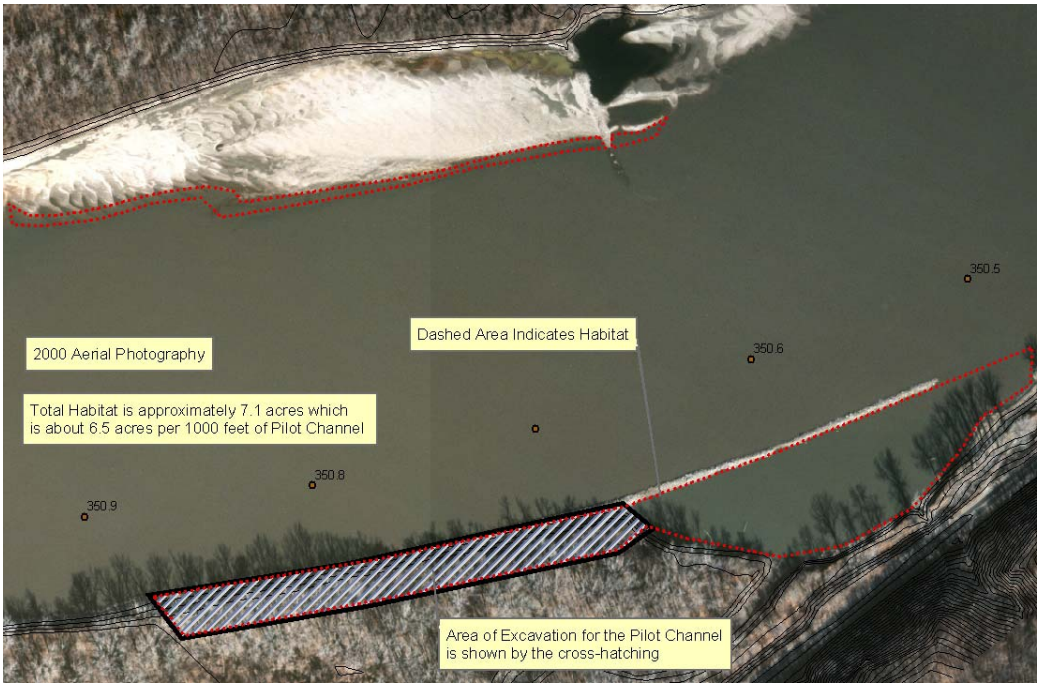
DREDGING. During the Spring of 2004, there are four backwater areas to be dredged in the Missouri River from Ponca State Park to Blair, Nebraska: California Bend, Soldier Bend, Tyson Bend and Ponca. All of the backwater dredge areas are under construction and will be completed by July 1, 2004. The estimated shallow water habitat from the dredging projects is 135 acres.

Habitats created from dredging operations fall into two primary categories. Dredging in chute habitats (Secondary Channel Connected) such as the projects at California Bend, Soldier Bend and Tyson Bend result in channel widening; whereas the dredging operations at sites such as Ponca result in the formation of a backwater (Secondary Channel Non-Connected) habitat or re-connects a backwater habitat restoring connectivity back to the river. Biological benefits of channel widening (chutes) include the enhancement of a range of depths and velocities available to native river species, provides connectivity to the floodplain, provides off-channel habitat for spawning and promotes the erosive processes (i.e., sediment and woody debris) resulting in enhanced ecosystem diversity and function. The following picture is looking upstream at the California Bend with construction nearly complete.

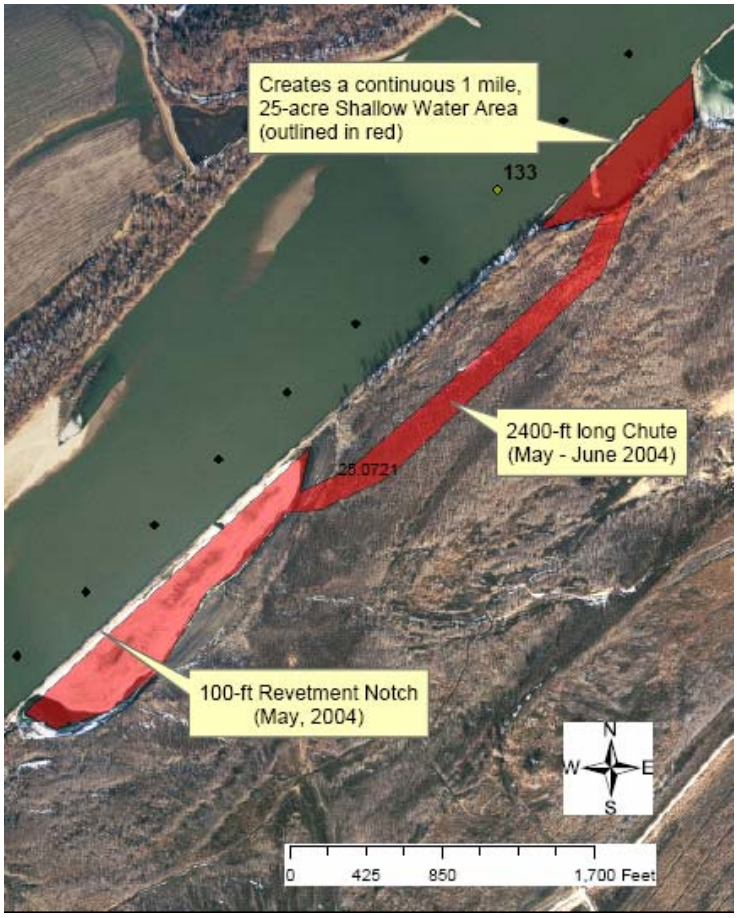
Backwater (Secondary channel non-connected) areas developed through dredging such as the Ponca Project increase connectivity to the floodplain, provide diversity in temperature, velocity, increased nutrient load resulting in increased energy necessary for invertebrates and native fish species while restoring functionality to the ecosystem. The following picture is the Ponca project looking southwest at the dredge area and the emergent sandbar habitat being created.

