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2006 Status Report

Characterization and Monitoring Data for Evaluating Constructed Emergent Sandbar Habitat in the Missouri River Mainstem

CA Duberstein
JL Downs

November 2008

Pacific Northwest
NATIONAL LABORATORY

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Pacific Northwest National Laboratory
Richland, Washington 99352

Summary

The U.S. Army Corps of Engineers (Corps) provides the primary operational management of the Missouri River Main Stem Reservoir System and is responsible under the Endangered Species Act to take actions within its authorities to conserve listed species. As a result of formal consultation, the U.S. Fish and Wildlife Service issued a biological opinion amendment (USFWS 2003) to modify reasonable and prudent alternatives to an earlier biological opinion and provide measures to minimize take/harm of the endangered interior least tern (*Sternula antillarum athalassos*) and the threatened Northern Great Plains piping plover (*Charadrius melodus*) and describe conservation recommendations that would benefit these species. In response, the Corps initiated numerous management actions to comply with the habitat restoration/creation/acquisition element of the amended biological opinion.

Historic management of the Missouri River has generally reduced the magnitude, frequency, and duration of peak river flows required to move river sediments, scour existing sandbars, and form new sandbar habitats. Emergent sandbars, an important habitat element for the interior least tern and the Northern Great Plains piping plover (*Charadrius melodus*), are non-vegetated, dynamic sandbars that form within a river channel. Least terns and piping plovers rely on emergent sandbars and non-vegetated shorelines along the Missouri River for nesting. The Corps, through the Missouri River Recovery Program initiated efforts to create new nesting habitat for these federally listed bird species and to rejuvenate existing habitat, while also monitoring breeding success and studying habitat use. Numerous entities are involved with different research aspects regarding the creation and management of emergent sandbar habitats. Investigations studying tern and plover ecology and their use of constructed emergent sandbars are ongoing as well as studies of other biota that may benefit from constructed sandbar habitat. In addition, the effects of management actions taken to maintain and enhance emergent sandbar habitat are being assessed. The objective of this document is to provide a synthesis of information gathered before and during the 2006 calendar year concerning the construction of emergent sandbar habitat, management actions taken, results of tern and plover productivity monitoring, habitat use, and other research activities directed toward use of managed habitats by non-target species.

During 2004 and 2005, sandbars were constructed in three sandbar complexes within the Gavins Point Segment along the South Dakota-Nebraska border between Vermillion, South Dakota, and Ponca, Nebraska. Additional sandbar creation began in August 2007 on three complexes at RM 791.5, near Wynot, Nebraska, and south of Vermillion, South Dakota, at river mile (RM) 774, and RM 777.5. River flows have also been managed to increase available habitat by exposing natural sandbars and low-lying shoreline habitat. In some areas, existing sandbars were treated using herbicide and vegetation removal beginning in fall 2004 and continuing during 2005-2006 to rejuvenate existing habitat. The Corps subsequently implemented monitoring of the management actions by collecting information on the quantity and quality of the terrestrial and aquatic habitat, the geomorphology of constructed habitats in relation to the river, the productivity of the target species, and habitat use of by non-target species.

Erosion and vegetation growth were observed on emergent sandbar habitat complexes following construction. Cross-sectional changes of the river channel and bank erosion were observed after a year, but long-term effects are not yet known. Modeling of shallow water habitat and river discharge has been initiated, but results are pending. Methods to use satellite imagery for sandbar habitat mapping and monitoring are being developed and results are also pending.

Surveys conducted before 2007 to evaluate wildlife use of constructed and managed sandbar habitats documented numerous fish species, turtles, and mussels using constructed sandbars and associated shallow backwater habitats. Least terns and piping plovers also utilized both constructed and rejuvenated habitats. Over half of the Gavins Point Segment tern nests occurred on constructed sandbars from 2005-2007, and piping plovers nested more often on constructed sandbars than on natural sandbars during the year following construction. Terns and plovers also nested on exposed shorelines and within sprayed and mowed sandbars. Tern and plover reproductive success, an important metric in evaluating success of these management actions, was variable. Confounding factors may be contributing to the observed variability in habitat use and nesting success, which may also be affected by factors not related to management action (e.g., local and regional climate or location-specific predation). These factors must be considered when evaluating short-term trends in reproductive success. Additional data on tern and plover habitat use, nest site characterization, behavior, and forage availability have been gathered during calendar years 2007 and 2008. These analyses and results will provide more robust information for developing adaptive management strategies.

Acronyms and Abbreviations

BiOp	Biological Opinion
cfs	cubic feet per second
Corps	U.S. Army Corps of Engineers
ESA	Endangered Species Act
ESH	emergent sandbar habitat
LIDAR	Light Detection and Ranging
MRMS	Missouri River Mainstem System
MRRP	Missouri River Recovery Program
NEPA	National Environmental Policy Act
RM	river mile
RPA	reasonable and prudent alternative
RPM	reasonable and prudent measures
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

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1.0 Introduction

Emergent sandbar habitat (ESH) in the Missouri River Mainstem System (MRMS) is an important habitat element for two federally listed bird species: the endangered interior least tern (*Sternula antillarum athalassos*) and the threatened Northern Great Plains piping plover (*Charadrius melodus*). Emergent sandbar habitats are essentially sandbars that form in the channel of the Missouri River, and the condition and availability of these habitats are important factors in determining distribution and productivity of least terns and piping plovers in the upper Missouri River system (Ziewitz et al. 1992; Kruse et al. 2002). Emergent sandbars (unlike most islands) have little to no vegetation and may be temporary formations. Interior least terns and the Northern Great Plains piping plovers prefer specific nesting habitat on the Missouri River—bare sandbars or gravel shorelines without vegetation. If plovers and terns do not have access to bare sandbar habitat in the spring, they are less likely to nest and reproduce successfully.

The available ESH for nesting in the MRMS can be impacted by climatic cycles and/or actions that change river hydrology and morphology. During periods of high rainfall and flooding, sand is moved to create new sandbars and existing sandbars are scoured. During drought periods, the high spring flows that form and maintain sandbars are reduced or absent, and vegetation increases on the sandbars. When vegetation encroaches on sandbars and along recently exposed reservoir shorelines, the amount of bare substrate available for nesting is decreased. Management activities such as the construction and operation of large federal reservoirs on the MRMS potentially have significant consequences for nesting habitat for these birds because such activities generally reduce the magnitude, frequency, and duration of peak river flows required to move river sediments, scour existing sandbars, and form new ones.

The U.S. Army Corps of Engineers (Corps) provides the primary operational management of the Missouri River and is responsible under the Endangered Species Act (ESA) to take actions within its authorities to conserve listed species. Formal consultation between the U.S. Fish and Wildlife Service (USFWS) and Corps under Section 7 of the ESA culminated in issuance of the USFWS (2000) *Biological Opinion on 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*. The 2000 Biological Opinion (BiOp) found that Corps operations on the Missouri River were likely to jeopardize interior least terns and piping plover populations unless the reasonable and prudent alternative (RPA) set forth in the BiOp was implemented. After further consultation in 2003 with the Corps, the USFWS issued a Biological Opinion Amendment (USFWS 2003) to modify RPAs described in the 2000 BiOp and provide reasonable and prudent measures (RPM) to minimize take/harm of the least tern and piping plover and describe conservation recommendations that would benefit the species. The 2003 BiOp Amendment modifications include an accelerated schedule for creation of new ESH and rejuvenation of existing sandbar habitat to improve habitat conditions for these federally listed bird species. Implementation of the RPA is achieved through the Corps' Missouri River Recovery Program (MRRP).

To comply with the habitat restoration/creation/acquisition element of the RPA in the 2000 BiOp and the 2003 amended BiOp, the Corps created three ESH complexes through artificial or mechanical means during 2004 and 2005, and also created shallow water habitat through modification of the river control structures, excavation, and dredging. Additional ESH construction was ongoing as this document was written. To comply with research, monitoring, and evaluation elements, the Corps has coordinated survey

efforts to assess tern and plover productivity, habitat use, and effects of management actions on these two species. The Pacific Northwest National Laboratory is working with the Corps to provide a synthesis and evaluation of available information and investigations documenting the construction, characterization, monitoring, and assessment of the constructed emergent sandbar habitat.

Work by the Corps to develop and monitor new ESH in the Missouri River is described in this report. Section 2 contains information on the construction and vegetation management activities being conducted to create and maintain ESH as well as preliminary and planned monitoring of these sites. Section 3 provides the results of interior least tern and piping plover nest monitoring and habitat characterization on the constructed ESH. Section 4 provides a brief summary of the current ESH status and monitoring information related to the ecological function of newly developed ESH as habitat within the river system.

2.0 Constructed Emergent Sandbar Habitat

Emergent sandbar habitat refers to exposed, inter-channel sand formations within the river. In contrast to islands, ESH complexes are often temporary formations and extremely dynamic in nature. Bare sands or gravel shorelines without vegetation suitable for least tern and piping plover nesting habitat were historically found on emergent sandbars within the MRMS. However, the availability and quality of these habitats has been altered by hydrologic and sediment transport changes in Missouri River flows. To ensure that suitable nesting and foraging habitat are adequate for these birds, the Corps is implementing a program for the mechanical maintenance and creation of emergent sandbar nesting habitat within the free-flowing reaches of the upper Missouri River from Fort Peck, Montana, downstream to near Sioux City, Iowa. Numerous goals for ESH creation and maintenance are identified in the 2003 BiOp Amendment (USFWS 2003), which maintained the ESH goals of the 2000 BiOp and prioritized reaches for ESH restoration (high, moderate, and low).

In response to the 2000 BiOp, the Corps developed an implementation plan to address options for creation and maintenance of ESH using methods that do not rely solely on natural or regulated river flows (USACOE 2003). These included the following options:

- increasing the height of existing submerged sandbars utilizing dredges to pump and place material to create exposed sandbar conditions,
- mechanical manipulation of existing sandbars by pushing submerged sand to exposed elevations utilizing bulldozers and/or excavators,
- contouring existing sandbars to either minimize high dunes or to add minor topographical height variations utilizing bulldozers, front-end loaders, scrapers, and/or excavators,
- contouring existing sandbars to provide depositional areas for organic material, wetted areas, and/or shallow ephemeral pools to increase forage production and forage availability,
- investigate supplemental nitrification of sites with poor or insufficient forage production,
- set up and removal of sand fences on existing habitat,
- short-term armoring of productive nesting areas with temporary materials such as logs or bales,
- vegetation removal by aquatically approved pre-or post-emergent herbicide application or by utilizing scrapers, mowers, discs, chippers or similar type machines, or by burning,
- creating dynamic sandbar complexes by cutting shallow water channels through existing large sandbars,
- reducing localized predator impacts by removal of land bridges and perches,
- enhancing terrestrialized linear habitats with livestock exclosures and enclosures, peninsula cutoffs, and providing site security through slope reductions and/or substrate modifications.

This section describes 1) the Corps projects being implemented to create and/or reclaim a sufficient amount of ESH to stabilize, and eventually recover, interior least tern and piping plover populations along the MRMS; and 2) monitoring activities associated with construction and the amount and delineation of ESH within the MRMS.

2.1 Construction and Management of ESH

To comply with the habitat restoration/creation/acquisition element of the RPA in the 2000 BiOp (USFWS 2000) and the 2003 amended BiOp (USFWS 2003), the Corps has applied several options to develop new sandbar habitat and manage existing sandbars to make them suitable for tern and plover nesting. The Corps is in the process of developing a programmatic National Environmental Policy Act (NEPA) document on the impacts of carrying out the mechanical habitat maintenance and creation described in the 2000 BiOp and the 2003 amendment. While the programmatic NEPA document is being developed, the Corps continues to implement elements of the RPA with short-term projects working in support of the amended 2000 BiOp.

Several projects managed by the Corps have used or plan to use large equipment to construct new sandbars in selected segments and reservoirs along the Missouri River, including the 59-mile long Gavins Point Segment (also known as the Missouri National Recreation River) that begins at Gavins Point Dam at river mile (RM) 811 near Yankton, South Dakota, and extends downstream to Ponca, Nebraska, at about RM 754. Other approaches focus on rehabilitating existing sandbars and include applying herbicides to kill encroaching vegetation, mowing or tilling of dead vegetation to expose bare sands, or placing more desirable surface materials over existing islands to provide sandbar type habitat. Herbicide spraying and subsequent mowing and removal of dead or dying vegetation has been employed on natural sandbars. Other management activities intended to enhance ESH include fencing to limit predation of nests and nest loss due to trampling by livestock.

The creation and maintenance of ESH within the MRMS is currently focused on specific segments of the river. Within the Gavins Point Segment, both artificial construction of new ESH and mechanical and herbicide control of encroaching vegetation on naturally deposited sandbars have been conducted to increase sandbar habitat available for nesting.

2.1.1 New ESH Construction

Artificial or mechanical methods are being used and are planned for use to create new ESH. The ESH creation/restoration projects employ various mechanical actions depending on the location and geomorphology:

- sand accretion and nourishment through dredging,
- exposure of submerged sand,
- vegetation removal and habitat development,
- contouring dredged materials.

These methods have proven successful in recent projects the Corps has completed near Ponca, Nebraska, and at two other locations downstream of Gavins Point Dam (Figure 2.1). During 2004 and 2005, three sandbar complexes were constructed by the Corps within the Gavins Point Segment along the South Dakota-Nebraska border between Vermillion, South Dakota, and Ponca, Nebraska. This segment of the Missouri River immediately below Gavins Point Dam is not channelized and, therefore, does not have impacts associated with channelization that affect the river downstream from Ponca State Park (USACOE 2004). However, the segment is affected by altered hydrology and sediment load resulting from the operation of Gavins Point Dam and bank stabilization by private landowners. The three sandbar

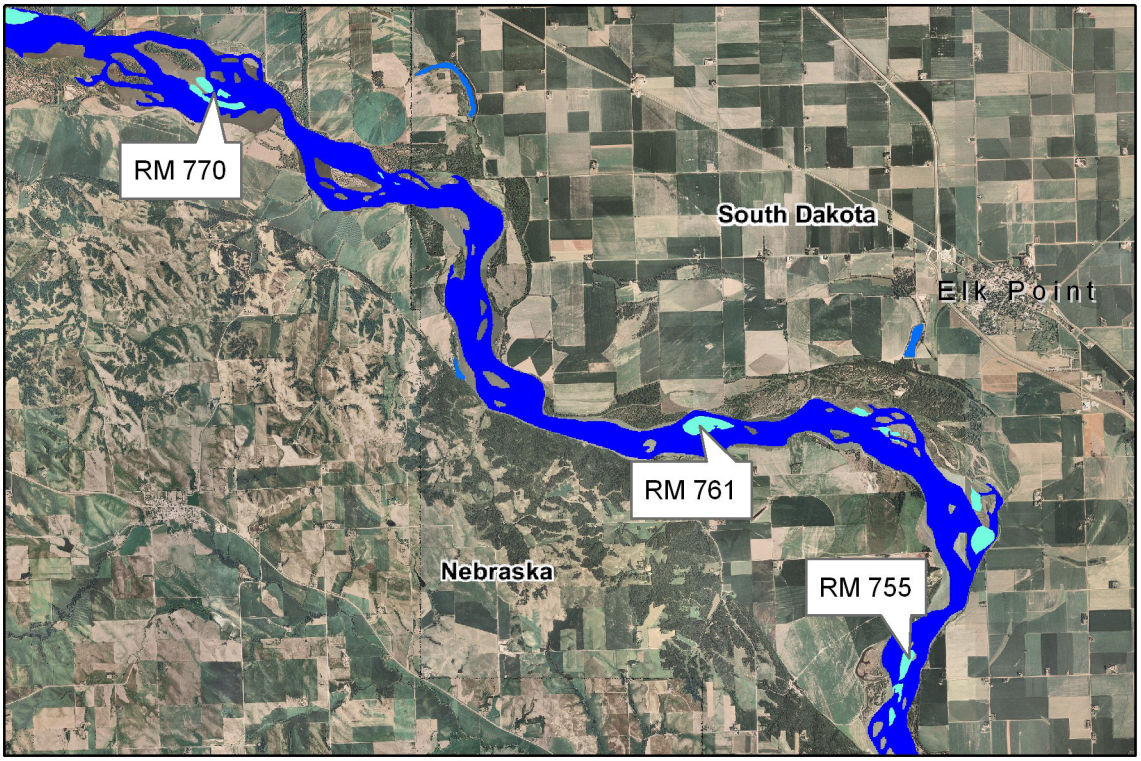

Figure 2.1. Locations of Completed ESH Construction Projects

complexes were constructed using differing techniques and timing of activities; these are described in more detail for each complex within following sections. Sandbar locations are given as approximate RM; the exact RM for the upstream to downstream extent is not listed here.

The sandbars were designed in cooperation with biologists, and potential construction sites were identified within lower energy sections of the river away from the main current (USACOE 2006) to minimize the potential erosion of the constructed features. The sandbars do not have hard points or erosion controls and are constructed of materials found in the river bed. Dredging of the two sandbar complexes furthest upstream at RM 761.3 and RM 770 was conducted to avoid cutting deeper than the thalweg and no deeper than 4 feet regardless of the thalweg elevation (USACOE 2006). These two upstream sandbar complexes were constructed so that the highest points on the landforms attain elevations that approximate a water surface for flows between 50,000 and 55,000 cubic feet per second (cfs).

Additional creation of ESH is also planned for future years, and work began in August 2007 on three new sandbar complexes to be built downstream from Gavins Point Dam. These constructed sandbars are located at RM 791.5, near Wynot, Nebraska, and south of Vermillion, South Dakota, at RM 774, and RM 777.5. ESH at the proposed locations will be developed through vegetation removal, hydraulic dredging to pump and place material onto existing sandbars, and contouring using earth-moving equipment. Construction of these complexes is planned for completion by April 2008.

2.1.1.1 River Mile 754.4 (RM 755.0)

A complex of three sandbars was created in 2004 at RM 754.4 near Ponca State Park. The sandbar complex was constructed as part of a larger ecosystem restoration project that also provided restoration of tallgrass prairie, wet meadows, backwaters, and wetlands in addition to emergent sandbars. The sandbar construction was accomplished using approximately 533,240 yd^3 of dredge spoils that were removed using a hydraulic cutter-head dredge to rehabilitate a nearby backwater habitat that had been filled with river sediments. The sandy dredge spoils were pumped to a shallow area on the Nebraska side of the river during May and June 2004 to create three sandbars parallel to the river flow that totaled about 37 acres during the summer 2004 flow regime (~28,000 cfs). The shoreline elevations were planned to be contoured using large earth-moving equipment, but terns and plovers occupied the upper two sandbars during construction and began nest initiation, so equipment was removed.

2.1.1.2 River Mile 761.3

Four sandbars were constructed in this area during October and November 2004 by adding substrates to raise the surface of an existing low-elevation sandbar complex located at RM 761.3. Heavy equipment including an excavator, earth-moving scrapers, and a bulldozer, contoured about 474,000 yd^3 of sand already found onsite to an engineered design to develop the complex. When completed, the four sandbar areas in the complex totaled between 38 and 45 acres depending on water level. During the final phase, a dredge pump was used to saturate two of the new bars to compact the sand and flush with nutrients contained in the river water. The other two bars were compacted using heavy equipment.

2.1.1.3 River Mile 770 (RM 770.0, RM 770.1, RM 770.2)

Construction began on the RM 770 sandbar complex in November 2004. Heavy equipment was used to move about 300,000 yd^3 of sand to build up existing low-elevation areas within the river into four sandbars. During construction, the complex was moved slightly from the location originally identified. A small, portable water pump was used to saturate a portion of this complex. Inclement weather delayed the finish of this complex until March 2005. About 50 acres of habitat at 30,000 cfs were created (82 acres at 20,000 cfs). Although erosion reduced this amount slightly, low flows during summer 2005 and 2006 resulted in the merging of two sandbars into one, resulting in three total sandbars with one substantially larger than the other two. The sandbar complex still contributed about 53 acres of nesting habitat in 2006 at 23,500 cfs.

2.1.2 Vegetation Management

Another approach employed by the Corps to provide additional acreage suitable for tern and plover nesting involves vegetation management to reduce the amount of vegetation on existing ESH. Management techniques used to date include fall herbicide treatments and subsequent removal of dead vegetation by mowing where possible. Initial spraying of 145 acres occurred in fall 2004 (Table 2.1), and additional ESH was identified and sprayed in 2005 and 2006. Of the sandbar habitat sprayed in 2006, vegetation was subsequently mowed on only a portion of the treated acres because access was limited by low water levels.

Table 2.1. Vegetation Management on Sandbars Within the Gavins Point Segment During 2004–2006

River Mile	Herbicide	Mowed	Comment
756.6	2004	2005 and 2006	Lower portion
756.8	2005	2006	Upper portion
757.2	2005	2006	
759.2	2005	Spring 2006	Nesting not in treated area
759.5	2005	Not Mowed	
768.0	2005	Not Mowed	Much eroded away
773.0	2005	2007	
777.7	2004 and 2005	2007	
778.5	2005	Not Mowed	
778.7	2005	2007	Now eroded away
781.5	2004	2005	
782.5	2005	2007	Nesting not in treated area
783.0	2005	2007	
784.5	2005	2007	
785.2	2005	2007	
786.0	2005	2007	
788.5	Not Sprayed	Not Mowed	
789.5	2005	2007	
790.0	2005	2007	
790.9	2005	2007	
793.3	2005	Not Mowed	
793.5	2005	2007	
794.0	2005	2007	
795.3	2005	2007	
796.0	2005	Not Mowed	
796.5	2005	2007	
797.0	2005	2007	
799.0	2005	2007	
801.1	2005	2006	Partially sprayed/mowed

2.2 Pre- and Post-Construction Monitoring of ESH

The 2003 BiOp Amendment (USFWS 2003) directed the Corps to monitor and evaluate created and manipulated sandbar habitat complexes to determine whether physical and biological requirements of the birds are being met. In response, the Corps is working to evaluate current and ongoing ESH projects by collecting information on the quantity and quality of the terrestrial and aquatic habitat, the geomorphology of constructed habitats in relation to the river, and the productivity of the target species. This section provides summary information on current efforts to quantify the physical attributes of constructed and created ESH and some information on surveys documenting wildlife occurrence and use of constructed ESH by species other than terns and plovers. Information on the use of constructed ESH and shallow-water habitat by non-target species is intended to provide insight regarding the ecological function of constructed and managed habitats. Additional information is provided in Section 3.0 on biological and physical habitat attributes measured at smaller scales that are important to nesting terns and plovers.

2.2.1 Condition and Status of Constructed ESH

Constructed ESH has been evaluated by Corps staff after heavy construction activities ceased. As expected in a dynamic river environment, some erosion and vegetation growth occurred following the development of the complexes, which in turn reduces the overall ESH available for terns and plovers (Table 2.2). The amount and condition of available ESH within the river varies significantly with the season and river flow regime and changes as the discharge from Gavins Point Dam is altered. Variations in river flow and environmental conditions make it difficult to develop acreage estimates at comparable flow rates. The acreage estimates of the areal extent of ESH shown in Table 2.2 are based primarily on use of aerial photography and manual delineation using global positioning systems and provide a snapshot at a particular river flow rate. Methods are being developed to quantify amounts of ESH and monitor changes in available habitat using remote sensing data (Section 2.2.4)

Table 2.2. Estimated Acreage of Constructed ESH as Built and Observed Post-Construction (Discharge measured at Gavins Point Dam)

Location	Number of Sandbars in Complex	Initial Size (acres at river discharge)	Post-Construction Size (acres at river discharge)	Date of Post-Construction Observation
RM 754.4	3	37 at 28000 cfs	9.5 at 30000 cfs	August 2006
RM 761.3	4	38 at 30000 cfs	45 at 23500 cfs	August 2005
RM 770	3	82 at 20000 cfs	53 at 23500 cfs	August 2005

The complex at RM 754.4, which was constructed to provide approximately 37 acres at 28,000 cfs, suffered from erosion during winter 2004–2005, and the middle sandbar of this complex was eroded away (Figure 2.2). Active erosion continues on the remaining two sandbars, and remaining ESH was estimated as 8.6 acres for the upper sandbar and 0.7 acres for the lower sandbar at 30,000 cfs flow on August 18, 2006. Parts of the upper sandbar were immediately colonized by cottonwood (*Populus deltoides*) trees (Jons 2006). By September (approximate 3–3.5-month growing season), some of the trees were already 36 inches in height. Forbs, primarily wild sunflower (*Helianthus* species) and cocklebur (*Xanthium* species), colonized the sandbar later in the summer. A lesser amount of trees and vegetation (same species) colonized parts of the middle sandbar. Little vegetative growth has occurred on this sandbar complex in the succeeding growing seasons.

The complex at RM 761.3, which was constructed to provide approximately 38 acres at 30,000 cfs, also suffered some post-construction erosion losses, particularly at the downstream end (Figure 2.3). On August 19, 2005, the size of the complex was estimated at 45.4 acres at 23,500 cfs flow. Erosion rates have declined and numerous snags have appeared at the upstream end of the sandbar complex. This sandbar was colonized by cottonwood trees during spring/summer 2005, and the majority of the trees appeared in a 20- to 100-foot-wide fringe around the perimeter of the sandbar complex (Jons 2006).

The complex at RM 770 was constructed to provide four sandbars, resulting in a total of approximately 50 acres at 30,000 cfs (Figure 2.4). Some erosion occurred on this sandbar complex, particularly at the downstream end on the South Dakota side, but the exposed sandbar complex still provided approximately 52.9 acres at a lower flow of 23,500 cfs in August 2005 (Jons 2006). Portions of the sandbar perimeters of this complex were also colonized by cottonwood trees and herbaceous vegetation, but the central portions of the sandbars remained free of vegetation. In the winter of 2007, a significant scouring event again changed this complex.

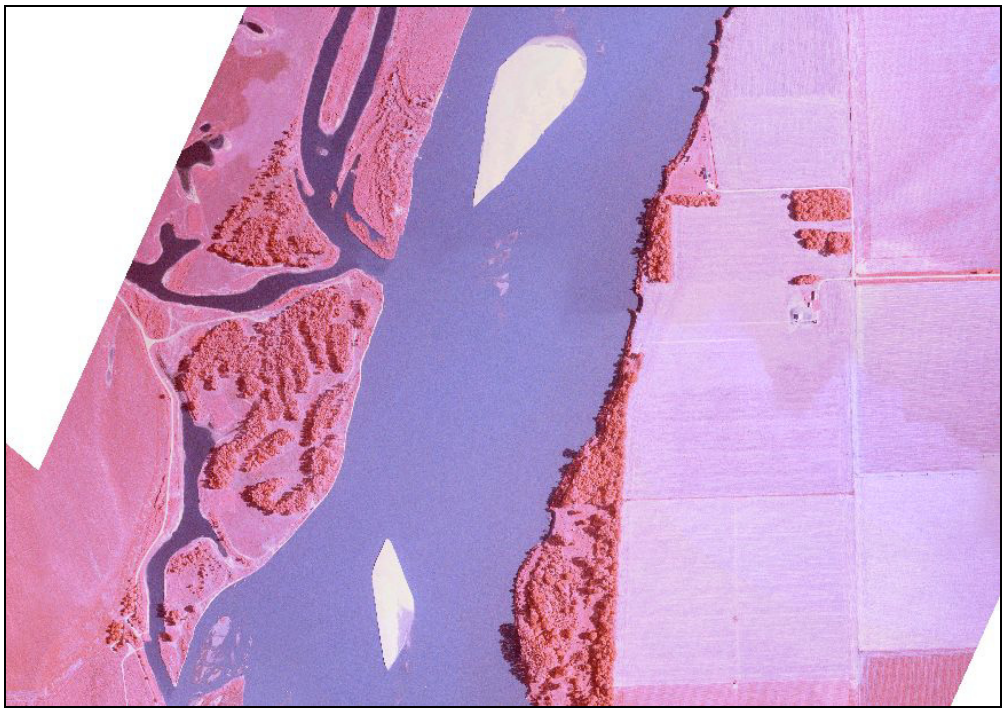

Figure 2.2a. Infra-Red Aerial Photograph of Emergent Sandbar Complex at RM 755 taken June 2005 (river flows ~21,500 cfs)

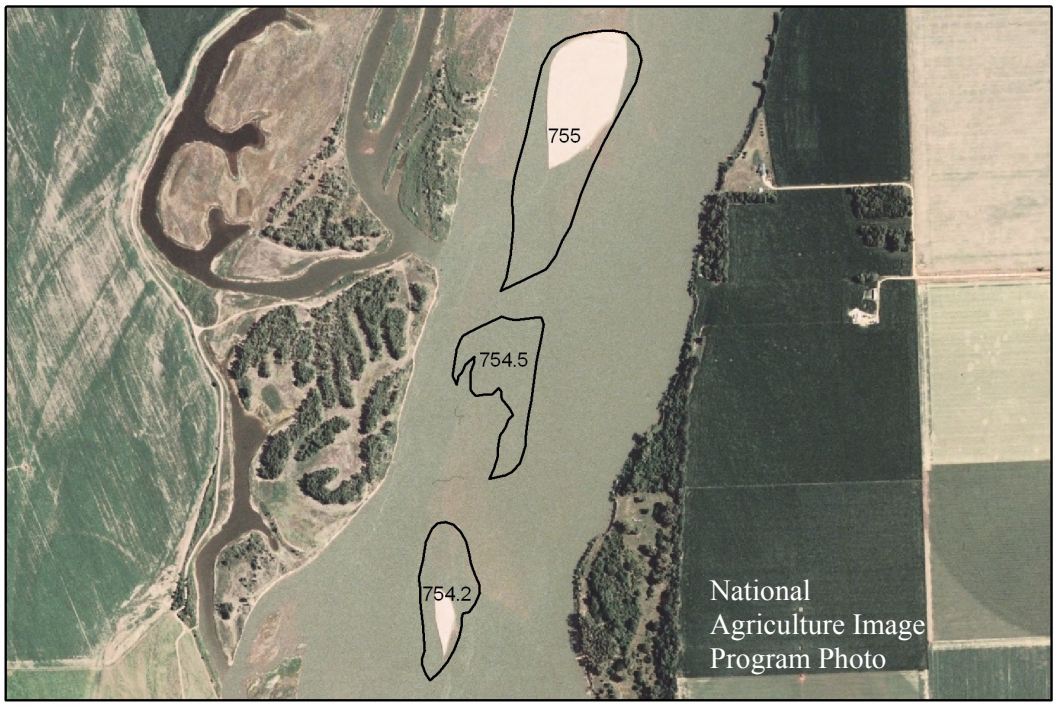

Figure 2.2b. Aerial Photograph of Emergent Sandbar Complex at RM 755 taken July 2006 (river flows ~25,000 cfs)

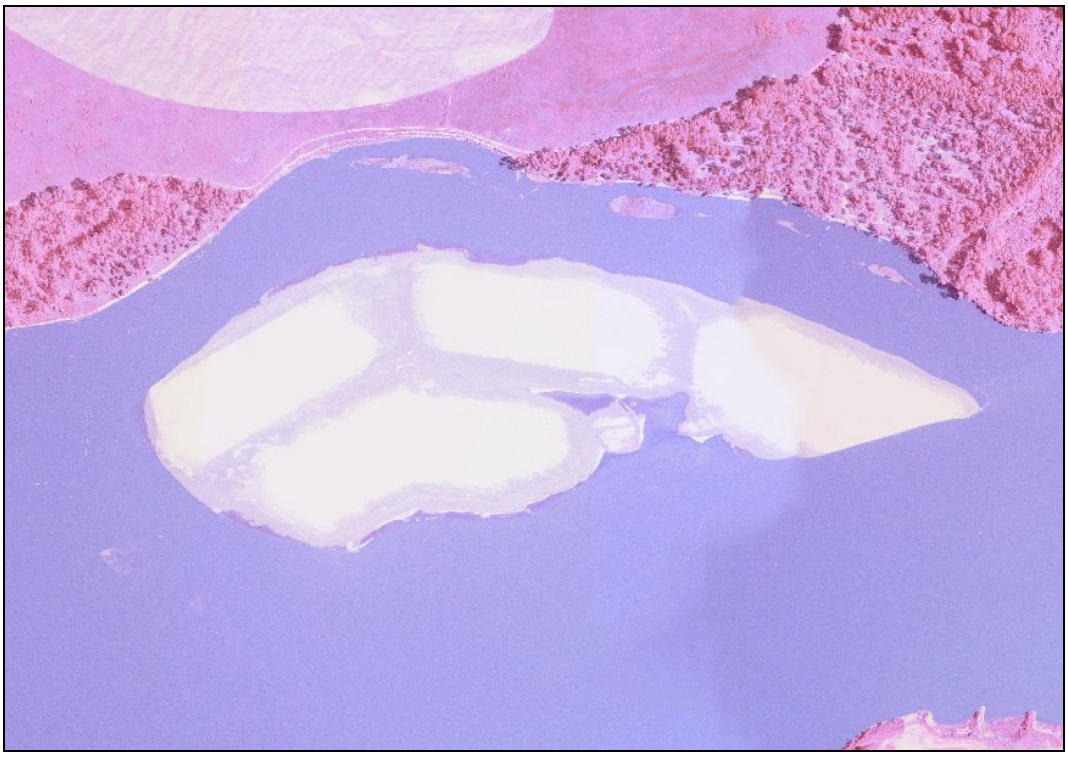

Figure 2.3a. Infra-Red Aerial Photograph of Emergent Sandbar Complex at RM 761 taken June 2005 (river flows ~21,500 cfs)

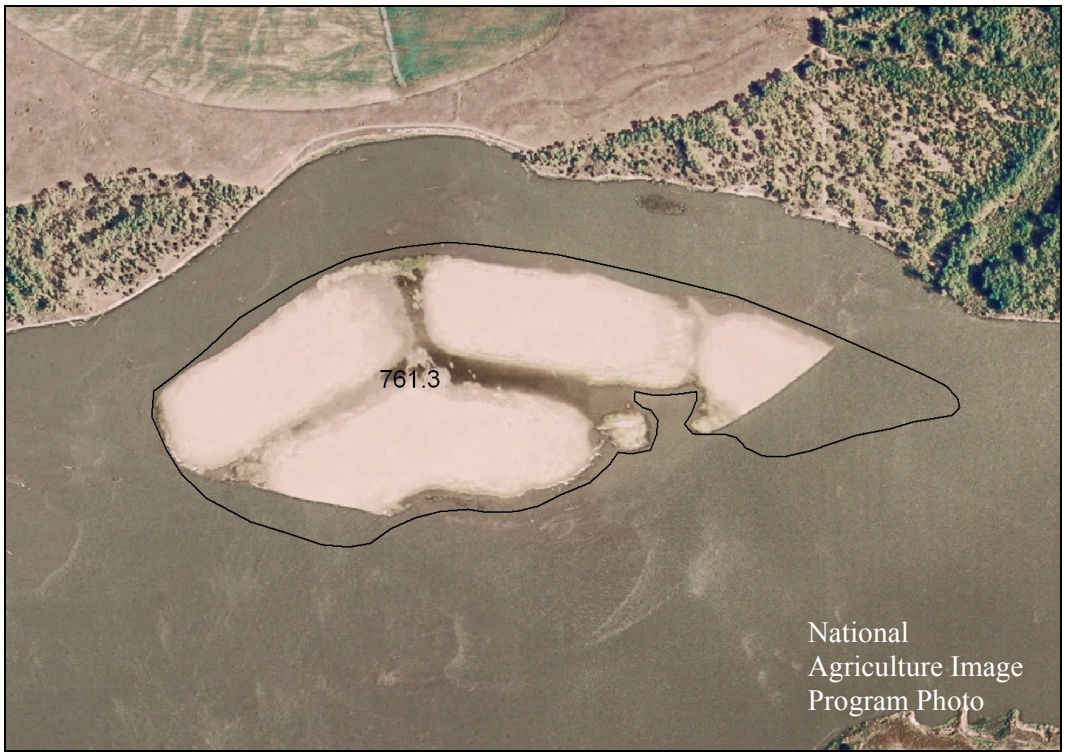

Figure 2.3b. Aerial Photograph of Emergent Sandbar Complex at RM 761 taken July 2006 (river flows ~25,000 cfs)

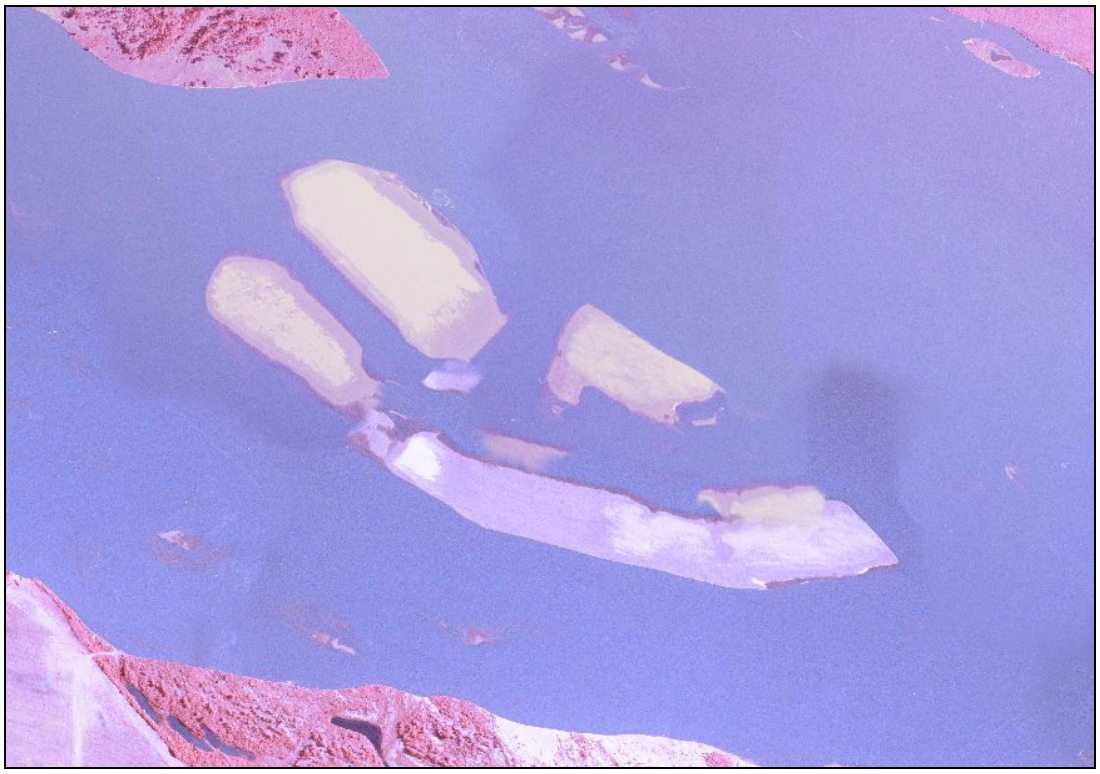

Figure 2.4a. Infra-Red Aerial Photograph of Emergent Sandbar Complex at RM 770 taken June 2005 (river flows ~21,500 cfs)

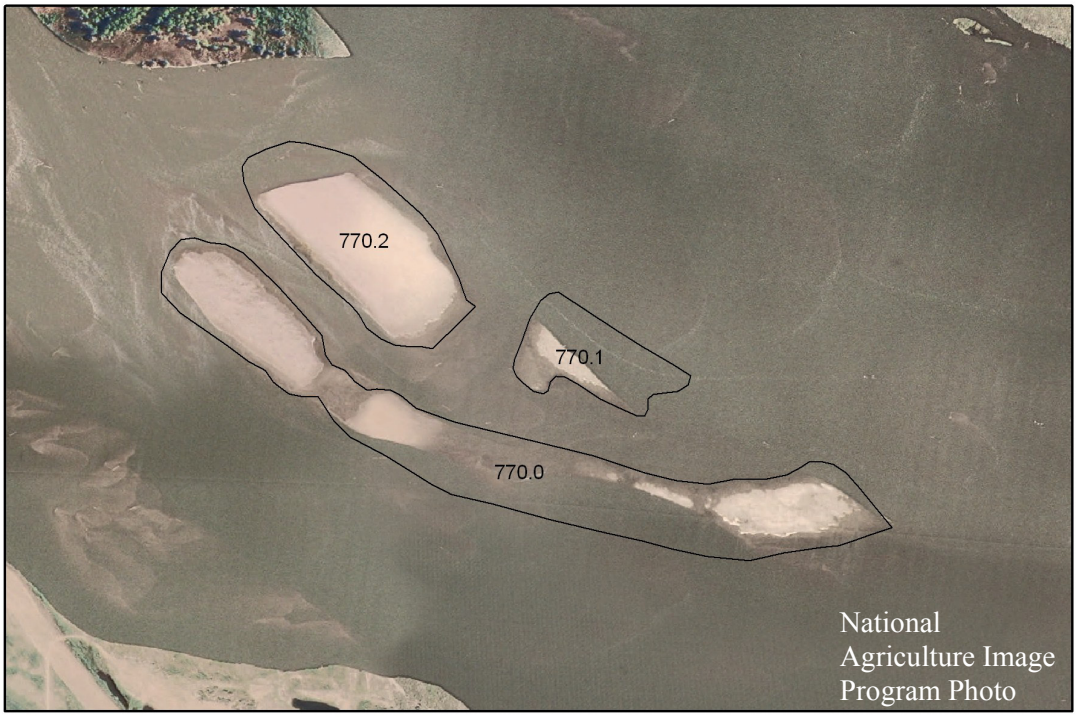

Figure 2.4b. Aerial Photograph of Emergent Sandbar Complex at RM 770 taken July 2006 (river flows ~25,000 cfs)

2.2.2 Assessments of Geomorphology Related to Constructed Habitat

At the two ESH complexes constructed near RM 770 and RM 761.3, data were collected by the U.S. Geological Survey (USGS), in cooperation with the Corps, to evaluate the success of the habitat construction (Figure 2.5) (Thompson et al. 2007). Specific goals were to provide baseline data necessary to assess the physical and potential ecological effects of the channel alterations. Both sandbar complexes were surveyed just before construction and again about 1 to 1.5 years after construction to provide a baseline for assessing future changes in constructed ESH elevation and river channel upstream and downstream of the complex. Preconstruction data were collected during fall 2004, and post-construction data were collected during November 2005 and February 2006.

Data collected include channel-geometry data (bathymetric and topographic) for areas upstream from, downstream from, and within each construction site. Data were collected along survey transects crossing the river from high bank to high bank along segments that reached from 2 miles upstream to 2 miles downstream of each constructed sandbar. Survey data included water depths in areas with depth generally greater than 3 feet, land-surface elevation on the high bank and shore and sandbar areas, and riverbed elevation in areas with water depths generally less than 3 feet. Water-velocity data were collected on selected transects near RM 769.8. These data are intended to provide information for documenting effects of Missouri River channel alterations, as well as providing a baseline from which future sedimentation and erosion rates may be evaluated.

Initial data review by the Corps (USACOE 2006) indicated changes in cross-sections between the pre- and post-construction surveys as would be expected in a dynamic river system. The amount of time between pre-construction data collection and the initial post-construction survey was deemed too short to provide indications of longer-term effects. Aerial photographs and imagery were also evaluated by the Corps to assess changes in the bank line by digitizing the boundaries from QuickBird or the rectified imagery taken on October 26, 2005, and U.S. Department of Agriculture aerial photography taken on July 17, 2003. Comparisons of the image data from the two time periods bracketing the construction in 2004 appeared to indicate that two areas showed evidence of bank erosion. Generally, where the aerial imagery indicated erosion and change in shoreline extent, the cross-sections (Thompson et al. 2007) also showed indications of change or erosion.

2.2.3 Sediment and Hydraulic Modeling

During 2006, Dr. Kenner and graduate students at the South Dakota School of Mines began work to provide improved modeling capabilities to predict shallow water habitat availability at a range of discharges and to provide better model capabilities to quantify changes in shallow water and ESHs. The study design and objectives were developed in conjunction with the Corps to aid in developing improved hydraulic and sediment transport models that can be used to provide information to guide ongoing habitat restoration.

Field data collection was done in collaboration with the Corps and USGS to acquire bathymetry and velocity data during the May 2006 Gavins Point Dam simulated spring rise. Data collected with the USGS teams were used to map bathymetry and velocities adjacent to the constructed ESH at the RM 770 site and within a side channel containing large woody debris. Work included development of a bathymetric profile of the Vermillion and Missouri River confluence area for inclusion in the hydraulic

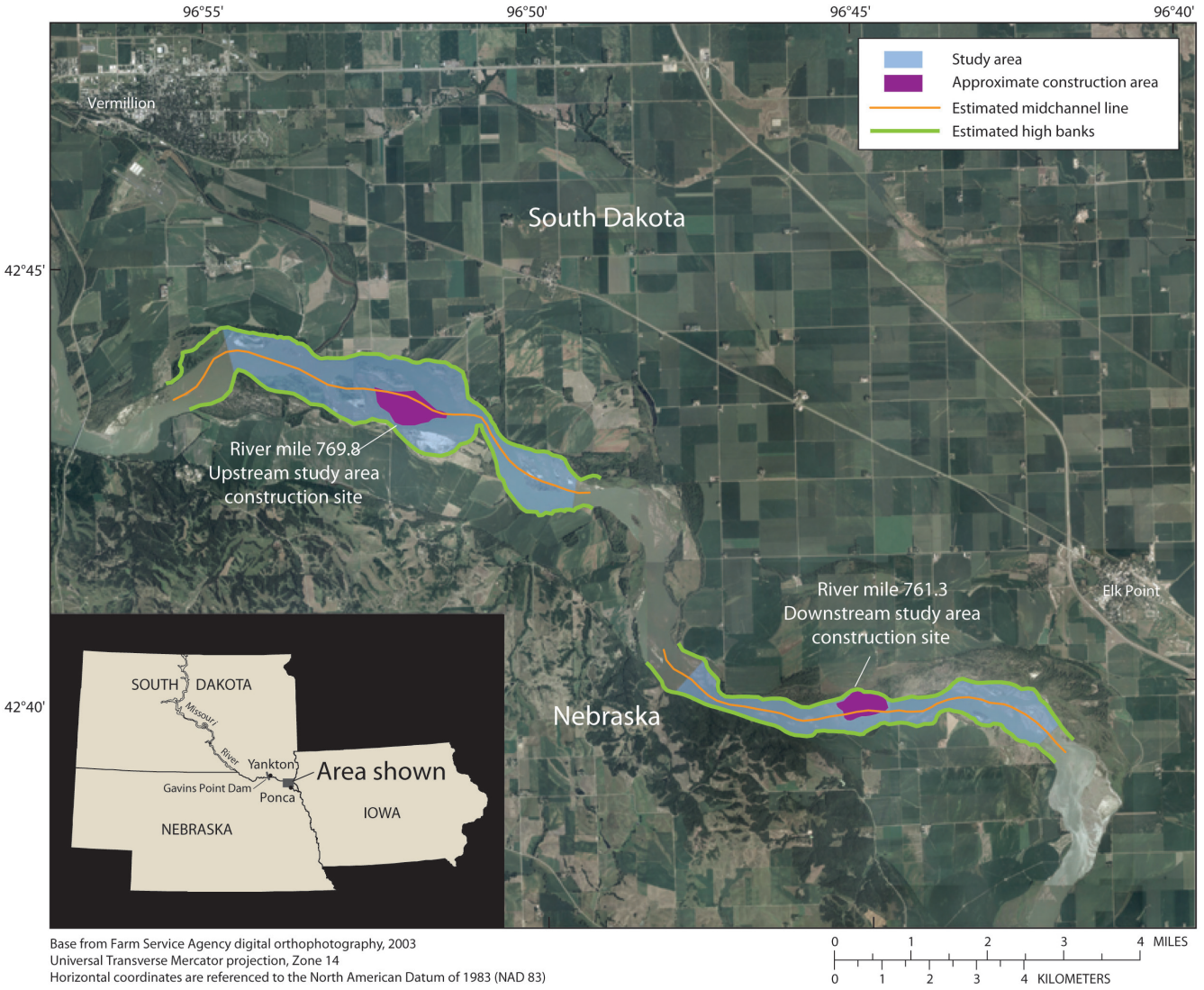

Figure 2.5. Location of USGS Study Areas for Monitoring Pre- and Post-Construction Channel Geometry Around Constructed ESH (from Figure 1 in Thompson et al. 2007)

models and collection of suspended sediment concentrations before, during, and after the May 2006 simulated spring rise. Temporary stage gages were established within the study site and stage-discharge relationships were developed for discharge ranges of 13,500 cfs to 31,300 cfs.

River2D hydraulic simulations were directed at quantifying shallow water habitat availability relative to a range of discharge events. The RMA2 hydraulic and SED2D sediment transport simulations were designed to quantify changes in shallow water and ESHs, relative to a range of discharge events, based on bathymetric changes related to bed erosion, sediment transport, and deposition. Results from these studies, planned for completion during 2007, will be included in subsequent status reports.

2.2.4 Sandbar Habitat Delineation

A study conducted by USGS-Northern Prairie Wildlife Research Center is evaluating techniques for reach-scale inventory of ESH using remote sensing data (Strong 2007; Sherfy et al. 2007a). The USGS is investigating acquisition and analyses of multi-spectral and panchromatic satellite imagery to inventory, map, and monitor piping plover and least tern habitat. Evaluating these types of riverine habitat is difficult because the amount and condition of the habitat varies with the variation in river discharge. Multitemporal image analyses conducted by the USGS may be used to help solve this problem by quantifying habitat availability in relation to river discharge, quantifying annual change in habitat availability, and identifying emergent sandbar and river channel habitat in variables that are useful for predicting nest success, fledgling success, and nest density. Specifically, the research strategy has three main thrusts:

1. Use probability-based accuracy assessment of the habitat maps to calculate unbiased estimates of the area of habitat.
2. Analyze habitat maps from different dates to quantify accretion and erosion of sandbars, vegetation succession, bank erosion, and other temporal dynamics in the riverine system.
3. Use generalized linear models to relate nest density and nest success to habitat metrics derived from the remotely sensed imagery.

This strategy is being applied to five segments of the Missouri River identified in the 2003 BiOp Amendment—the Fort Peck Segment, the Garrison Segment, the Fort Randall Segment, the Lewis and Clark Lake Segment, and the Gavins Point Segment (USFWS 2003). Analysis of the Gavins Point Segment will provide information on the status of constructed and manipulated ESH projects in that segment.

Two kinds of imagery are being acquired to delineate habitat and predict ESH available at differing river flows. Pan-sharpened multispectral QuickBird imagery (http://www.digitalglobe.com) is being acquired for the four river segments in 2006–2008. Two image acquisitions are attempted for each year: one during the nesting period and the other during the brood rearing period. Imagery is analyzed using hierarchal object-based image segmentation and classification procedures to develop classified maps of available ESH. For the Gavins Point Segment, QuickBird imagery was also acquired in 2005 during June–July (~21,000 cfs discharge from Gavins Point Dam), September (25,000 cfs), and October (9,000 cfs).

Light Detection and Ranging (LIDAR) data were collected in November 2005 (11,000 cfs discharge) for the Gavins Point Segment. This technology employs optical remote sensing to determine range from laser pulses to provide high-resolution data for mapping physical features and in the USGS study is used to develop a bare-earth elevation model for the Gavins Point Segment (Strong 2007). An estimated planar surface for water elevation at a particular time and discharge for the segment is subtracted from the bare-earth elevation model to provide sandbar inundation predictions for areas that were above the water surface at the time of the LIDAR acquisition. Methods are being developed and applied to compare predictions of sandbar inundation with QuickBird imagery classifications of habitat. Preliminary evaluations of the sandbar inundation modeling for the Gavins Point Segment corresponding to June 2005 and July 2006 QuickBird imagery classifications have been completed (Strong 2007). The USGS plans to use model predictions with habitat maps from 2007 and 2008 QuickBird imagery to further evaluate the bare-earth elevation model derived from the November 2005 LIDAR data.

2.2.5 Ecological Surveys Related to Constructed ESH

In addition to survey and monitoring of the physical habitat characteristics and populations of the two federally listed birds, several other investigations have been initiated to survey other biota use of ESH. Information describing how constructed ESH is used by non-target wildlife species should provide a better understanding of the structure and function of the habitat. These efforts include research designed to:

- characterize fish assemblages in shallow backwater habitats and adjacent constructed sandbars before and after construction,
- locate and characterize specific nesting areas for spiny softshell (*Apalone spinifera*), smooth softshells (*Apalone mutica)*, and false map turtles (*Graptemys pseudographica*), and compare habitats being used for turtle nesting to those not being used for nesting,
- develop information describing the shallow water unionid (freshwater mussel) communities.

Available results for these investigations are summarized in the following sections.

2.2.5.1 Characterizing Fish Assemblages

When the ESH complex was constructed near Ponca State Park (RM 754.4), the methods used to create ESH also allowed enhancement of shallow water habitats. Material was removed from in-river borrow areas to build up the sandbars, resulting in the expansion of three shallow water areas that provided approximately 30.9 acres of post-construction slack water that serves as spawning, rearing, and foraging habitats for native riverine fish (Figure 2.6). To document results of these management actions on fish populations, pre- and post-construction sampling was conducted (Wallace 2000; Mestl 2004). Fish sampling with beach seines and gill nets was initiated in 2000 to develop a pre-construction baseline for fish communities in backwater habitats. Post-construction sampling utilized seines, mini-fyke nets, frame nets, and barrel nets during July and August 2004. Limited nighttime electrofishing was also utilized for sampling in backwater habitats in 2004. Multiple samples were gathered both in the backwater areas as well as in shallow water near adjacent constructed sandbar habitats.

During post-construction surveys, 44 different species were collected from backwater habitats and 21 species were found adjacent to constructed sandbars. All 21 species at sandbars were also observed in the backwater, and fish in backwater habitats were more than twice as abundant as near sandbar habitats (Table 2.3). Although the initial assessment used seines and gill nets (Wallace 2000), that study was qualitative in nature and so quantitative comparisons of these data sets with data collected after construction are limited. It was noted that species diversity sampled before and after construction using the same equipment (only seine) was much greater post-construction (27 species versus 14 species). Post-construction sampling was conducted during July and August while pre-construction sampling occurred in October, and it is not known how the difference in timing may have influenced results.

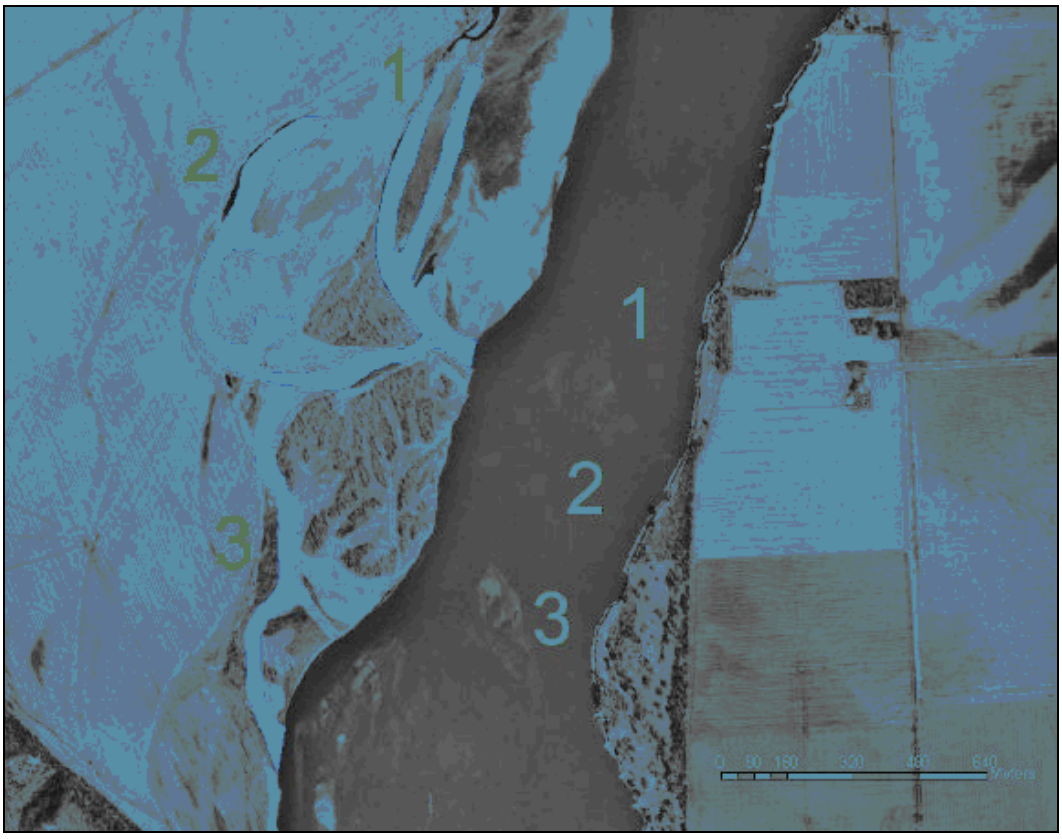

Figure 2.6. Aerial Photograph of Created Shallow Water Habitats near Ponca State Park (Figure 2 from Mestl 2004)

In addition to fish, five species of turtles were captured within various net types. Fourteen false map turtles (*Graptemys pseudographica*), ten painted turtles (*Chrysemys picta*), four spiny softshell turtles (*Apalone spinifera*), four common snapping turtles (*Chelydra serpentina*), and a single smooth softshell turtle (*Apalone mutica*) were caught in backwater habitats.

2.2.5.2 Turtle Nesting and Nest Habitat Survey

During May–August 2006 and 2007, constructed sandbars within the Gavins Point Segment were surveyed for nesting turtles as part of a larger survey of the Missouri National Recreational River (RM 835 to RM 753) (Dixon and Dieter 2007). Objectives of this study were to locate nesting areas of spiny softshell, smooth softshell, and false map turtles, characterize nesting habitat, and examine habitat

relationships and distribution on constructed sandbars. Searchers traversed sandbars looking for turtle sign (tracks or disturbance). Prospective nests were excavated, and if eggs were present, the following attributes were recorded: location; slope, as well as distance to water; and vegetation. Eggs were counted and measured, nest temperature was measured, and physical size of the nest was also determined.

Table 2.3. Summary of Post-Construction Fish Sampling Results from All Sampling Techniques in New Backwater and Sandbar Habitats of the Missouri River (Mestl 2004)

Species	Backwater	Sandbar
Bigmouth buffalo	45	
Bigmouth shiner	79	33
Black bullhead	1	
Black crappie	100	
Bluegill	21	
Centrarchidae spp.	0	3
Common carp	231	10
Creek chub	18	
Cyprinidae spp.	116	15
Emerald shiner	328	459
Fathead minnow	25	
Freshwater drum	8	
Gizzard shad	851	433
Goldeye	2	
Ictiobus spp.	1	
Johnny darter	7	10
Largemouth bass	49	
Lepomis spp.	19	1
Longnose gar	5	1
Northern pike	1	
Orangespotted sunfish	2	
Plains minnow	1	
Quillback	140	260
Red shiner	30	1
River carpsucker	437	241
River shiner	53	44
Sand shiner	235	244
Sauger	14	20
Shorthead redhorse	36	155
Shortnose gar	15	
Smallmouth bass	1	3
Smallmouth buffalo	1	

Table 2.3. (contd)

Species	Backwater	Sandbar
Spotfin shiner	874	382
Spottail shiner	1	2
Walleye	51	2
White bass	146	35
White crappie	6	
White sucker	3	
Yellow perch	6	
Total	3,959	2,357
Total Species	39	21

Twenty-six turtle nests were located during the 2006 field season of which 20 (16 soft shell and 4 false map) were found intact. In 2007, 29 soft shell and 13 false map turtle nests were located intact, while 183 nests were located that had been depredated (Dixon and Dieter 2007). Preliminary summaries of nesting surveys (Dixon and Dieter 2007) indicate that turtle nesting occurred on the constructed ESH: at RM 755, surveyors located one soft shell nest in 2006 and two false map nests in 2007; the complex at RM 761.3 supported nesting in 2006 (two soft shell and one false map) and 2007 (seven soft shell and five false map); and three soft shell nests were found in 2007 on the constructed ESH at RM 770. Further analyses of these data sets for the entire river segment surveyed will be conducted and these analyses are expected to be completed during summer 2008.

2.2.5.3 Mussel Surveys

The substrate of sandbars is home to a number of invertebrate species including freshwater mussels (unionids) that occur in shallow water habitats. Results from recent surveys conducted within the Gavins Segment indicate unionids occur within this area and at least 16 species have been found in the Missouri River between RM 810 and RM 753 (ESI 2007). Freshly dead shells of *Leptodea leptodon* (scaleshell mussel), a federally endangered species, were found in the study area in 1983 and observed in the past decade as recently as 2005 (Hoke 1983; ESI 2005, 2007). However, survey of the Gavins Point Segment in 2006 did not find any evidence of *L. leptodon* in samples.

Mussel surveys were completed in the construction areas of RM 761 and RM 770. Informal surveys at RM 761 were conducted by the Corps, National Park Service, and South Dakota Game Fish and Parks. In addition, Ecological Specialists, Inc. worked under contract to complete surveys at RM 761 and RM 770. Species collected were giant floater (*Pyganodon grandis*), fragile papershell (*Leptodea fragilis*), pink papershell (*Potamilus ohiensis*), pink heelsplitter (*Potamilus alatus*), white heelsplitter (*Lasmigona complanata*), and yellow sandshell (*Lampsilis teres*). Surveys by Ecological Specialists, Inc. in October 2006 (ESI 2007) near the Ponca State Park ESH complex found giant floater, fragile papershell, and pink papershell in backwaters.

3.0 Monitoring of Interior Least Terns and Piping Plovers

The Corps has annually monitored populations of piping plovers and interior least terns on the Missouri River since 1987. This monitoring incorporated nest searches and nest fate determinations, adult census, and monitoring and fate determinations of chicks. In addition to population monitoring, the Corps also directs management actions, such as flagging (signing) those sandbars with bird activity to reduce human disturbance, installing predator exclosure cages for piping plover nests and occasional predator control, raising/moving nests to prevent nest loss due to erosion or rising water levels, and communicating with public and law enforcement officials regarding federal law violations and vandalism. Although nesting survey results vary annually, tern and plover populations have increased since monitoring began and were highest throughout the monitoring area for both species during the 2005 nesting season (USACOE 2006).

The Corps is pursuing several avenues to evaluate current and ongoing ESH projects in order to determine if constructed and managed ESH provides suitable habitat features for nesting and foraging of interior least terns and piping plovers. The Missouri River Emergent Sandbar Habitat Monitoring Plan (Sherfy et al. 2007a) provides a general framework for collection of biological data in support of the monitoring needs of the ESH program to meet the RPA and RPM requirements of the 2003 BiOp Amendment (USFWS 2003). The plan focuses on monitoring of the nesting habitat for least terns and piping plovers and productivity of these birds as the target resource.

As described in Section 2, sandbar complexes were created at three locations in the Gavins Point Segment (RM 770, RM 761.3, and RM 754.4) in 2004 and early 2005. During that time period, vegetation management was also undertaken to improve nesting conditions on existing ESH.

3.1 Monitoring Bird Productivity and Populations on Constructed/Created ESH

Recent investigations undertaken by the Corps and others have been designed to evaluate plover and tern use of constructed sandbars (Catlin and Fraser 2007a, 2007b; Sherfy et al. 2007a). The goals of these ongoing studies are to implement biologically and statistically sound protocols for long-term monitoring of habitat quantity, habitat quality, and productivity of least terns and piping plovers and also to evaluate quantity and change over time of ESH acreage with regard to the ESH objectives outlined in the 2000 BiOp (USFWS 2000). The specific objectives of least tern and piping plover population monitoring are to quantify abundance of nesting habitat and temporal trends in habitat acreage and to characterize bird responses to changing habitat conditions and management actions. The monitoring methods are designed to assess the accuracy of existing nest survey and monitoring procedures, provide guidance on metrics needed to assess adult numbers and reproductive success of piping plovers and least terns, and develop standardized protocol for data collection (Sherfy et al. 2007a).

During 2005 and 2006, five tasks were identified to address the objectives for ESH within the Gavins Point Segment: 1) characterize least tern and piping plover productivity and foraging ecology, 2) evaluate procedures for assessing tern and plover populations and productivity, 3) explore use of remotely sensed data to inventory and map habitat (Section 2.2.3), 4) monitor and evaluate ESH construction and management (Section 2.2.2), and 5) assess effects of human disturbance on terns and plovers (Sherfy et al. 2007a,

2007b). To assist in accomplishing these tasks, the USGS and Virginia Polytechnic Institute were contracted to develop and test field methods as well as gather, analyze, and report field data.

The USGS is working to evaluate interior least tern nesting, productivity, and use patterns around created and natural sandbars downstream from Gavins Point Dam (Sherfy et al. 2007a, 2007b). Nesting surveys were conducted, nests and chicks were monitored to determine clutch size and fate about every 2–3 days, and habitat attributes were measured for all nests located. Additionally, pilot research was conducted to evaluate and formalize methods to characterize foraging habitat for both terns and plovers on and nearby constructed sandbars. Individual terns were trapped, marked, and fitted with a radio-transmitter to allow recognition and relocation during behavioral study. Tern movements were tracked with fixed station and boat transported receivers. Blinds were used near focal colonies to record behavioral data to characterize timing, location, forage frequency, foraging efficiency, prey delivery frequency, and were compared between sandbar types. These data were coupled with forage availability data gathered with trawls near constructed and natural sandbars (Sherfy et al. 2007b).

Virginia Polytechnic Institute is working under contract to the Corps to evaluate piping plover nesting on both created and natural sandbars below Gavins Point Dam (Catlin and Fraser, 2007a, 2007b). Nest surveys, monitoring, and productivity assessments were conducted. Similar to tern nest monitoring, nests and broods were checked every 2–3 days. Forage (insects) was also characterized and forage rates of fledglings were observed. Stick traps were periodically placed on transects to assess slower invertebrates, while soil cores were removed and preserved for later analyses. Adults and young were also captured and marked with both bands and radio-transmitters, and birds were observed to characterize habitat use and activity budgets.

3.1.1 Interior Least Terns Productivity

Constructed sandbar habitats are important to nesting least terns within the Gavins Point Segment, as just over 50% of tern nests were established on the constructed sandbars from 2005–2007 (Figure 3.1). However, the number of total nests may not be an adequate measure of reproduction because this metric does not indicate the contribution of young terns to the regional tern population. Instead, fledge ratios are a better measure of productivity. During 2005, least tern fledge ratios exceeded the 0.95 fledglings/adult pair ratio set forth in the 2003 BiOp (USFWS 2003) on both constructed and natural sandbars, and the fledge ratio observed on constructed sandbars far exceeded that on natural bars. However, fledge ratios on constructed bars declined during 2006 and 2007 to levels below both the BiOp goal and that observed on natural sandbars (Figure 3.2).

Terns nested on created sandbars, shorelines and bars exposed by lower than normal releases from Gavins Point Dam, sandbars treated for vegetation control, and untreated natural sandbars. Although total tern nests decreased during each year from 2005 to 2007, the proportion occurring on created sandbars varied (Table 3.1). Terns were successful at hatching eggs within all treatments, but increases/decreases in nesting and success from 2005 to 2007 varied and may be attributed to habitat availability. In 2006, higher river flows decreased the available habitat in areas previously exposed by lower flows during 2005. Increased herbicide spraying and mowing activities during 2005 resulted in more area being suitable to nesting terns in 2006. Thus, different flow regimes coupled with management actions during successive years somewhat confound a determination of management action effect on tern nest location and productivity.

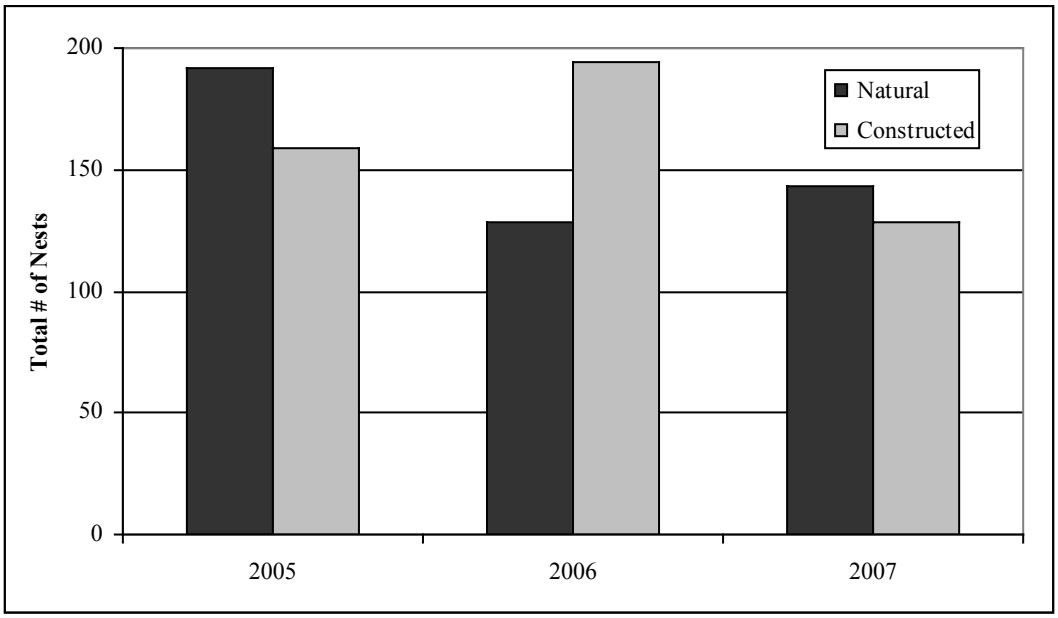

Figure 3.1. Total Least Tern Nests in the Gavins Point Segment of the Missouri River During 2005–2007

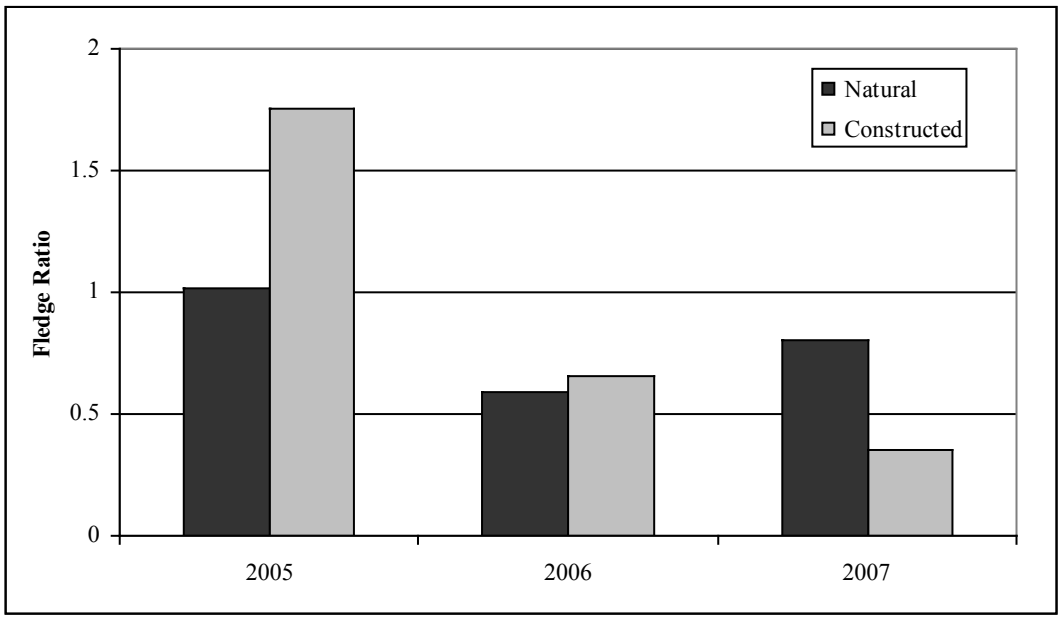

Figure 3.2. Fledge Ratios for Natural and Constructed Sandbars within the Gavins Point Segment of the Missouri River During 2005–2007

Table 3.1. Least Tern Nesting by Management Action within the Gavins Point Segment during 2005–2006 (USACOE 2007b)

Management Action	2005 Nests	2005 Successful	2005 %Success	2006 Nests	2006 Successful	2006 %Success
Constructed	159	103	64.8	194	116	59.8
Low Release	71	35	49.3	40	14	35.0
Spray	0	0	n/a	29	12	41.4
Spray and Mow	32	23	71.9	13	6	46.2
Untreated	90	32	35.6	46	19	41.3
Total	352	193	54.8	322	167	51.9

Preliminary results from the 2006 nesting season indicate mixed responses to management actions. Tern nests on managed habitats showed higher success than on untreated areas in 2005 but in 2006 success was lower on low-release exposed shorelines. The total number of nests decreased on low release, sprayed/mowed habitats, and untreated habitats between 2005 and 2006, yet increased on both constructed and spray only habitats. Nest success declined for all habitat treatments except areas with herbicide spray only; whereas success increased marginally on untreated habitats. One sandbar (RM 795.3) experienced increased use and nesting success in 2006 following spraying in 2005, while eight other sprayed sandbars previously used by nesting terns witnessed decreased use. Three sprayed sandbars were utilized by terns, but nest sites occurring outside the treated areas were chosen.

Nesting success measured in young fledged/adult pair also indicates mixed results. Fledge ratios exceeded the BiOp target of 0.94 fledglings/adult in 2005 in all treatments, but not on untreated sandbars (Table 3.2). Fledge ratios were lower in all treatments during 2006 than in 2005, and sandbars that had been sprayed and mowed had the lowest fledge ratios.

Table 3.2. Tern Fledging Ratios by Management Action in the Gavins Point Segment during 2005–2006

Management Action	Year	Adults	Fledglings	Fledge Ratio
Constructed	2005	206	181	1.76
Low Release	2005	98	61	1.24
Spray	2005	0	0	NA
Spray/Mow	2005	56	33	1.18
Untreated	2005	116	43	0.74
Subtotal	2005	476	318	1.34
Created	2006	254	83	0.65
Low Release	2006	41	15	0.73
Spray	2006	50	19	0.76
Spray/Mow	2006	16	1	0.13
Untreated	2006	22	3	0.27
Subtotal	2006	383	121	0.63
Total		859	439	1.02

Care must be taken in drawing any conclusions from these data summaries. High year-to-year variation in use of managed habitats was likely influenced by multiple factors, including significant changes in the amount of habitat available for nesting. Exposed shoreline nesting habitat was made available by lowering the total discharge, new ESH was constructed, and existing ESH was enhanced through vegetation treatment and removal all during the same time frame. Multiple management actions occurring simultaneously within the same river system make it difficult to discern the true nature of the effects of individual management actions on tern nesting.

3.1.2 Piping Plovers Productivity

As found for interior least terns, nesting habitat in the Gavins Point Segment was heavily utilized by piping plovers. Total nest numbers for each segment of the Missouri indicate that about one-fourth of the total Missouri/Kansas River piping plovers nest within the Gavins Point Segment, which averaged about 193 nests/year from 2005–2007. Natural sandbars supported a greater number of nests than constructed sandbars over the 3-year period, but numbers of nests on natural sandbars only exceeded nests on constructed sandbars during 2005, the first year after construction (Figure 3.3). Similar to tern nesting ecology, total plover nests may not be an adequate measure of reproduction as it does not indicate contribution of young birds to the regional population. Instead, fledge ratios are a better measure of productivity. Plover fledge ratios observed in the Gavins Point Segment were higher in 2005 than in subsequent years and exceeded the BiOp goal of 1.22 fledglings/adult pair in both natural and constructed sandbars (Figure 3.4). Fledge rates fell below the goal and stayed below on natural sandbars in 2006–2007, while fledge rates on constructed sandbars fell below goals in 2006 (Table 3.4). However, the 3-year average fledge rate for constructed sandbars was 1.27 fledglings/pair, exceeding the BiOp threshold. Fledge rates over the same 3-year period on natural sandbars (0.94 fledglings/pair) did not exceed the fledge rate goal.

Piping plovers nested on created sandbars, shorelines and bars exposed by lower than normal releases from Gavins Point Dam, sandbars treated for vegetation control, and untreated natural sandbars. Hatching success rates were very similar during 2005, but varied in 2006 (Table 3.3). Plovers were more likely to nest on created sandbar habitat than within habitat areas subjected to other management treatments, but this may simply be a function of availability as there was more constructed sandbar habitat area available for nesting. Plovers that established nests within either the created or sprayed (and not mowed) habitats were more likely to successfully hatch eggs in 2006.

Piping plover fledgling ratios observed in the Gavins Point Segment exceeded the 2003 BiOp (USFWS 2003) target of 1.22 fledglings/adult pair during 2005–2006, with 2005 being a very successful year exhibiting a 1.97-fledge ratio for all nesting areas within the segment (Table 3.4). Fledge ratios were highest during 2005 in areas not sprayed (i.e., the created, low release, and untreated), and declined considerably in 2006 within all habitat treatment areas. However, untreated nesting areas also had low survival in 2006 with only 0.22 fledged/pair, indicating the factors decreasing fledge ratios may be unrelated to management actions.

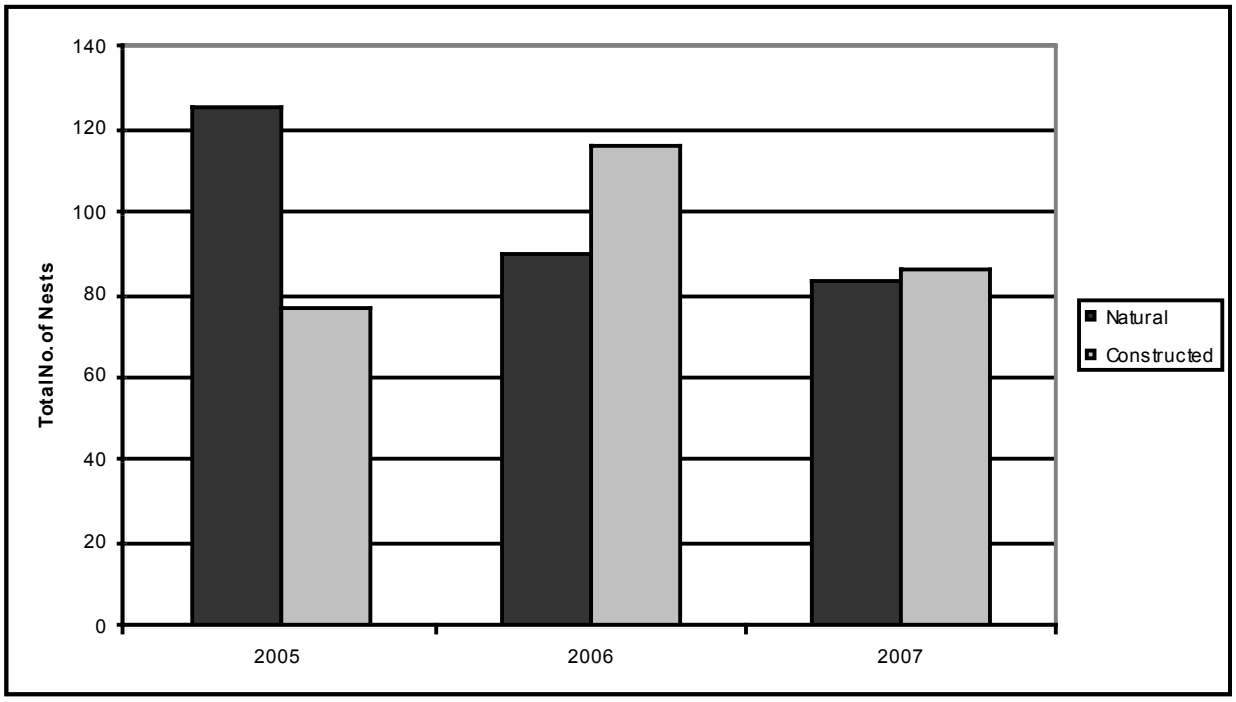

Figure 3.3. Total Piping Plover Nests in the Gavins Point Segment of the Missouri River during 2005–2007

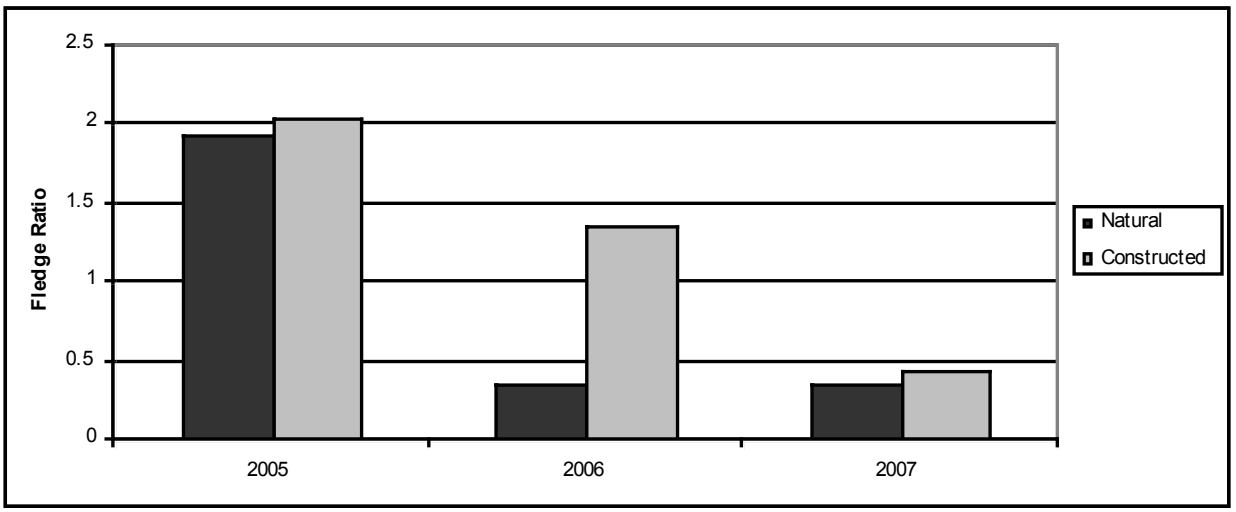

Figure 3.4. Fledge Ratios for Natural and Constructed Sandbars within the Gavins Point Segment of the Missouri River During 2005–2007

Table 3.3. Piping Plover Nesting by Treatment within the Gavins Point Segment during 2005–2006

Treatment	2005 Nests	2005 Success	2005 %Success	2006 Nests	2006 Success	2006 %Success
Constructed	77	55	71.4	116	81	69.8
Low Release	20	14	70.0	29	14	48.3
Spray	0	0		7	5	71.4
Spray and Mow	20	14	70.0	9	2	22.2
Untreated	87	52	60.0	45	14	31.1
Total	204	135	66.2	206	116	56.3

Table 3.4. Piping Plover Nesting Fledging Ratios by Management Treatment in the Gavins Point Segment during 2005–2006

Treatment	Year	Adults	Fledglings	Fledge Ratio
Constructed	2005	136	138	2.03
Low Release	2005	42	54	2.57
Spray	2005	2	0	NA
Spray/Mow	2005	30	22	1.47
Untreated	2005	130	121	1.86
Subtotal	2005	340	335	1.97
Constructed	2006	156	90	1.15
Low Release	2006	41	17	0.83
Spray	2006	40	7	0.35
Spray/Mow	2006	18	1	0.11
Untreated	2006	54	6	0.22
Subtotal	2006	309	121	0.78
Total		649	456	1.41

3.2 Nest Site Habitat Assessment

As part of monitoring and assessment, site characteristics were recorded immediately around nests to provide data about specific habitat features that may be preferred, and at what spatial scales they may be important. Objectives of these efforts are to evaluate changes in tern and plover habitats in response to construction of new habitats and vegetation control on existing sandbar habitats (Sherfy et al. 2007b). These measurements coupled with productivity data should provide resource managers with information on habitat preferences allow, allowing the application of adaptive management principles to ESH management.

Within the Missouri River Main Stem, the river was divided into sections four RMs in length; each section was then subdivided into ten 0.4-RM segments. Each segment was assigned a relative value (high, medium, low) of nesting use for both terns and plovers. Habitats were stratified by type (terrestrial or aquatic). Points were established within seven terrestrial habitat classes (dry sand, wet sand, sparsely vegetated, vegetated, wetlands, submerged sand, water) in proportion to occurrence (Sherfy et al. 2007b).

In areas where this classification was not completed, a simple random design was utilized to establish survey points. The following terrestrial habitat variables related to vegetation, substrate, and site characteristics were recorded using a 1-m^2 quadrat at the nest and 3 m from nests: woody stem density for cottonwood, willow, and other species present; cover classes for woody, terrestrial herbaceous, and wetland herbaceous species; mean and maximum vegetation height; substrate (silt, sand, pebble, gravel, cobble, boulder, leaf litter, wrack, large debris); habitat class; landform; elevation; slope; aspect; distance to water; and presence of mammal tracks (Sherfy et al. 2007b). Aquatic habitat variables, including water depth, temperature, velocity, and turbidity were also measured and recorded at random points within this habitat. Results of these efforts are pending analyses.

3.3 Behavioral Observations and Forage Evaluation

Although terns and plovers nest in the same habitats, their diet is greatly different. Therefore, different methods were employed to characterize prey availability. Least terns forage on fish over open water, so surface and benthic trawls were conducted near colonies and observed foraging sites. Piping plovers prefer terrestrial and aquatic invertebrates that occur on sandbars and near-shore environments. Sticky traps and soil cores were used to sample insects on sandbars utilized by plovers (Catlin and Fraser 2007a, 2007b). Results from these efforts will be provided in subsequent status reports.

3.3.1 Least Terns Behavior and Foraging

Fourteen areas were sampled within 0.5 RM of sandbars that historically supported terns, including constructed ESH. Six 100-meter trawl samples (three surface, three benthic) were gathered at each site every 2 weeks and site attributes such as depth, temperature, turbidity, and substrate were recorded. All captured fish were identified to genus or species and weighed, measured, and photographed. Live fish were released and deceased fish were retained and preserved (Sherfy et al. 2007b). A total of 2,718 individuals of 17 genera were captured, and 1,517 fish remain unidentified pending consultation with taxonomic experts (Table 3.5).

Behavioral studies were conducted to document timing, location, and frequency of tern foraging events (Sherfy et al. 2007b) on the three constructed sandbar complexes and four natural complexes. Forty-four adult terns were trapped, marked, and fitted with a radio-transmitter. Movements were documented using boat-mounted and fixed-location receivers. Preliminary results indicated terns travel farther than previously recorded to preferred forage sites (Sherfy et al. 2007b). Results of these study efforts are pending analyses and will be provided in subsequent status reports.

Blinds and boats were utilized to observe breeding tern colonies for 3-hour periods. Focal nests/pairs were selected and behavior was recorded at 5-minute intervals using an ethogram approach modified from Inca terns. Preliminary results indicate terns spend considerable time foraging, caring for broods, or inactive (see Figure 8 in Sherfy et al. 2007b). Results from these efforts will be provided in subsequent status reports.

Table 3.5. Count of Fish Captured by Taxon in the Gavins Point Segment in 2006 (from Table 17 in Sherfy et al. 2007b)

Common Name	Gavins Point (RM 753–808)
Shovelnose sturgeon	3
Longnose gar	2
Shortnose gar	3
Skipjack herring	1
Gizzard shad	303
Chub spp.	2
Shiner spp.	1,740
Suckermouth minnow	489
Common carp	5
Carpsucker/quillback	21
White sucker	1
Channel catfish	5
Bass	13
White crappie	1
Johnny darter	22
Walleye/sauger	100
Freshwater drum	7
Unidentified	1,517
Total	4,235

3.3.2 Piping Plovers Behavior and Foraging

During 2005–2006, surface and subsurface invertebrate abundance was characterized near plover nests and known foraging areas using two methods: sticky traps and soil cores (Catlin and Fraser 2007a, 2007b). Sticky traps, consisting of a paint stirrer coated with Tanglefoot® insect trap coating, were placed both horizontally and vertically within stratified habitat types (saturated, moist, dry, vegetated). Traps were fenced to prevent access by plovers and exposed for 30 minutes. Captured invertebrates were counted, measured, and identified to order. To assess subsurface invertebrate abundance, 10-cm-diameter by 2-cm-deep soil cores were sampled in moist and saturated habitats and nearby sticky trap emplacements and preserved in ethanol for later identification.

Behavioral studies were conducted to assess foraging behavior and habitat use of plover chicks on constructed sandbars. Radio-transmitters (9 in 2005, 20 in 2006) were affixed to pre-fledge plover chicks. Subsequently, chicks would be relocated and activity, location, and habitat type would be recorded at time of relocation and at 15-minute intervals. Behavior of unmarked chicks was also monitored for 5-minute intervals. Foraging events (pecks) were tallied by habitat type (saturate, moist, dry) every 10 seconds. Vegetation on natural sandbars obscured view of plover chicks and prevented assessment of forage rates.

3.4 Implications of Management Actions for Terns and Plovers

Historical surveys conducted throughout the mainstem of the Missouri River watershed to determine the status and distribution of both tern and plover breeding populations indicated the importance of the Gavins Point Segment of the Missouri River in South Dakota to both species as far back as 1986 (Figure 3.5). These early surveys indicated 82% of the tern and 90% of the plover nesting within the Missouri River system occurred within 24 different nesting areas between Gavins Point Dam and Ponca State Park (Schwalback et al. 1986). Currently, the Gavins Point Segment of the Missouri River continues to be an important nesting ground for both least terns and piping plovers. Although population levels and fledging rates varied considerably during subsequent years (Schwalback et al. 1988; USFWS 1989, 1991; USACOE 1993, 1995, 2002, 2003, 2007a), habitats below Gavins Point Dam continue to support substantial numbers of breeding terns (Figure 3.6) and plovers (Figure 3.7).

Mechanical creation of ESH for nesting terns and plovers appears to be a viable management tool, as both terns and plovers had demonstrated in 2005 the ability to successfully reproduce at or above levels stipulated in the BiOp (USFWS 2000, 2003) on constructed sandbars. However, monitoring of the constructed ESH habitat has only occurred for a short period of time. Use of and breeding success on constructed ESH by both plover and terns has been inconsistent. During the 2005-2007 time-period river hydrology varied significantly, and during low water years the birds utilized recently exposed natural bars, confounding short-term reproduction and habitat use trends.

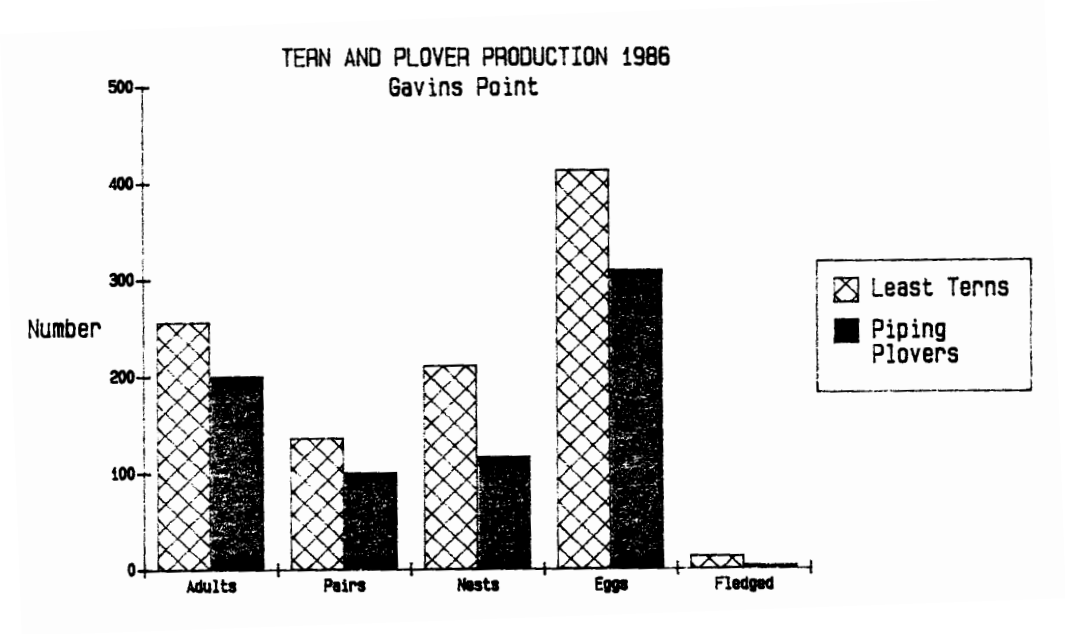

Figure 3.5. Least Tern and Piping Plover Production Within the Gavins Point Segment of the Missouri River During 1986 (Figure 24 from Schwalback et al. 1986)

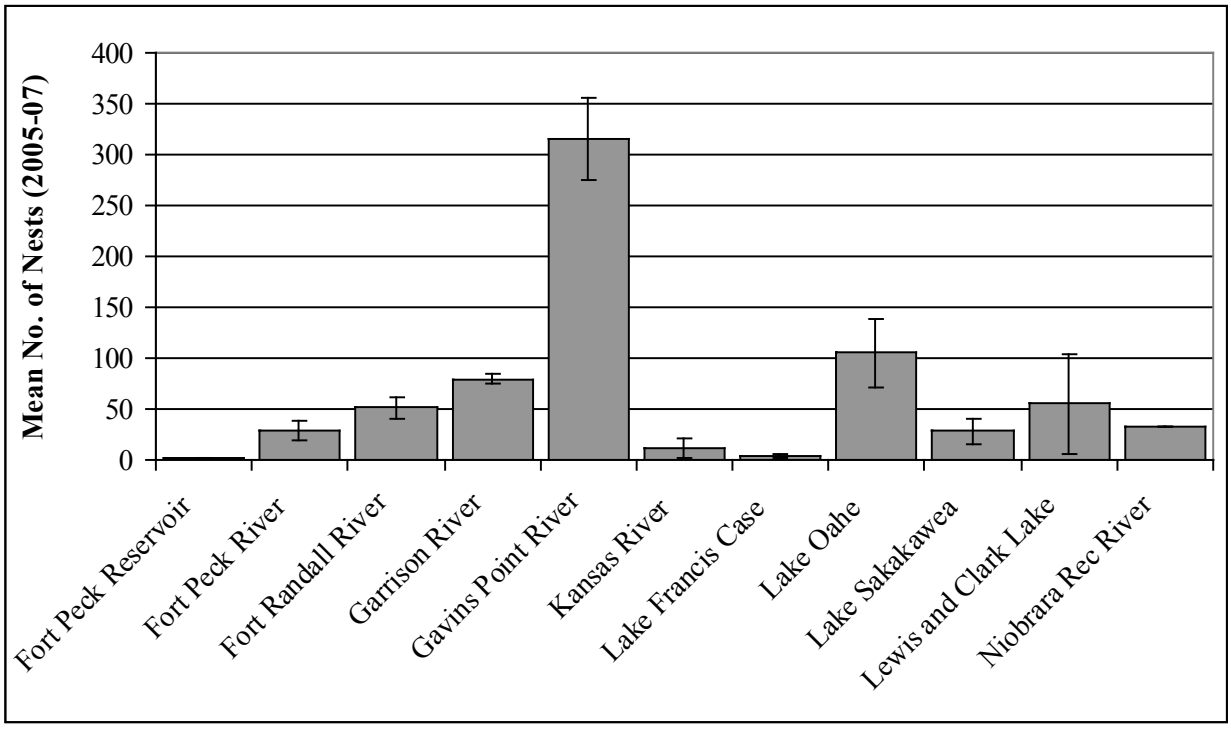

Figure 3.6. Total Nesting of Interior Least Terns Along the Missouri, Kansas, and Niobrara Rivers by Segment (±1 std. dev.) During 2005–2007 (USACOE 2007b)

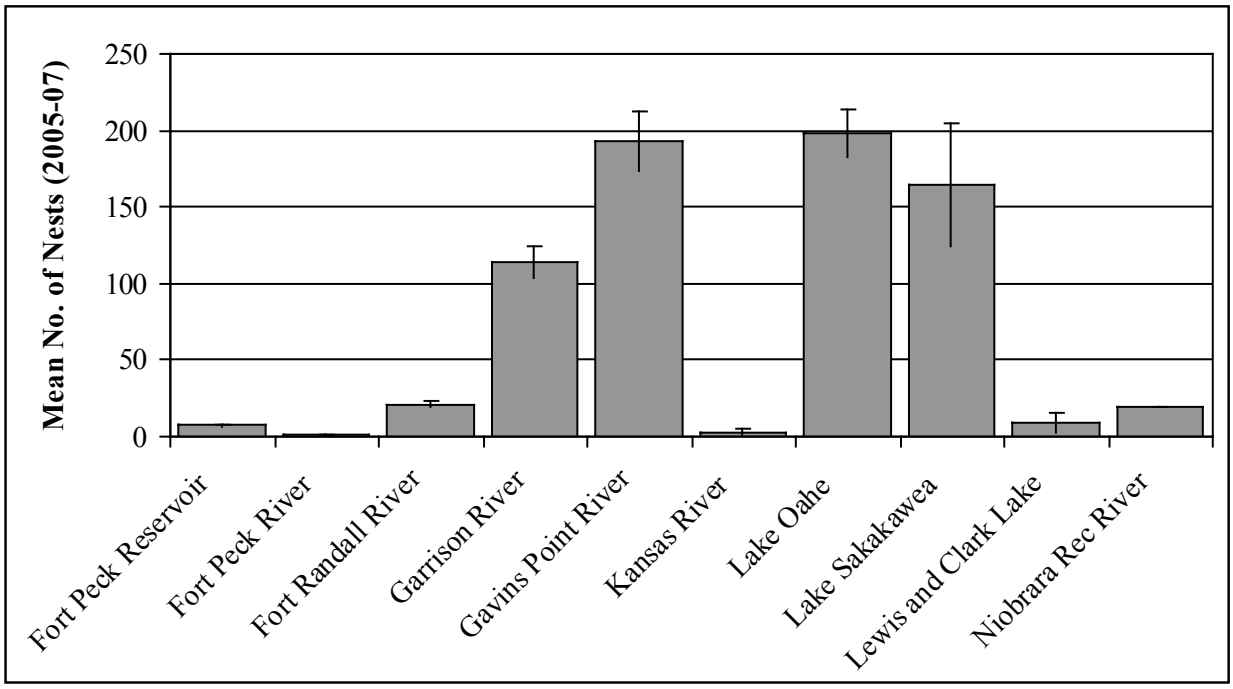

Figure 3.7. Total Nesting of Piping Plovers Along the Missouri, Kansas, and Niobrara Rivers by Segment (± 1 std. dev.) During 2005–2007 (USACOE 2007b)

Management actions within the Gavins Point Segment to enhance existing sandbar habitat by eliminating encroaching plant cover using low flow releases, herbicide spraying, and plant material removal by mowing have also had mixed results. Similar to trends on created ESH, year-to-year variation of nesting activity is likely related to river levels and availability of other suitable habitat. Regardless, vegetation control measures may also provide managers with another option as both terns and plovers have successfully nested within treated habitats and fledged young above the BiOp thresholds for a given year. More data are needed to determine the effectiveness of various treatments.

Final results and reporting of current investigations focused on characterizing important nest site characteristics for both terns and plovers and assessing forage availability are not yet available. However, anecdotal observations indicate extensive use of newly created shallow backwater habitat for foraging (Mestl 2004). Data gathered on terns by the USGS using radio telemetry techniques should clarify the role that new shallow water habitats associated with constructed ESH may play with respect to tern foraging efficiency, which has been linked to fledging success (Sherfy et al. 2007b). Many different species and life stages of fish have colonized shallow water habitat that is enhanced by the creation of new ESH.

4.0 Summary and Status of Constructed ESH

During 2004 and 2005, the Corps engaged in construction activities to create additional ESH (three sandbar complexes consisting of approximately 157 acres at flows between 20,000 and 30,000 cfs) in the Gavins Point Segment of the Missouri River. Post-construction monitoring indicates that although erosion has occurred and continues to occur at each of the three complexes, more than 100 acres of constructed ESH are estimated to persist at similar flows in the segment. Baseline monitoring and ongoing studies of wildlife and habitat features are being conducted at each of these complexes provide information on the status and condition of the constructed ESH. Table 4.1 summarizes the types and timing of monitoring surveys and studies that have been conducted in the Gavins Point Segment and have collected data in association with the constructed ESH. The Corps also plans to complete a construction project initiated in August 2007 to provide three additional ESH complexes in this segment by spring 2008.

Initial monitoring information on the persistence and function of constructed ESH below Gavins Point Dam indicates that constructed sandbars provide suitable habitat features for nesting and foraging least terns and piping plovers and may provide important habitat for other wildlife as well. Although some erosion and vegetation growth occurred following the development of the complexes as expected in the dynamic environment of the main stem Missouri River (Jons 2006; USACOE 2006; Thompson et al. 2007), the constructed ESH has provided additional nesting habitat for terns and plovers over the 3-year post-construction monitoring period. Constructed sandbars in the Gavins Point Segment also provided new nesting habitat for turtles (Dixon and Dieter 2007).

The results gathered to date indicate that terns and plovers are using created sandbar habitats, and have at times successfully reproduced at or above levels stipulated in the BiOp on constructed sandbars. Management actions to enhance existing natural sandbar habitat by eliminating encroaching plant cover have been marginally successful in providing additional bird nesting habitat within the Gavins Point Segment. Both terns and plovers utilized habitats enhanced by low flow releases, herbicide spraying, and plant material removal by mowing.

Management actions related to restoring Missouri River habitats, specifically the mechanical creation of ESH and enhancement of shallow backwater habitats, and to a much lesser extent the management and removal of encroaching vegetation on sandbars, are clearly having an initial positive impact on both target and non-target species. However, whether such positive impacts (i.e., increases in available nesting habitat and use of 'new' habitat) will persist cannot yet be adequately assessed. Results of ongoing studies to quantify and map ESH habitat types and quantities will provide important information on year-to-year variability and persistence of suitable habitat for tern and plover nesting, and for other wildlife species of concern. A significant effort is also being conducted to characterize nest-scale habitat features related to nest placement and subsequent nest fate as well as food availability for both plovers and terns. Results of these studies will also provide information to guide future vegetation and habitat management activities.

Impacts of individual management actions on interior least terns and piping plovers cannot yet be fully determined until data from ongoing investigations (Catlin and Fraser 2007a, 2007b; Sherfy et al. 2007a, 2007b) and monitoring activities (Jons 2006) have been analyzed and interpreted. Tern and plover reproductive success, an important metric in evaluating success of these management actions, was highly

variable. Confounding factors may be contributing to the observed variability in habitat use and nesting success, which may also be affected by factors not related to management action (e.g., local and regional climate or location-specific predation). These factors must be considered when evaluating short-term trends in reproductive success. However, initial comparisons of reproductive success between managed and unmanaged habitats clearly indicate benefits of management actions in increasing available habitat. Results of ongoing monitoring studies will provide additional information to develop adaptive management approaches that are most beneficial to all wildlife that utilize ESH and associated shallow water habitats, including the interior least tern and piping plover.

Table 4.1. Monitoring Activity (Year of Survey or Data Collection)

Location	Tern Nesting Surveys	Tern Habitat Surveys	Tern Forage Availability	Plover Nest Surveys	Plover Habitat Surveys	Plover Forage Surveys	Remote Sensing Habitat Delineation	Geomorphology Assessments		Sediment Modeling	Unionid Surveys		Turtle Surveys	Fish Characterization	
								Pre-construction	Post-construction		Pre-construction	Post-construction		Pre-construction	Post-construction
RM 754.4	2005, 2006, 2007	2006, 2007	2006, 2007	2005, 2006, 2007	2005, 2006, 2007	2005, 2006, 2007	2005, 2006, 2007					2006, backwater areas	2006, 2007	2000	2004
RM 761.3	2005, 2006, 2007	2006, 2007	2006, 2007	2005, 2006, 2007	2005, 2006, 2007	2005, 2006, 2007	2005, 2006, 2007	2004	2005		2004	2005?	2006, 2007		2006, 2007
RM 770	2005, 2006, 2007	2006, 2007	2006, 2007	2005, 2006, 2007	2005, 2006, 2007	2005, 2006, 2007	2005, 2006, 2007	2004	2006	2006	2004	2005?	2006, 2007		2006, 2007

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