PILOT CHANNELS. Pilot channels are trenches excavated immediately landward of a stone fill revetment. Pilot channels have at least a 50' bottom width and range between 1000' and 2400' in length. By excavating the overbank, pilot channels have the immediate effect of increasing the amount of available shallow aquatic habitat. This desirable habitat will be immediately adjacent to and highly connected to the main channel. In addition, the excavated overbank and woody debris disposed on the riverside of the revetment will provide additional habitat as the organic matter is washed into the river. Pilot channels are in general located upstream of slack water off-channel pools so that the flow through the pilot channel will flow into the pool and diversify the habitat of the pool.

It is expected that by the first of July, the pilot channels will erode to a topwidth of 100'. The result will be 2.3 acres of aquatic habitat per 1000' of pilot channel. In addition, the increased diversity of the pool area downstream of a pilot channel and the deposition in the dike field across the river will result in an additional 1.7 acres of aquatic habitat per 1000' of pilot channel. The net effect is the creation of 4 acres of shallow water habitat per 1000' of pilot channel. The following picture shows area of improved aquatic habitat as a result of pilot channel construction at Liberty Bend near river mile 350. It is estimated that constructing approximately 11,000 feet of pilot channels will create approximately 44 acres of SWH.



CHUTES. Chutes are trenches excavated entirely within the overbank and connected to the river at the entrance and the exit. The secondary channel increases the total amount of aquatic habitat available. During normal summer flows, the flow in the chutes will be shallow and slow with a high degree of diversity. The chute bottom will be very dynamic with a sandy substrate. The following picture shows the area of improved aquatic habitat as a result chute construction at Smokey Waters. A total of 78 acres of SWH will result due to the construction of chutes.



MAJOR DIKE MODIFICATIONS. Major dike modifications consist of lowering a large portion of the riverward ends of the dikes and construction of a chevron structure between approximately every pair of lowered dikes. This type of modification is placed at 6 bends in the river. The dike lowering will allow the high bank to erode an amount approximately equal to the amount the dike is lowered into the high bank. The chevrons will perform two functions. First, the chevrons will create an area where sediment can accumulate in and adjacent to the main channel. The second function is to force a portion of the flow against the high bank, thus facilitating the erosion process. The erosion process adds to the top width of the river, adds large woody debris to the main channel, and provides for a slight increase in the amount of sediment available for alluvial processes. The combination of these two effects leads to a greater diversity of depths and velocities through the bends. The following picture is a chevron and sandbar at RM 555.0 approximately 6 weeks after construction.

Qualitative analysis of these modifications indicates the erosion process leading to a greater diversity of depths and velocities can occur very quickly. During the joint inspection conducted on April 27, 2004, pre-construction depths in Snyder and Winnebago Bends were 17-20 feet. Chevrons were constructed on April 28-30. During the joint inspection conducted on May 4, 2004, depths of 2-6 feet were observed in the same area under similar discharge conditions. These changes were further verified during the joint inspection on June 2-3, 2004. Based on all of the information available on this type of modification, the increase in SWH is 8-15 acres per mile of modification. As of July 1, 2004, construction of 85 lowered dikes and 40 chevrons will result in an estimated range of 130 to 246 acres of SWH.

SUMMARY OF SWH CONSTRUCTION. The Corps has developed SWH by modifying the existing channel and bank stabilization structures. As described above, this work has included bank, dike, and revetment notches, dredging to widen the existing channel and connect backwater areas, creation of pilot channels and chutes, and major dike modifications. While these modifications will effectively operate over a wide range of flows, it is important to understand that these modifications have been designed to function most effectively in creating shallow water habitat at or near service level flows in order to meet all project purposes. The technical engineering studies conservatively estimate that as of July 1, 2004, the Corps will have created between 1420 and 1810 acres of shallow water habitat since the issuance of the 2003 Amended Biological Opinion. The following table summarizes SWH by structure type.

Summary Table SWH Acres		
Structure Type	Minimum Acres	Maximum Acres
Bank Notches	300	450
Dike Notches	492	492
Revetment Notches	118	118
Type B Notches	124	248
Dredging	135	135
Pilot Channels	43	43
Chutes	78	78
Dike Modifications	130	246
TOTAL SWH ACRES	1420 Minimum	1810 Maximum

CONCLUSION

Section VII.1.b. of the Amended Biological Opinion provides that when approximately 1,200 acres of new shallow water habitat has been made available above that which currently exists between Sioux City and Omaha (approximately the amount that would be developed through flow management) the Corps, in consultation with the Service, may modify flows to take advantage of that habitat and more fully meet project purposes.

As addressed in the Corps' letters dated February 13 and March 2, 2004, the Corps believes that based on new information, it is biologically warranted for the benefit of the pallid sturgeon, to extend the geographic reach of the 1,200 acres of new shallow water habitat set forth in the 2003 Amended Biological Opinion, from Ponca State Park to the mouth of the Osage River. The information provided included engineering analysis of current shallow water habitat deficiencies, biological studies of the drifting phase of pallid sturgeon, population assessment sampling below the Platte River, and sampling within the Platte River itself. The FWS letter of March 5, 2004, evaluated the information and concurred in the modification of the geographical reach of river for habitat development in Section VII.1.b.

The Corps is developing over 1,200 acres of shallow water habitat by modification of the existing channel and bank stabilization structures from the Ponca State Park to the Osage River. As described above, this work has included bank, dike, and revetment notches, dredging to widen the existing channel and to connect backwater areas, creation of pilot channels and chutes, and major dike modifications. These modifications will effectively operate over a wide range of flows, however, they will perform most effectively for pallid sturgeon shallow water habitat with discharges approximately equal to or slightly higher than full service.

The Corps' technical engineering studies conservatively estimate that as of July 1, 2004, between 1420 and 1810 acres of shallow water habitat will have been created since the issuance of the 2003 Amended Biological Opinion. This shallow water habitat meets the criteria discussed in the 2003 Amended Biological Opinion and further described in the FWS March 5, 2004, letter to the Corps. Over time, flows that meet all project purposes are expected to increase the effectiveness of these structural modifications and further expand the amount of shallow water habitat already created as well as increase the biological productivity of these sites.

The Corps is proposing to operate in accordance with the 2004 AOP dated March 19, 2004, based on meeting the provisions of Section VII.1.b. of the 2003 Amended Biological Opinion. The AOP provides for releases of 30,000 cfs in July and August to meet flow targets as downstream tributary flows decline, but as noted in the AOP, actual releases will be dependent on the hydrologic conditions existing at that time. Should the tributary flows drop below the high run-off flows experienced in early May, the Corps will consider increasing the Gavins Point Dam releases to more than 30,000 cfs. However, if wet conditions persist downstream of Gavins Point Dam, releases less that 30,000 cfs will be considered to meet service levels and to conserve water in the upstream reservoirs. As stated above, the releases above those described in Section VII 1.a., are intended to optimize the newly created shallow water habitat maximizing benefits to pallid sturgeon while providing for authorized purposes on the lower river.

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LIST OF ACRONYMS AND ABBREVIATIONS

Acronym/Abbreviation	Phrase
Amended Opinion	2003 Amendment to the 2000 Biological Opinion on the Operation of the Missouri River Main Stem System, Operation and Maintenance of the Missouri River Bank Stabilization and Navigation Project, and Operation of the Kansas River Reservoir System
AOP	Annual Operating Plan for the Missouri River
BiOp	Biological Opinion on the Operation of the Missouri River Main Stem System, Operation and Maintenance of the Missouri River Bank Stabilization and Navigation Project, and Operation of the Kansas River Reservoir System dated November 30, 2000.
BSNP	Missouri River Bank Stabilization and Navigation Project
cfs	cubic feet per second
CRP	Construction Reference Plane. An imaginary sloping plane from Sioux City, IA to the mouth of the river. The elevation is set at a river stage that is exceeeded 75% of the time during the eight month navigation season.
Corps	U.S. Army Corps of Engineers
EA	Environmental Assessment
EIS	Environmental Impact Statement
ERDC	Engineering Research and Development Center
ESA	Endangered Species Act
FWS	U.S. Fish and Wildlife Service
FY	Federal Fiscal Year from October 01 to September 30
HQUSACE	Headquarters, U.S. Army Corps of Engineers
IDIQ	Indefinite Delivery Indefinite Quantity (type of contract)
MNRR	Missouri National Recreational River

Opinion	Biological Opinion on the Operation of the Missouri River Main Stem System, Operation and Maintenance of the Missouri River Bank Stabilization and Navigation Project, and Operation of the Kansas River Reservoir System dated November 30, 2000.
RM	River Mile
RPA	Reasonable and Prudent Alternative
RPM	Reasonable and Prudent Measures
SEIS	Supplemental Environmental Impact Statement
SWH	Shallow Water Habitat
T&E	Threatened and Endangered
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey