2008 Interior Least Tern and Piping Plover Monitoring, Research, Management, and Outreach Report for the Lower Platte River, Nebraska

TERN & PLOVER CONSERVATION PARTNERSHIP

NONGAME BIRD PROGRAM

2008 Interior Least Tern and Piping Plover Monitoring, Research, Management, and Outreach Report for the Lower Platte River, Nebraska

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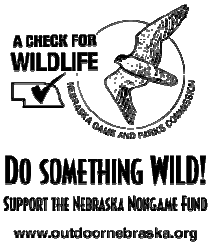

We extend our thanks to the people who assisted with the project. Adam Behmer, Jeanine Lackey, Jamie McFadden, Diane Pratt, Kristal Stoner, Jason Thiele, Chris Thody, Melissa Vander Linden, and Ben Wheeler assisted with field work. Sarah Rehme and Melissa Vander Linden assisted with data management. Sarah Rehme assisted with data analysis. Kristal Stoner, Rick Schneider, and Martha Tacha provided input during at various times during the project period.

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PREFACE

This is a preliminary report on our research, monitoring, and outreach programs during the past 12 months. The report was prepared to inform our partners and funding agencies of our activities and to provide a preliminary summary of results. ***These data analyses are not final and should be treated as such when citing information, data, or analyses found in this document.***

In effort to make the document more readable, we divided it into five sections: Introduction, Monitoring, Research, Management, and Education and Outreach.

Introduction: This section provides details of the study area and summarizes conditions during the 2008 season.
Monitoring: This section presents data that are collected annually for basic demographic analyzes and includes the number of nests, adults, chicks, and fledglings found in the area. These data are collected and summarized in a form that allows comparison across the entire range of each species. This section also includes annual survey results.
Research: This section provides details on data collection and analyzes these data relative to specific defined objectives, and involves more rigorous statistical analysis of the data.
Management: This section describes actions designed to protect Least Tern and Piping Plovers colonies and nests from human interference.
Education and Outreach: This section describes activities designed to increase public awareness and understanding of Least Terns and Piping Plovers.

Topics within the Monitoring and Research sections follow the standard organization of introduction, methods, results, and discussion. Our approach and techniques differed slightly from river to off-river habitats and where appropriate, we highlight the differences.

The following icons are used on site maps to designate nest locations.

 Least Tern Nest

 Piping Plover nest

"…so now that man is no longer its deadly enemy, there is little to check the species from repopulating its breeding haunts in its former numbers…"

A.C. Bent, Life Histories of North American Shorebirds
1929

INTRODUCTION

The Interior Least Tern (*Sternula antillarum athallassos*) is a state and federal endangered species; it was first listed in 1985. The Piping Plover (*Charadrius melodus*) is a state and federal threatened species; it was also first listed in 1985. As a result of their listing status they are protected by the federal Endangered Species Act and the Nebraska Nongame and Endangered Species Conservation Act. Terns and plovers are both identified as Tier1-At Risk species by the Nebraska Legacy Project. In Nebraska, terns and plovers nest on sparsely or non-vegetated expanses of sand in the Platte River valley and along its tributaries. These two species use similar habitats and often co-exist in the same colonies during the nesting season.

The Tern and Plover Conservation Partnership (TPCP) and the Nongame Bird Program (NBP) at the Nebraska Game and Parks Commission (NGPC) work cooperatively on Interior Least Tern and Piping Plover monitoring, research, management, education, and outreach activities in Nebraska. Our program includes terns and plovers nesting on midstream river sandbars, sand and gravel mines, and lakeshore housing developments. These habitats are sufficiently different that they require different management methodologies. This document summarizes our activities during 2008 and highlights our activities during the nesting season. The TPCP led our efforts at sand and gravel mines and lakeshore housing developments, while the NBP took the lead in our efforts on river sandbars.

STUDY AREA

The study area includes the Platte, Elkhorn and Loup River systems in eastern Nebraska (Figure 1). The lower Platte River is the focus of our work because of its importance to Least Tern and Piping Plover recovery and because it supports the majority of the birds in the study area. The lower Platte River extends from the confluence of the Platte and Loup rivers near Columbus, Platte County, to the mouth, near Plattsmouth, Cass County, where the lower Platte empties into the Missouri River (103 RMs; RM = river mile). The Loup, Elkhorn, and central Platte Rivers are all tributaries of the lower Platte River.

In the lower Platte River system, tern and plover habitat is located at both river and off-river sites. River habitat includes midstream sandbars used for nesting and the river itself which is used for foraging. Off-river habitat includes spoil piles of sparsely or non-vegetated sand and the associated “sandpit lakes” at sand and gravel mines. After they are taken out of production, mines are usually renovated and converted into lakeshore housing developments. Some housing developers dredge the lake directly, bypassing the mine stage. Terns and plovers nest on the expanses of sandy beach at lakeshore housing developments. Birds nesting at these off-river sites forage on the river or at the sandpit lakes. See Table 1 for our 2008 off-river sites and Table 2 for our 2008 river sites.

2008 RIVER CONDITIONS

The amount of sandbar nesting habitat that is available to nesting terns and plovers in the lower Platte River is unpredictable from year to year. It is dependent upon the volume and depth of water that is flowing in the river, seasonal and daily fluctuations in the river flow, and segments of the river channel that, hydrologically, allow for open sandbar development. General flow conditions on the lower Platte River were monitored by checking USGS water gauge levels (http://waterdata.usgs.gov/ne/nwis/rt) and by visual inspection of the river at bridge crossings. These visual inspections were supplemented a time-series of photographs. See Figures 2 – 5 for examples.

Flows were unremarkable from April through the middle of May in 2008. Above average rainfall across the region occurred during the early summer and resulted in the highest peak flows on the lower Platte River in 13 years (http//water.usgs.gov). More specifically, the 2008 peak flow followed seven years of drought that produced low annual flows (Ginting, D., R.B. Zelt, and J.I. Linard. 2008. U.S. Geological Survey Scientific Investigations Report 2007-5267, 43 pgs). Peak high flows occurred during the last week of May, continued through the middle of June and then rapidly decreased (Figures 6 – 9). The peak flow recorded at the Louisville gauge was 96,600 cubic feet per second (cfs) on 31 May 2008. The peak flow recorded at the North Bend gauge was 45,500 cfs on 30 May 2008. The peak flows measured at both of these gauges were markedly higher than the flow, 38,170 cfs, identified by Parham (2007. Report prepared for the Nebraska Game and Parks Commission, 138 pgs) as necessary to maintain sandbar habitat on the lower Platte River. River levels declined in mid to late June and sandbar habitat was available to the birds from the latter half of June onward. A subsequent peak flow of 19,500 cfs was recorded at the Louisville gauge on 18 July 2008 which was a result of water run-off from Salt Creek.

Least Tern chick

Table 1. Location of off-river sites. Numbers correspond with Figure 1.

#	Site Name[1]	River	Owner	Site Type	County
1	Four Mile Creek	Platte	Lyman Richey	Active Mine	Cass
2	Louisville Lakes	Platte	Western Sand and Gravel	Active Mine	Sarpy
3	Linoma Beach	Platte	Lyman-Richey	Active Mine	Sarpy
4	Melia	Platte	Private	Inactive Mine	Sarpy
5	Riverside	Platte	Western Sand and Gravel	Active Mine	Saunders
6	NW Riverside	Platte	Western Sand and Gravel	Active Mine	Saunders
7	Big Sandy	Platte	Homeowners	Housing Develop.	Saunders
8	OMG-Venice	Platte	Old Castle Minerals	Active Mine	Douglas
9	Lake Clagus	Platte	Lyman Richey	Active Mine	Douglas
10	Timber Lodge Lake	Platte	Dial Development	Housing Develop.	Douglas
11	Pleasure Lake	Platte	Lyman Richey	Active Mine	Douglas
12	N Woodcliff	Platte	Western Sand and Gravel	Active Mine	Dodge
13	NE Fremont	Platte	Lyman Richey	Active Mine	Dodge
14	Riverview Shores	Platte	Homeowners	Housing Develop.	Dodge
15	Socorro Lake	Platte	Homeowners	Housing Develop.	Colfax
16	Wilson Creek	Platte	Central Sand and Gravel	Active Mine	Butler
17	Shady Lake Road	Loup	Central Sand and Gravel	Active Mine	Platte
18	W Lookingglass Creek WMA	Loup	Central Sand and Gravel	Active Mine	Platte
19	Haskell Creek	Loup	Ulrich Sand and Gravel	Active Mine	Valley
20	Overland	Loup	Overland Sand and Gravel	Active Mine	Hamilton
21	North Loup SRA	Loup	Central Sand and Gravel	Active Mine	Howard
22	E Elba	Loup	Tri-County Sand and Gravel	Active Mine	Howard
23	LPPD-Genoa Loup Diversion	Loup	Preferred Rocks of Genoa-LPPD	Active Mine	Nance
24	Medelman's Lake	Elkhorn	Central Sand and Gravel	Active Mine	Madison
25	Andy's Lake	Elkhorn	Pilger Sand and Gravel	Inactive Mine	Madison
26	Red Fox WMA	Elkhorn	Pilger Sand and Gravel	Inactive Mine	Stanton
27	Horseshoe Lake	Elkhorn	Stalp Sand and Gravel	Active Mine	Cumming

[1]Site name as it is recorded in NGPC database

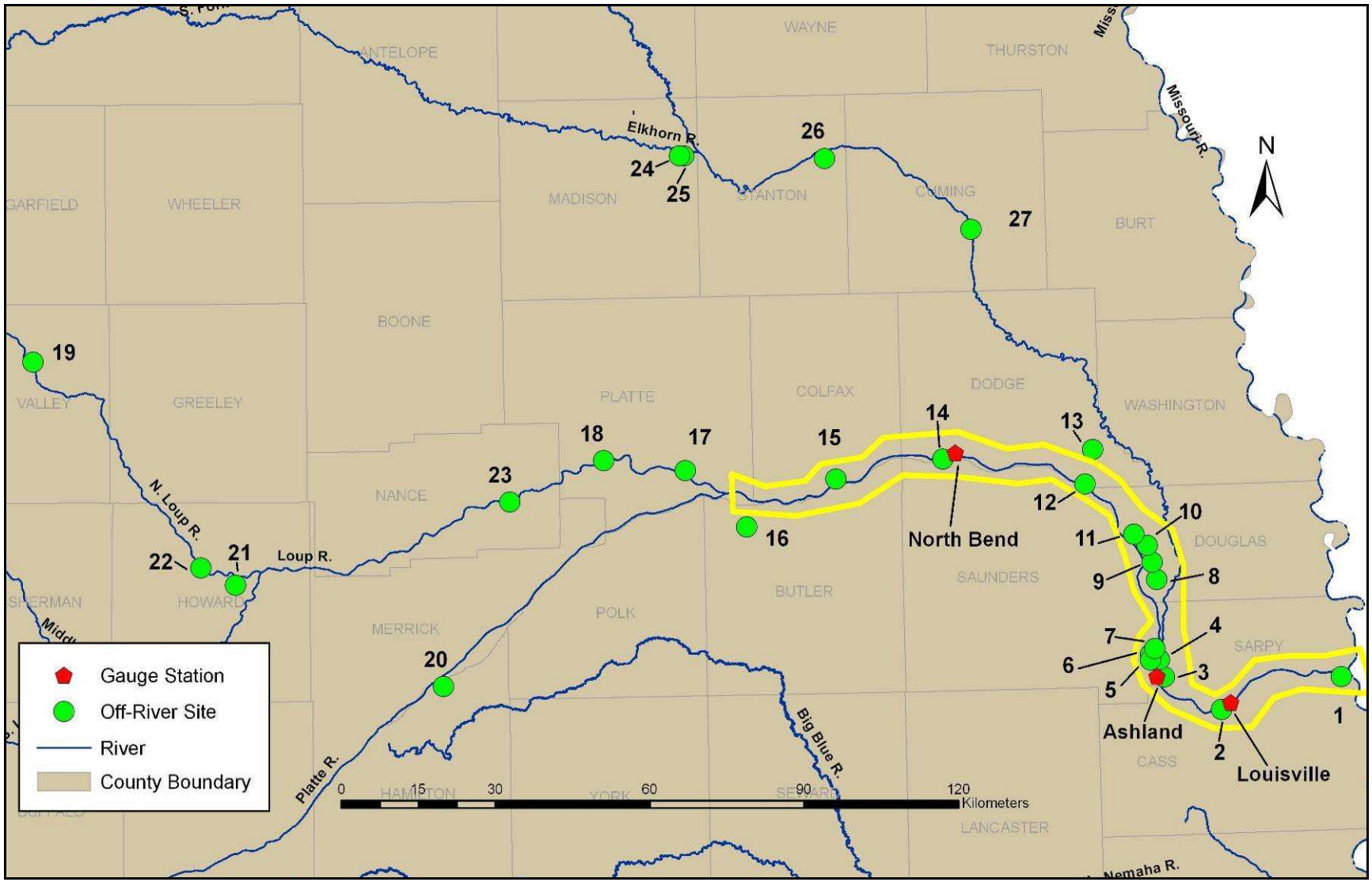

Figure 1 Study area in eastern Nebraska. Our focal area, the lower Platte River, is outlined in yellow. Off-river sites can be matched to numbers in Table 1.

Figure 2. The lower Platte River at the Schramm State Park river access (looking northwestward at 12:44 DST on 7 June 2008). The Louisville gauge station measured 51,500 cfs (8.44 ft) at 13:30 DST on 7 June 2008.

Figure 3. This is the same view as Figure 2 at 12:03 DST on 19 June 2008. The Louisville gauge station measured 14,900 cfs (5.39 ft) at 13:30 DST on19 June 2008. Note the appearance of a large mid-stream sandbar which was not visible just days earlier.

Figure 4. The lower Platte River at the Mahoney State Park tower (looking northward at 14:32 DST on 7 June 2008. The Louisville gauge station measured 51,500 cfs (8.44 ft) at 13:30 DST on 7 June 2008.

Figure 5. This is the same view as Figure 4 at 15:11 DST on 19 June 2008. The Louisville gauge station measured 14,900 cfs (5.39 ft) at 13:30 DST on 19 June 2008.

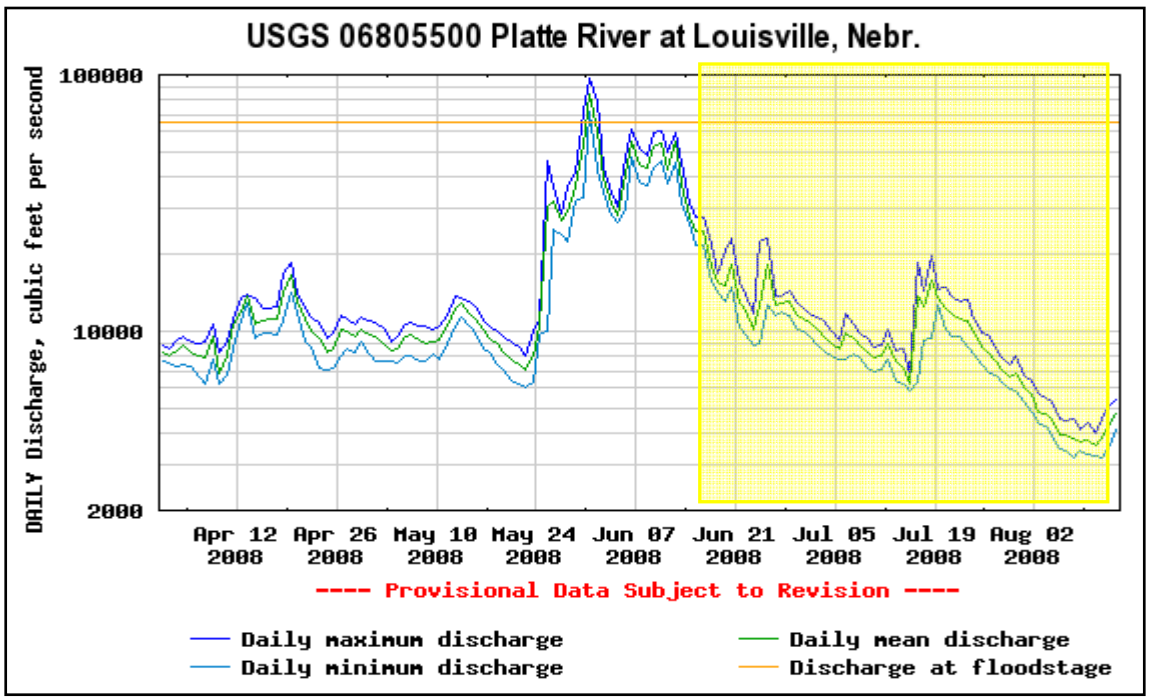

Figure 6. Daily water discharge (cubic feet per second; cfs) measured at the Louisville USGS gauge station. The river sandbar nesting season is highlighted in yellow.

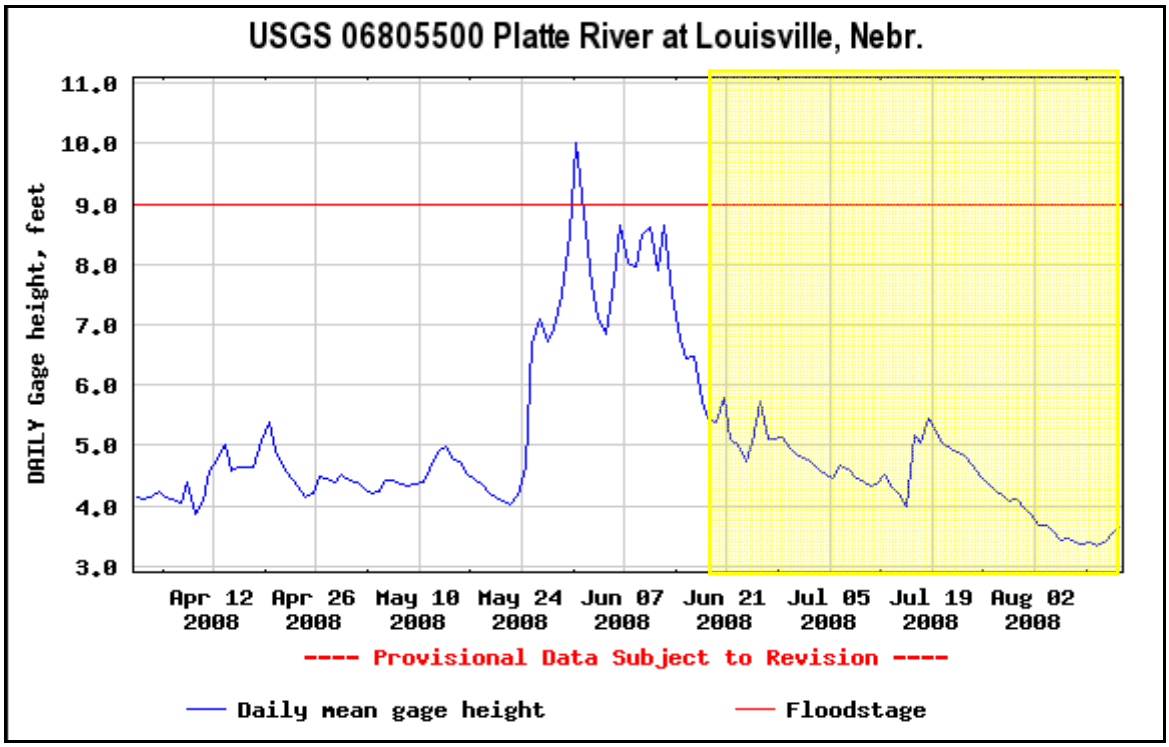

Figure 7. River height (feet; ft) measured at the Louisville USGS gauge station. The river sandbar nesting season is highlighted in yellow.

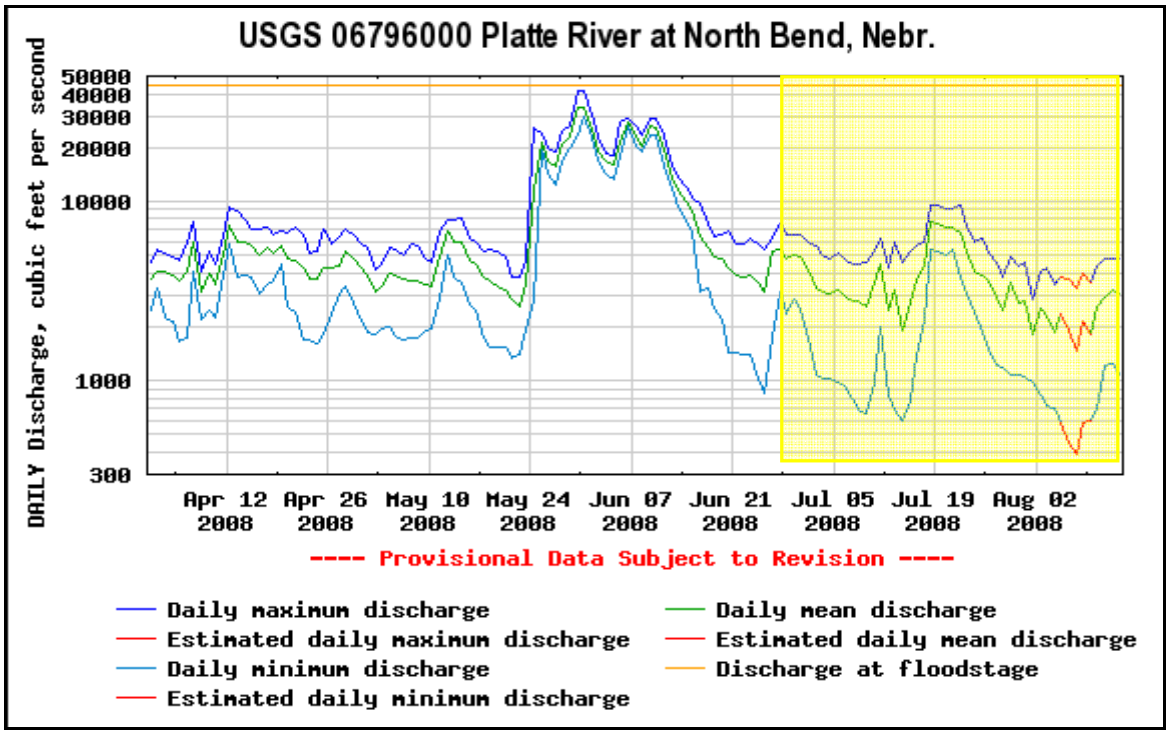

Figure 8. Daily water discharge (cubic feet per second; cfs) measured at the North Bend, NE, USGS gauge station. The river sandbar nesting season is highlighted in yellow.

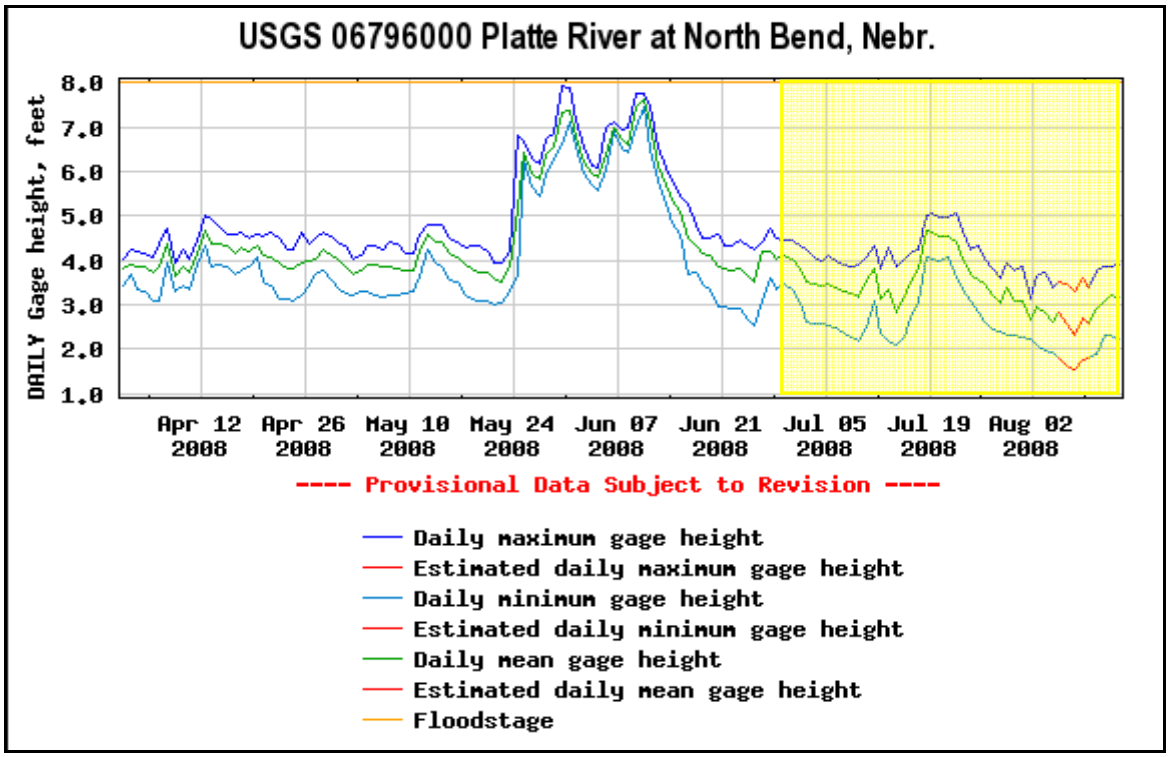

Figure 9. River height (feet; ft) measured at the North Bend USGS gauge station. The river sandbar nesting season is highlighted in yellow.

MONITORING

MID-SUMMER SURVEY

Since 1987, the Nebraska Game and Parks Commission has coordinated a standardized survey of adult Least Terns and Piping Plovers on the lower Platte River system. The TPCP began participating in this survey in 1999. The survey area extends 103 river miles, from near Columbus, Platte County to near Plattsmouth, Cass County. In 2008, the survey was conducted 16–19 June.

Methods: We planned to survey the lower Platte River sites by airboat and the off-river sites by vehicle and foot during the 4-day survey period. High water on the lower Platte River prevented safe access to the river, thus our survey was limited to off-river sites. The river was surveyed later in the nesting season after conditions improved (see Nest Monitoring section).

Results: We recorded 61 adult Piping Plovers and 200 adult Least Terns during the 2008 mid-summer survey (Figures 10 –15). Adult Piping Plover totals increased from 39 in 2007, but adult Least Tern totals declined from 418 in 2007. The proportion of both species nesting on off-river habitat has steadily increased over the past 20 years. It should be noted, that relatively high numbers of Least Terns compared to past years colonized river sandbar habitat shortly after the mid-summer survey took place. It is likely that some of these birds were re-nesting after earlier nesting attempts at off-river sites failed, but others may have delayed nest initiation until habitat was available on the river. This pattern was not observed with Piping Plovers, as very few birds were observed nesting on the river.

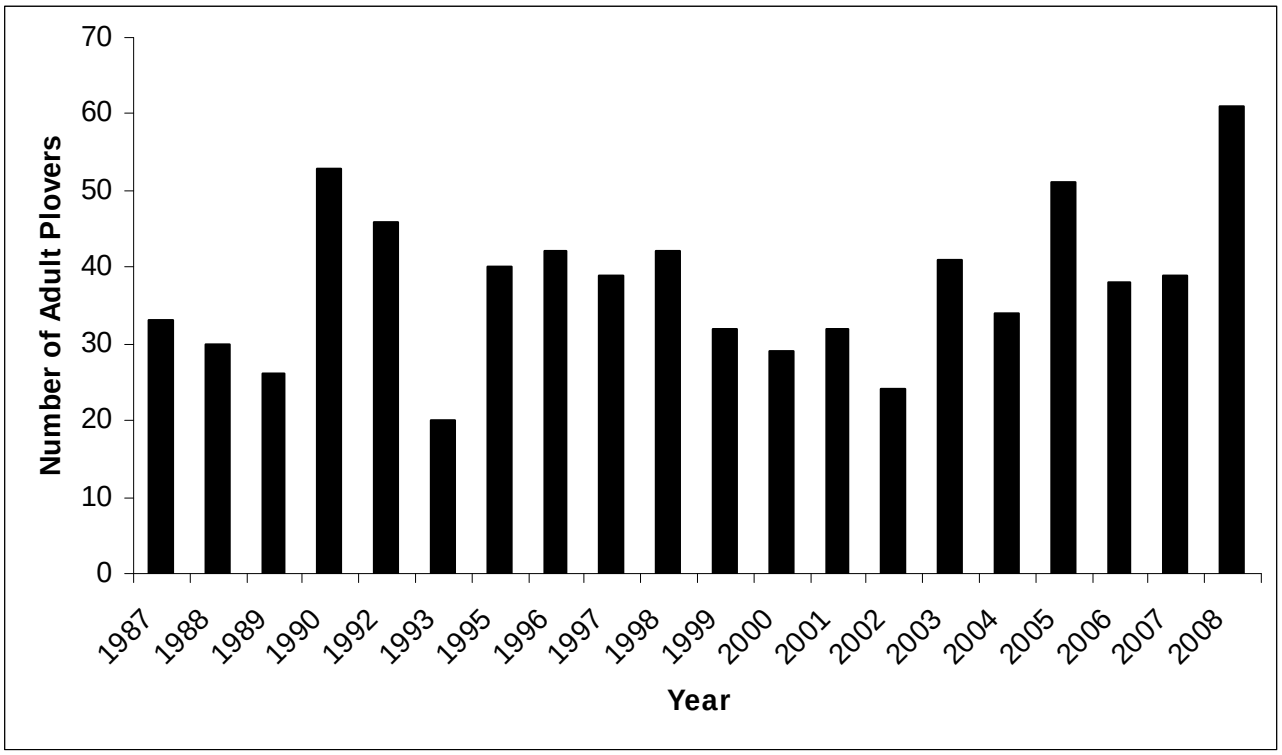

Figure 10. Number of Piping Plovers recorded at off-river sites on the lower Platte River during the annual mid-summer survey (1987–2008).

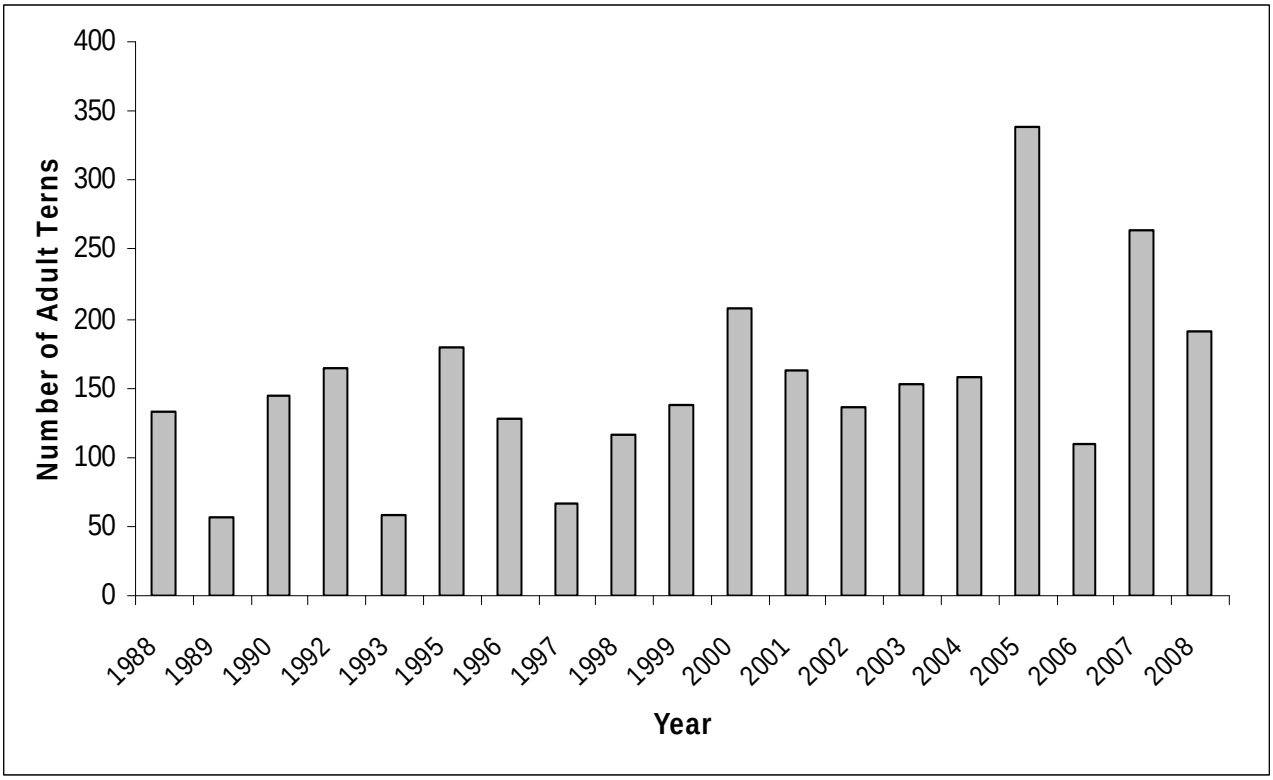

Figure 11. Number of Least Terns recorded at off-river sites on the lower Platte River during the annual mid-summer survey (1987–2008).

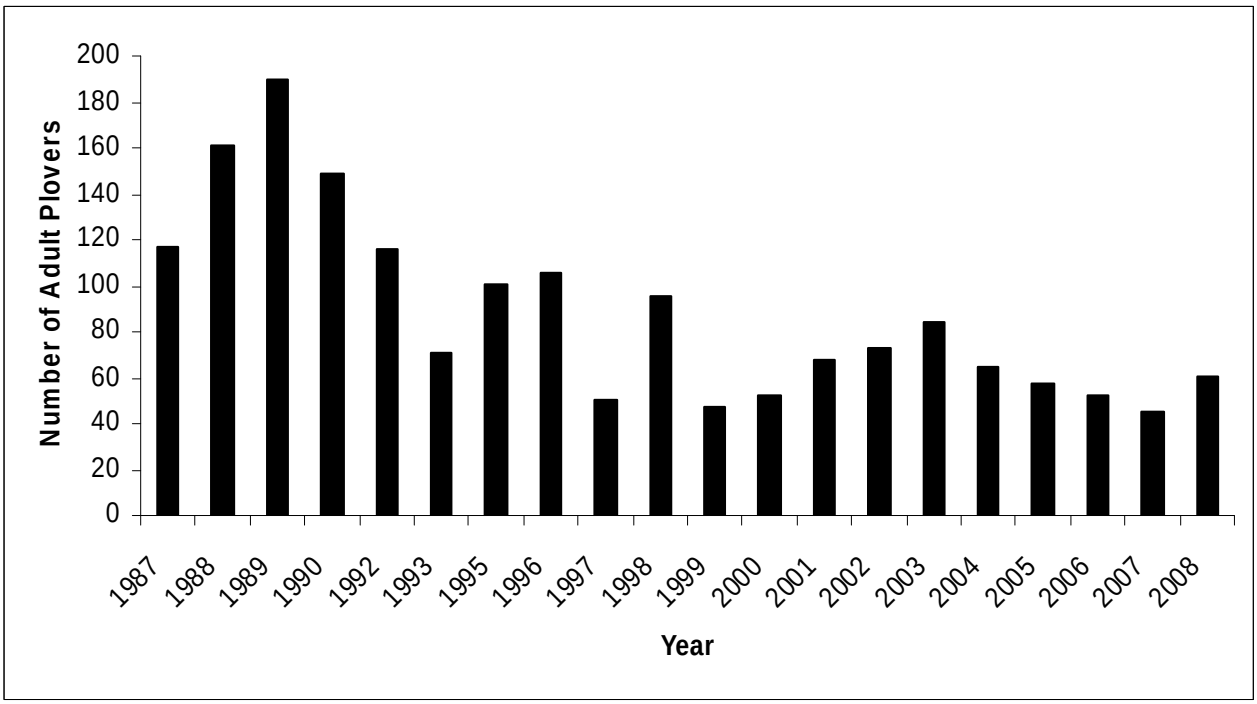

Figure 12. Total (river and off-river sites) number of Piping Plovers recorded on the lower Platte River system during the annual mid-summer survey 1987–2008.

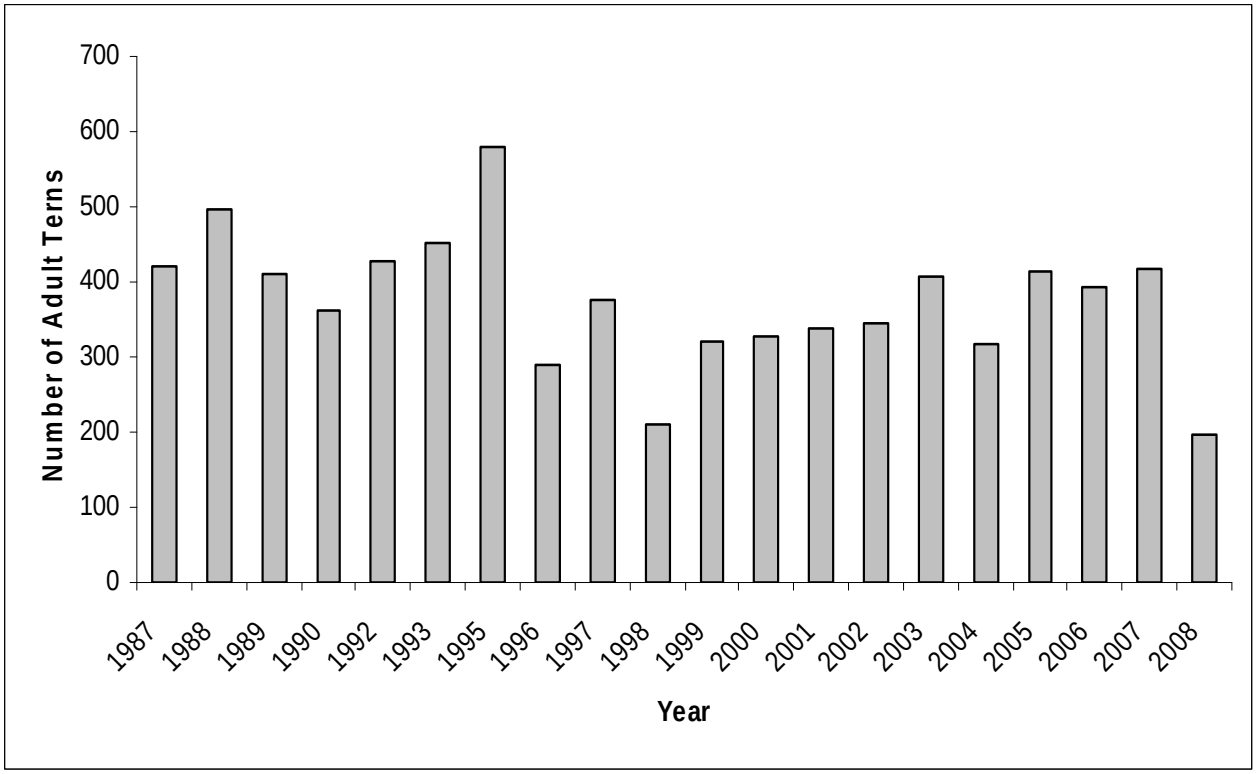

Figure 13. Total (river and off-river sites) number of Least Terns recorded on the lower Platte River system during the annual mid-summer survey (1987–2008).

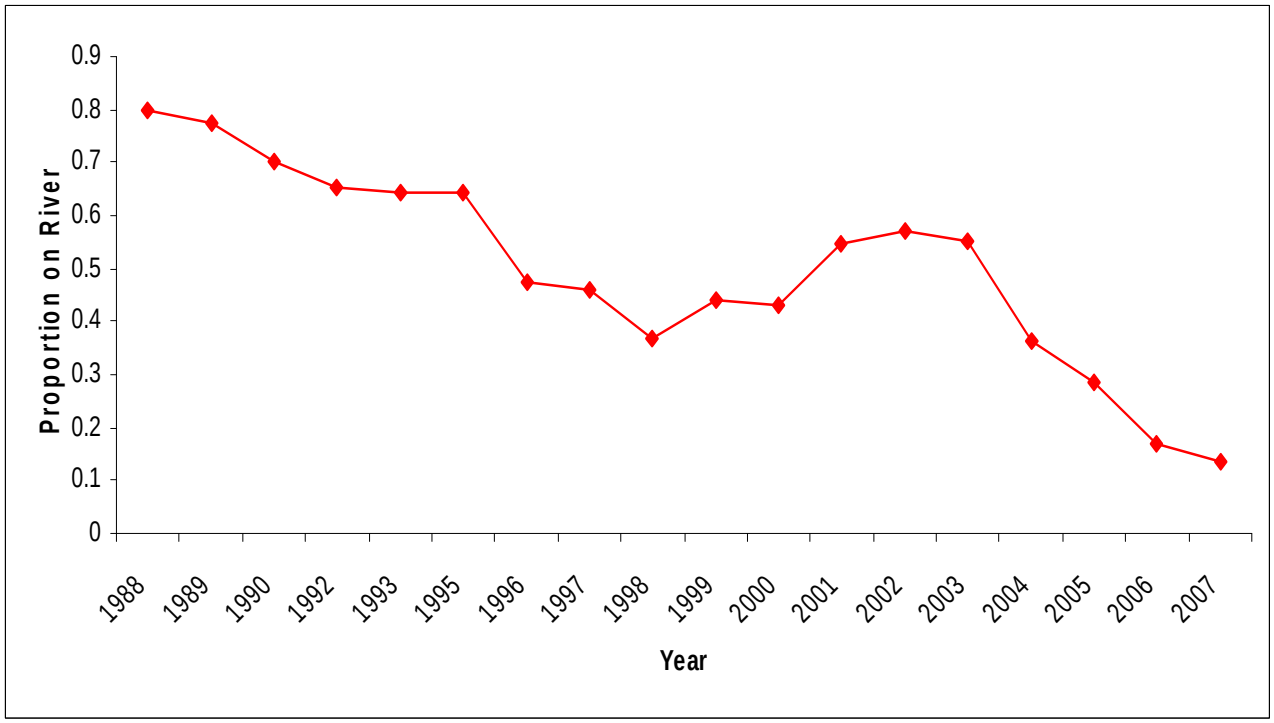

Figure 14**.** Proportion (smoothed) of Piping Plovers recorded on river habitat on the lower Platte River during the annual mid-summer survey (1987–2008).

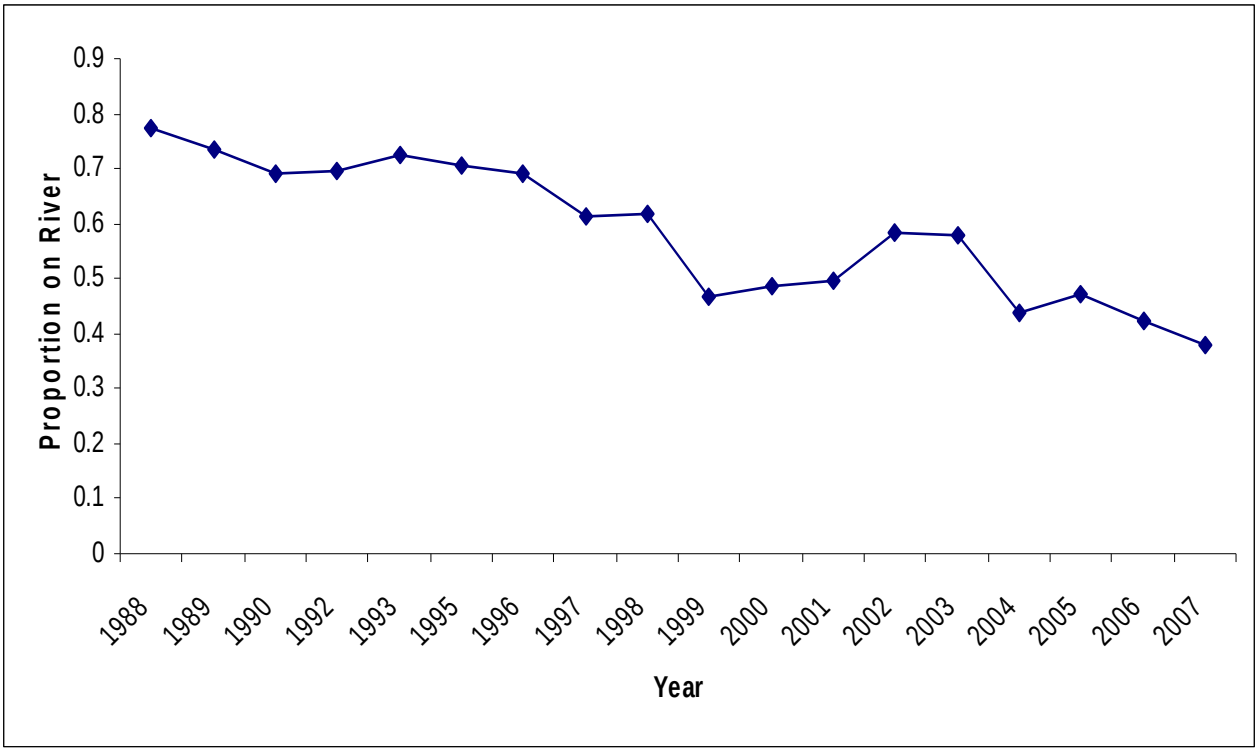

Figure 15. Proportion (smoothed) of Least Terns recorded on river habitat on the lower Platte River during the annual mid-summer survey (1987–2008).

NEST MONITORING

Methods – Off-River

Beginning in mid-April, we began visiting all sand and gravel mines and lakeshore housing developments in the area. We concentrated on sites that our records indicated terns and plovers had nested at in previous years. We visited all sites regularly, surveying them thoroughly for terns and plovers. Each site was surveyed every 4 – 5 days. The same observers surveyed the sites in an effort to minimize inter-observer bias. When individuals of either species were located, they were observed to determine whether they were migrants or potential breeders. When potential breeders were observed at a location, the open sandy areas were thoroughly searched for evidence of nests or nest scrapes. Most often, nests were found by observing adult birds sitting on nests incubating eggs.

For every tern and plover nest that we found, we recorded the location using a handheld GPS and 'floated' the eggs to determine their age (Hays and LeCroy 1972. Wilson Bulletin 83: 425 – 429). Nearly all nests were located within 1 – 6 days after initiation. We continued to locate nests throughout the field season.

All nests at off-river sites were visited every 4 – 5 days during incubation until the eggs began hatching. We did not disturb the nests. The visits were only to check for the presence of incubating adults and the number of eggs present. We scored the status of each nest based on the following criteria:

confirmed successful: pipped eggs or newly-hatched chick(s) observed in or in the immediate vicinity (<1 m) of the nest cup
likely successful: empty, but intact nest cup found with/without pieces of pipped egg-shell at/after the expected hatch date
confirmed failure: nest cup and/or eggs found destroyed
likely lost: nest not relocated on repeat visits prior to expected hatch date

At some sand and gravel mines, terns and plovers placed their nests in areas that were not accessible to us for safety reasons. In these cases, we only recorded the number of nests, adults, juveniles, fledglings, chicks that were visible.

Least Tern and Piping Plover Daily Counts
On each of the regular survey visits to each site (done at 4 – 5 day intervals), the total number of Least Tern and Piping Plover adults, juveniles, fledglings, 1 – 3 day old chicks, 4 – 10 day old chicks, 11 – 15 day old chicks, unknown age chicks, and nests was recorded. Any miscellaneous observations were also recorded.

Results – Off-River

Nesting terns and plovers were distributed across 23 off-river sites. This included four lakeshore housing developments and 19 sand and gravel mines. See Table 1 for description and location information for these sites. All of these sites had been used for nesting in previous years. We are not aware of any previously unused sites being colonized for nesting in 2008.

Interior Least terns and Piping Plovers returned to and began nesting at the off-river nesting areas earlier in the season than at the on-river nesting areas. Plovers began to arrive in the area in late April. The first off-river sighting was at LPPD-Genoa Central Diversion on 23 April 2008 when a single bird was seen. Terns began to arrive in the area in mid May. The first off-river sighting was at Shady Lake Road on 5 May 2008.

During the early part of the nesting season, there was no river habitat available to the birds (see 2008 River Conditions) for nesting due to high flows in the lower Platte River. Consequently, all nesting terns and plovers were restricted to off-river sites until late June. On the afternoon of 27 June 2008, a thunderstorm with hail (1.75 inch diameter), strong winds (+ 60 mph gusts), and rain (+ 0.5 inches), destroyed a large number of Least Tern nests at off-river sites (see http://www.spc.noaa.gov/ for storm details). We estimate that more than 95 nests were lost. In late June at the approximate time of this storm, water flows in the river dropped, which exposed expanses of suitable sandbar nesting habitat. Soon after the sandbars appeared, terns initiated nesting on the sandbars. Without a population of color-marked birds we can not know with certainty, but based on the correlation in time, it appears that some of the terns that lost their nests in the storm moved to the river to attempt nesting again.

At the off-river sites, the first Piping Plover egg was laid on 2 May 2008 (Wilson Creek), and the last on 20 June 2008 (Timber Lodge Lake), a span of 50 days. The first Least Tern egg was laid on 27 May 2008 (Socorro Lake), and the last on 24 July 2008 (Lake Clagus), a span of 28 days.

At the off-river sites, the first Piping Plover eggs hatched on 2 June 2008 (Big Sandy, LPPD-Genoa Central Diversion, Riverview Shores) and the last on 18 July 2008 (Louisville Lakes), a span of 47 days. The first Least Tern eggs hatched on 24 June 2008 (Socorro Lake, Riverview Shores), and the last on 7 August 2008 (Louisville Lakes), a span of 45 days.

At the off-river sites, the last sighting of a Piping Plover was of an adult on 5 August 2008 (Wilson Creek). The last sighting of a Least Tern was of an adult on 14 August 2008 (N. Woodcliff).

Keep out sign on perimeter of nesting area

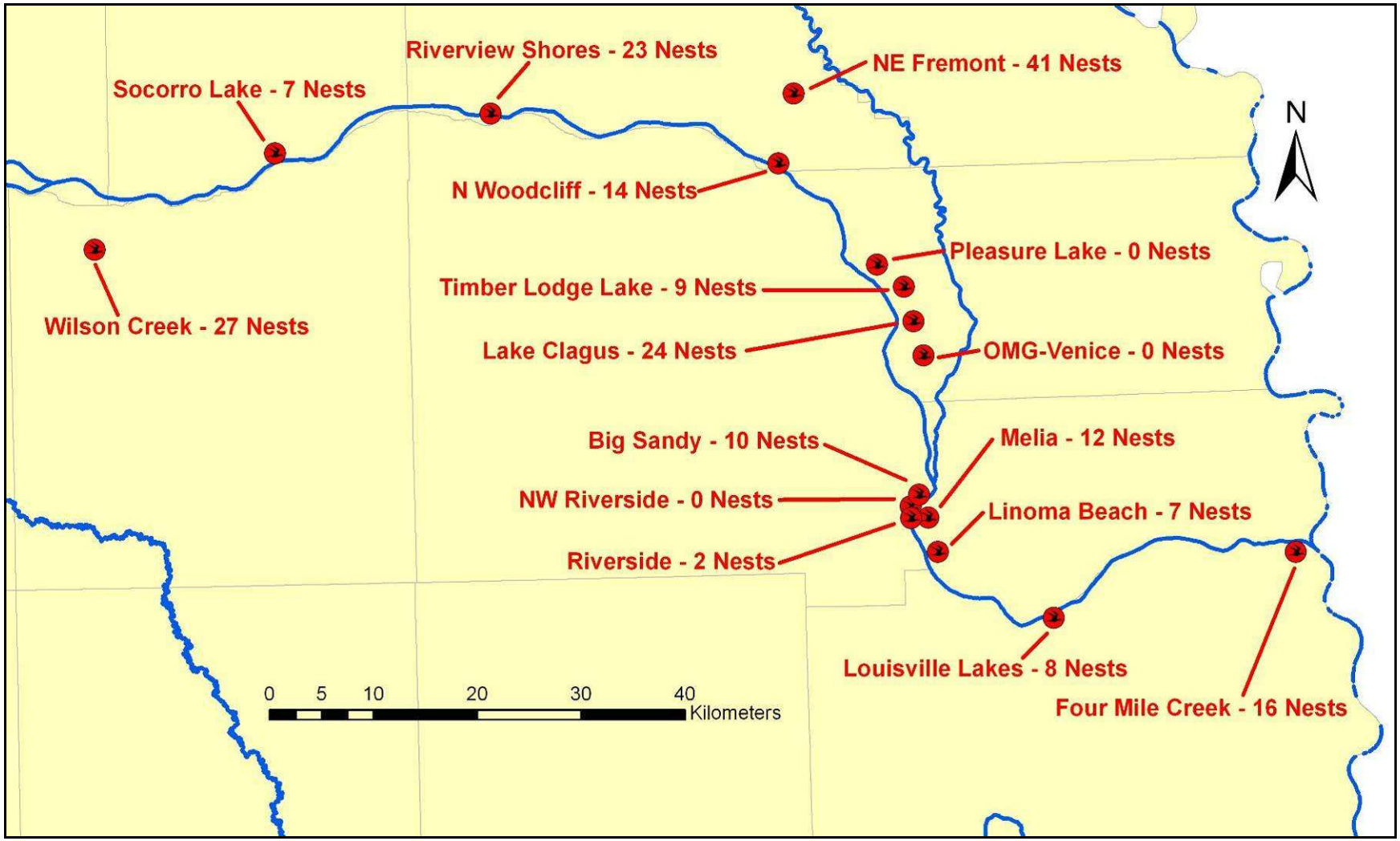

Figure 16. Location of Least Tern colonies and the number of nests at off-river sites.

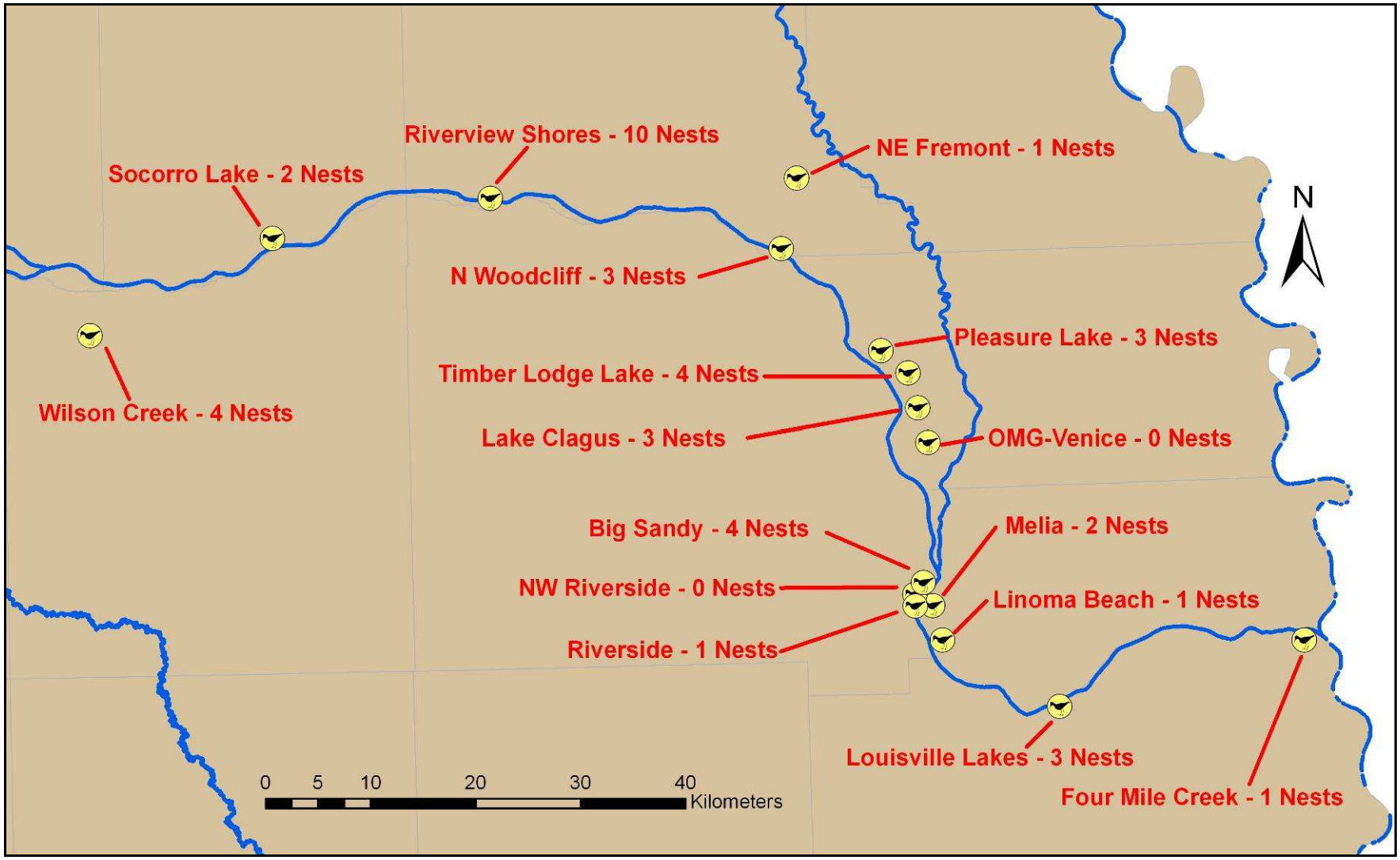

Figure 17. Location of Piping Plover colonies and the number of nests at off-river sites.

Methods – River

Because river conditions are unpredictable and access to nesting sites differs markedly from off-river sites, our approach to working with the birds nesting on the river was different. Early in the nesting season, we monitored river conditions for the presence of sandbar habitat. We did not survey the river for nesting terns and plovers until sandbar habitat became available.

Surveys of the lower Platte River began on 24 June 2008 and continued through 8 August 2008. The lower 57 river miles (Hormel Park boat ramp near Fremont, Dodge County to the Missouri River confluence) were surveyed by canoe from 24 June 2008 through 2 July 2008 to assess habitat availability and locate nesting colonies. The majority of nesting colonies were located in two reaches of the river, Cedar Creek to Plattsmouth (RM 13 to 3) and Two Rivers State Park to Schramm State Park (RM 39 to 20). These two reaches were routinely surveyed every 2 – 7 days by canoe until the nesting season ended. The upper portion of the lower Platte River from the Loup River confluence to the Hormel Park boat ramp (RM 57 to 103), was surveyed by airboat on 17 and 28 July 2008, in cooperation with the USFWS, to document the location and number of nesting colonies

Canoe surveys provided the advantage of moving slowly (< 10 kph) and quietly on the river which limited the amount of disturbance to nesting terns and plovers. The presence of birds foraging in the river indicated to us that nesting might be occurring on a nearby sandbar. Nesting colonies were usually identified by the vocal, aggressive behavior of Least Terns once the observers landed the canoe and began walking on the sandbar.

When a colony was located, the sandbar was thoroughly surveyed for nests. Once found, nest locations were recorded with a handheld GPS unit, the number of eggs was recorded, and the eggs were 'floated' to determine the nest initiation date (see Hays and LeCroy 1971 Wilson Bulletin 83: 425 – 429). Selected colonies were visited every 2 – 7 days. On each visit, known nests were checked to determine whether they survived or hatched since the previous visits and new nests were located. We scored the status of each nest based on the following criteria:

confirmed successful: pipped eggs or newly-hatched chick(s) observed in or in the immediate vicinity (<1 m) of the nest cup
likely successful: empty, but intact nest cup found with/without pieces of pipped egg-shell at/after the expected hatch date
confirmed failure: nest cup and/or eggs found destroyed
likely lost: nest not relocated on repeat visits prior to expected hatch date

Nest data collected during monitoring surveys were used to estimate daily survival rates.

Results - River

During 2008, we located 150 Least Tern and 3 Piping Plover nests in 15 colonies on the lower Platte River. All nests were located between RM 7 and 99. See Table 2 and Figure 17 for description and location information for these sites. Of these nests, 104 Least Tern nests and three Piping Plover nests were monitored through the incubation period. The fate of the Least Tern nests we monitored are: 50 confirmed successful, 13 likely successful, 5 confirmed failure, 16 likely lost, and 12 fate unknown. The fate of the Piping Plover nests we monitored are: 1 confirmed successful, 1 confirmed failure (inundated by high river flows), and 1 fate unknown.

Table 2. Location of Least Tern and Piping Plover colonies on the lower Platte River in 2008. The sandbars in bold were monitored regularly during the nesting season.

Colony Name	No. of LETE nests	No. of PIPL nests
River Mile 99	5	-
River Mile 98	4	-
River Mile 90	4	-
River Mile 84	3	-
River Mile 70	5	-
River Mile 66	15	-
River Mile 45.5	2	-
River Mile 38.75	**8**	**-**
River Mile 37	**13**	**-**
River Mile 35	**5**	**-**
RM 29 (Camp Ashland)	**5**	**-**
RM 24.5 (Interstate)	**9**	**-**
RM 12.5 (Cedar Creek)	**26**	**1**
RM 9 (Gun Club)	**32**	**1**
RM 7 (Cullom)	**14**	**1**

At on-river sites, the first Least Tern eggs were laid on approximately 16 June 2008 (RM 37) and the last on 20 July 2008 (RM 24.5), a span of 35 days. The first on-river Least Tern nests hatched on 11 July 2008 (RM 12.5W and RM 9) and the last nest hatched on 26 July 2008 (RM 35), a span of 16 days. The single successful Piping Plover nest was found with newly hatched chicks on 24 July 2008. The adult was seen attending chicks as late as 2 August 2008.

Platte River sandbar and river channel

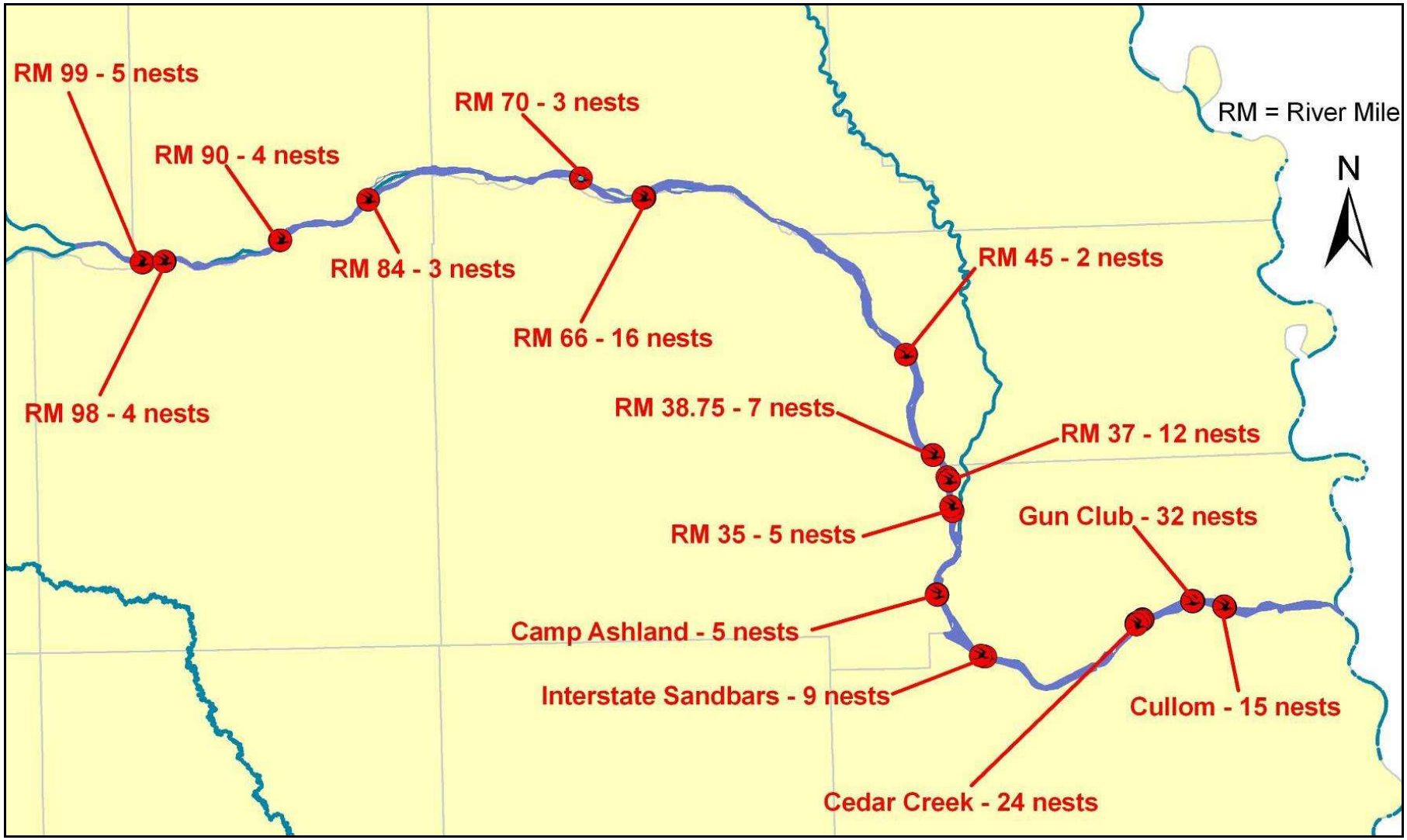

Figure 18. Location of Least Tern colonies and the number of nests on the lower Platte River during 2008.

RESEARCH

The 2008 breeding season was the first year that we added specific research objectives to our monitoring, management, education, and outreach program (for summaries of past years, see Held 2006 and Held et al. 2004, 2005). The primary objectives of our research included: 1) refining survey methods to account for individual bird detectability, 2) estimating nest and chick survival using advanced statistical modeling techniques, 3) assessing the quality of nesting habitat on river sandbars, and 4) determining the efficacy of our protection techniques at sand and gravel mines and lakeshore housing developments. We also added estimating chick growth rates where data were available.

OBJECTIVE 1: REFINING SURVEY METHODS

Every year, the Nebraska Game and Parks Commission conducts, in cooperation with the TPCP since 1999, a standardized survey of adult Least Terns and Piping Plovers nesting on the lower Platte River system from Columbus to Plattsmouth (see Monitoring). The Endangered Species Act recovery plans for both species call for the development and use of standardized survey protocols to assess the range-wide status of the two species. Currently used survey protocols do not adequately consider the effects of observer, effort, weather, or other factors on bird detection. Survey usefulness can be improved by using methods that account for detectability. In 2007 during the annual survey, we used methods that statistically account for bird detection rates.

Methods: We used a double-observer approach in a closed-model mark-recapture framework following the general methods of Fletcher and Hutto (2006. Auk 123: 695 - 707). We conducted the survey by airboat from the Platte – Loup River confluence to RM 9 on 11 July 2007. The survey crew consisted of a boat driver and two observers. The two observers sat side by side in a seat behind the driver. The driver steered the airboat down the middle of the main channel at a constant speed and did not participate in any bird observations. The observers recorded the location of tern or plover sightings using a hand-held GPS. To avoid bias by one observer being cued to birds by the other observer, both observers pretended to record sightings at random intervals.

Because fewer than six Piping Plovers were recorded during the survey, we only used Least Tern observations in this analysis. Three types of capture histories were created: 1) observation where bird(s) were seen by both observers (11), 2) observation where bird(s) were only observed by observer #1 (10), and 3) observations where bird(s) were only observed by observer #2 (01). A total of 64 capture histories were created.

Capture histories were analyzed in program MARK using the Huggin's Closed Capture Model utility. Two models were tested, one where detection probability (p) between observers 1 and 2 were the same ($p_1 = p_2$) and the other where detection rates were different ($p_1 \neq p_2$).

Results: A total of 154 Least Terns were counted during the survey. Model ($p_1 \neq p_2$) was selected as the model that best fit our data based on lower AIC_c and higher model weight (w_i) value (Table 3). Estimates of population size and observer detection probability were derived from Program MARK (Tables 4 and 5).

Table 3. Model comparison, based on AIC (adjusted for sample size; AIC_c) using ΔAIC_c and model weight (w_i).

Model	ΔAIC_c	w_i	Model Likelihood	K^1	Deviance
$p_1 \neq p_2$	0	0.91989	1	2	1250.2573
$p_1 = p_2$	4.8817	0.08011	0.0871	1	1257.1653

[1] Number of Parameters

Table 4. Least Tern population estimate.

Model	Population Estimate (± SE)	95% C.I.
$p_1 \neq p_2$	157.51 (± 2.23)	155.12 – 165.00
$p_1 = p_2$	158.16 (± 2.47)	155.44 – 166.06

Table 5. Estimates of observer detection probability

	Detection Probability (± SE)	95% C.I.
Observer 1	0.79 (± 0.03)	0.71 – 0.85
Observer 2	0.90 (± 0.03)	0.83 – 0.94

Estimates of the number adults in a breeding "population" are often used in conservation planning. Even though our detection rates were relatively high, our results show that neither observer detected all the birds that were present. Our estimates of total number of adults were slightly higher than our field count of 154 Least Terns. We intend to use this method in future years and further refine other aspects of our survey protocol.

OBJECTIVE 2: ESTIMATING SURVIVAL RATES

Accurately estimating demographic parameters leads to a better understanding of population dynamics. These estimates are crucial in developing management strategies. In 2008, we began to improve our estimates of nest and chick survival by using advanced statistical modeling techniques. We analyzed chick growth rates and began developing a chick growth curve tool.

Methods

We captured, banded, and color marked adult Piping Plovers during incubation. Banding was authorized by the USGS Banding lab and the U.S. Fish and Wildlife Service through an intra-agencies agreement. Color-banding schemes were coordinated prior to the field season with the species coordinator (Greg Pavelka, U.S. Army Corps of Engineers). We did not attempt to capture adult Least Terns. Out of concern for the birds' safety, we used a simple box trap placed over the nest for capture (see Figure 19). Box traps have no moving parts, so the nesting birds and their eggs cannot be injured during capture; the bird walks through the door, settles on its nest, and is captured.

Our capture and banding protocol was developed prior to the nesting season to avoid problems and minimize disturbance to nesting birds. We exercised caution when handling and banding

birds. We did not band birds during extreme weather or when the temperature was above 85 degrees Fahrenheit; only JGJ and MBB (both hold USFWS Master Bander permits with endangered species endorsements) handled and banded birds. Birds were observed closely after banding and on subsequent days to determine if there were any problems or visible signs of injury. As part of our protocol, we were to suspend banding activities and conduct an investigation if problems or injuries were observed at any time. We did not observe or record any problems or injuries to birds as a result of banding.

Each plover received an individually numbered USGS 1A band on the upper left leg. On the lower left leg, the bird received a unique combination of color bands indicating its specific identity. On the upper right leg, each bird received a light blue plastic flag; the light blue color indicates that the bird was banded along the lower Platte River. On the lower right leg, the bird received a solid green band; the green color indicates that the bird was banded at an off-river site. See Appendix A for complete listing of all color band combinations used in 2008.

After banding, the mass of each bird was measured by placing the bird in a cloth bag and suspending it from a Pesola® scale (± 0.5 gram accuracy). The following standard morphological measurements were taken from every bird captured: left and right flattened wing chord (±1 mm) length (wrist to the distal end of the outermost primary rectrice), left, right, and middle remiges (tail feathers) length (±1 mm), left and right tarsi (unfeathered leg above the hallux) length (± 0.1 mm), exposed culmen (midline ridge of the beak) length (± 0.1mm), beak width (± 0.1 mm) at the nares, and total skull (distal end of the beak to the posterior end of the occiput) length (± 0.1 mm). All measurements were taken by one individual (MBB) to minimize measurement error and variation. Each morphological measurement was taken twice so a "repeatability index" can be calculated and all measurements adjusted appropriately. A composite metric of all these measurements will be calculated (the geometric mean) to provide an index of each individual bird's overall size. The left and right sides of each bird were measured so a measure of bilateral symmetry (fluctuating asymmetry) can be calculated. Symmetry is a commonly used measure of an individual bird's "quality". The symmetry of skeletal parts reflects the nutrition and health of an individual during development. The symmetry of structures, such as feathers, that are grown or replaced regularly reflects the current nutrition and health of the individual. Measurements of symmetry give us a metric to access the "quality" of birds hatched at different types of nesting sites at different times. This metric also gives us a way to assess the quality of the over wintering habitat for the birds; better foraging would provide better nutrition and health.

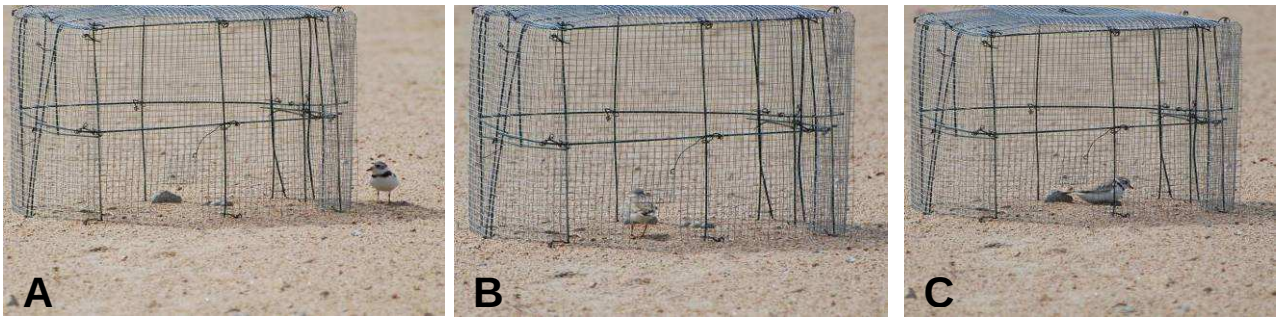

Figure 19. Wire box trap placed over a Piping Plover nest showing the bird approaching trap (A), entering through open "door" (B), and subsequently settling on nest (C). Time elapsed is approximately 1 minute.

We captured Piping Plover chicks by picking them up off the sand. Plover chicks' legs are long enough that we were able to band and color mark them in the same way as we did adult plovers. See Appendix A for a complete listing of all color band combinations used in 2008. We measured

each chick's body mass by placing chicks on a digital scale (Ohaus® SP401) which was accurate to ± 0.1 gram. Scales were calibrated using a standardized 200 g weight before and after chicks were weighed to ensure accuracy. We did not take any morphological measurements.

We captured Least Tern chicks by picking them up off the sand. Tern chick's legs are very short at hatching so we only put an individually numbered USFWS size 1A band on each bird's lower right leg and a split color (yellow-green) band on its lower left leg. The yellow-green split color band indicates that the bird was banded at an off-river site along the lower Platte River.

On the river, all chicks weighing less than 20 g were banded with an individually numbered USGS size 1A band on the right lower leg. Chicks weighing more than 20 g were given a single green band on the left lower leg in addition to a USGS band on the right leg (Figure 20). A single green band on the lower left leg indicated that the bird was banded on a river sandbar on the lower Platte River in 2008. See Appendix A for complete listing of all color band combinations used in 2008.

All chicks were weighed (± 0.1gram) using a digital scale (Ohaus® SP401). Scales were calibrated using a standardized 200 g weight before and after chicks were weighed to ensure accuracy. On subsequent visits, chicks were recaptured and reweighed. We did not take any morphological measurements.

Figure 20. Nearly-fledged Least Tern with green color band on left leg being weighed 26 July 2008.

Survival analyses: After individual terns and plovers were banded and color marked, we attempted to recapture or resight them. We used this recapture-resighting dataset to calculate daily and seasonal individual survival probabilities.

After individual tern and plover nests were located, we returned to them throughout the nesting season to monitor their progress. We used this monitoring dataset to calculate daily and seasonal nest survival probabilities.

We estimated survival probabilities with the software program MARK (White and Burnham 1999. Bird Study 46: S120 – S139). We used the general methods of Lebreton et al (Ecological Monographs 1992. 62: 67 – 118), Burnham and Anderson (2002. Model Selection and Multimodel Inference: a Practical Information-Theoretic Approach 2nd edition, New York: Springer), and Dinsmore and Dinsmore (Studies in Avian Biology 2007. 34: 73 – 83). Model fit for each analysis was assessed by the AIC (Akaike's Information Criterion); the model with the lowest AIC was considered the model that best fit our data.

Nest Survival Analysis

We used data from nest monitoring (see Monitoring) to conduct nest survival analysis. Nest survival probabilities were calculated using the nest-survival model tool in program MARK. Due to our small sample sizes we did not include any covariates in our model, combined all off-river sites together, combined all on-river sites together, and assumed constant survival across the season. We constructed the encounter histories by summarizing the day each nest was found (*k*), the last day the nest was found active (*l*), the last day the nest was checked for activity (*m*), and the fate of the nest (*f*).

Individual Survival Analysis

Encounter histories were constructed for all Piping Plovers caught or observed at off-river sites during the nesting season. All but seven of the adult Piping Plovers included in this analysis were captured and banded locally. These seven birds were produced and banded at nesting sites along the Missouri River near Gavin's Point Dam (D. Catlin, pers. comm.). All of the Least Tern chicks included in this analysis were produced and banded locally. Due to our small sample sizes we combined all off-river sites together and all on-river sites together. We did not include any covariates into the models. We tried to fit models with varying degrees of time-dependence to the data, but the model that included constant survival and constant recapture probabilities {phi(c), p(c)}, was always the best fitting model based on AIC. This is likely due to our small sample sizes.

Least Tern Growth Curve Analysis

Our growth curve analysis was restricted to Least Tern chicks that were produced at on-river sites. All tern chicks were banded and weighed when they were first encountered. They were weighed again every time they were subsequently encountered. In the cases where the chick was banded while still in or very close to their natal nest, we could 'age' them based on the nests known hatching date. The curve fitted to the data is a second-order polynomial.

Nest Initiation (Egg-Laying) and Hatching Synchrony Analysis

We used the temporal position of each nest with respect to others in the nesting area as a measure of the nest's synchrony. To measure synchrony, we ranked each nest's initiation (day first egg laid in nest) and hatching (day first egg hatched) dates. We used our egg floating data to estimate the first egg date of nests that we found after the clutch was complete. We calculated the hatching date using the known incubation periods (28 days for plovers and 21 days for terns) and the egg floating data for nests that we did not visit on the actual hatching day. We calculated the standard deviation of nest initiation and hatching dates and the modal nest initiation and hatching dates. Each nest was assigned, based on its initiation and hatching dates, to the appropriate number of standard deviations on either side of the modal date. This technique will allow us to analyze synchrony data between habitat (river and off-river) types and years since they will be measured on the same scale.

Statistical Analysis

All other statistical analyses were performed using either SAS (SAS Institute. 1990. SAS/STAT User's Guide, Version 6. Cary, NC: SAS Institute) or Prism (GraphPad Prism, Version 3.00 for Windows, Graph Pad Software, San Diego, CA, www.graphpad.com). Due to small sample sizes, we used nonparametric statistical tests for all of our analyses; statistical significance was set at $P < 0.05$. Means (± 1 SE) are reported.

Results

Observations of banded Missouri River Piping Plovers along the Platte River

We observed seven previously color banded Piping Plovers in our lower Platte River study area in 2008 (see Figure 21). All seven were originally color banded along the Gavin's Point Dam reach of the Missouri River between Sioux City, Dakota County, NE and Yankton, Yankton County, SD. Three were color banded as chicks on the United States Army Corps of Engineers constructed sandbars near Ponca, Dixon County, NE (D. Catlin, pers. comm.). All seven birds were at least two years old when we recaptured them.

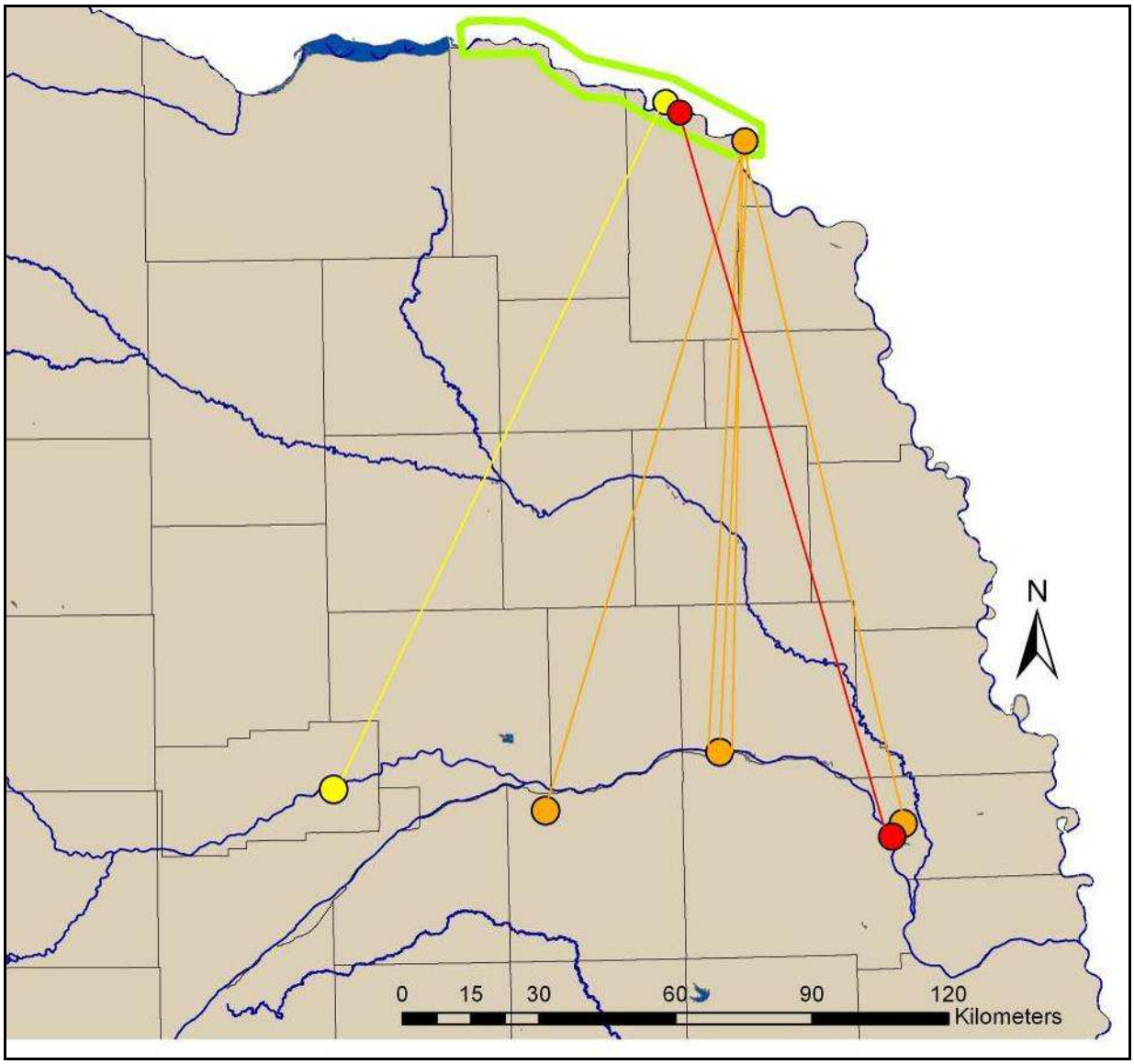

Figure 21. Location of Piping Plovers banded on Missouri River and recaptured along the lower Platte River in 2008. Colors indicate sandbar where initial banding took place.

We captured and banded 24 adult Piping Plovers at off-river nesting sites. We did not band any plovers at on-river sandbar sites. We captured and banded 11 plover chicks at off-river nesting sites. All plover chicks were less than one week old when banded. We recaptured or re-sighted 19 adult plovers after they were banded. We recaptured or re-sighted 4 plover chicks after they were banded.

Lower Platte River banding

We captured and banded 32 Least Tern chicks at off-river nesting sites. We did not attempt to capture and band adult terns at either off-river or on-river sites. We captured and banded 136 tern chicks at on-river sites. Most tern chicks were less than two weeks old when banded. We recaptured or re-sighted 91 (70 individuals) tern chicks after they were banded and before they fledged.

Adult Piping Plover Survival: Based on our population of 24 color-marked adult Piping Plovers, the estimated daily survival probability at off-river sites was 0.981 ± 0.0119 (see Figure 22). When that daily survival probability is extended over the 28 day incubation period, we estimate that adult plovers have a 0.584 probability of surviving to the egg hatching stage. Based on the same calculation, we estimate that the probability of adult plovers surviving the 28 day brood rearing period is also 0.584. We believe these estimates are biased low, likely due to small sample size.

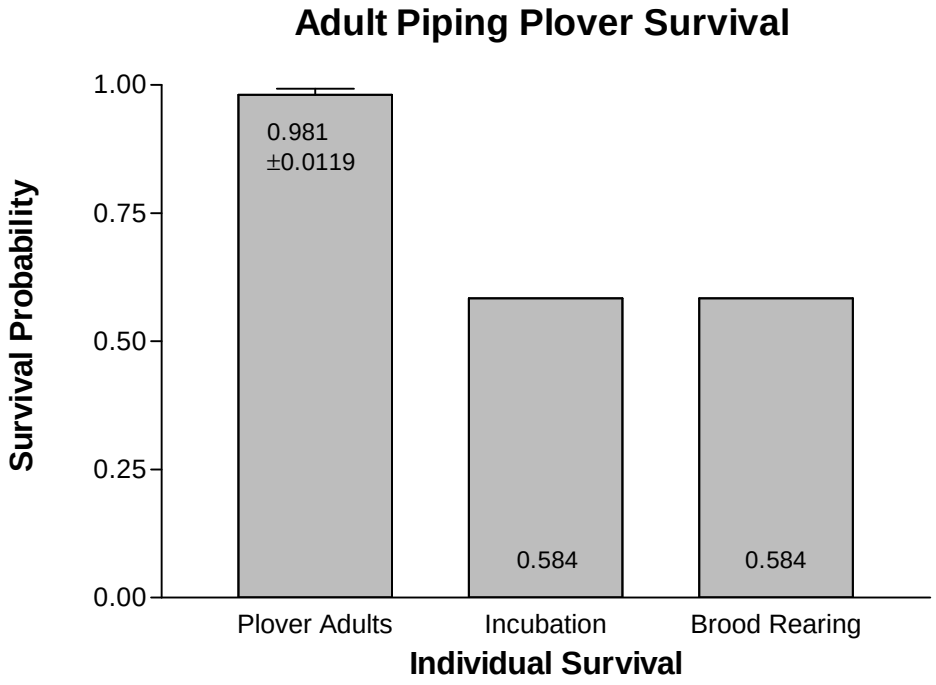

Figure 22. Adult Piping Plover daily survival, incubation period survival, and brood rearing period survival.

Piping Plover Nest Survival: We based our estimate of Piping Plover nest survival on a population of 63 nests, of which 42 were protected with exclosures and 18 were not protected. Nests with exclosures had a daily survival estimate of 0.997 ± 0.002. Nests without exclosures had a daily survival estimate of 0.985 ± 0.009. Protected nests had a 0.012 greater daily survival probability than unprotected nests. When those daily survival probabilities are extended over the 28 day incubation period, we estimate that protected plover nests had a 0.919 probability of surviving and that unprotected nests had a 0.655 probability of surviving. Protected nests had a 0.264 greater probability of surviving to the egg hatching stage than unprotected nests. See Figure 23.

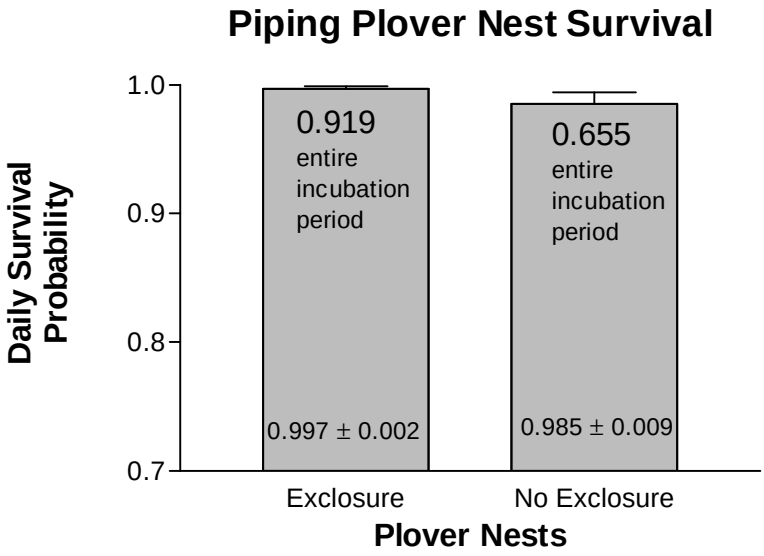

Figure 23. Piping Plover daily nest survival probability and incubation period survival probability.

Least Tern Nest Survival: We based our estimate of Least Tern nest survival on a population of 424 nests. Of these nests, 274 were at off-river sites (223 at sand and gravel mines and 51 at housing developments and 150 were at on-river sites). At sand and gravel mines, we estimate that tern nests had a daily survival probability of 0.952 ± 0.005. Nests at housing developments had a daily survival probability of 0.952 ± 0.010. Nests at on-river sites had a daily survival probability of 0.953 ± 0.006. When the daily survival probability is extended over the 21 day incubation period, we estimate that tern nests at sand and gravel mines had a 0.356 probability of surviving, nests at housing developments had a 0.356 probability of surviving and that nests at on-river sites had a 0.364 probability of surviving to the egg hatching stage. Least Tern nests at on-river sites had a 0.008 greater probability of surviving the incubation period than did nests at off-river sites. See Figure 24.

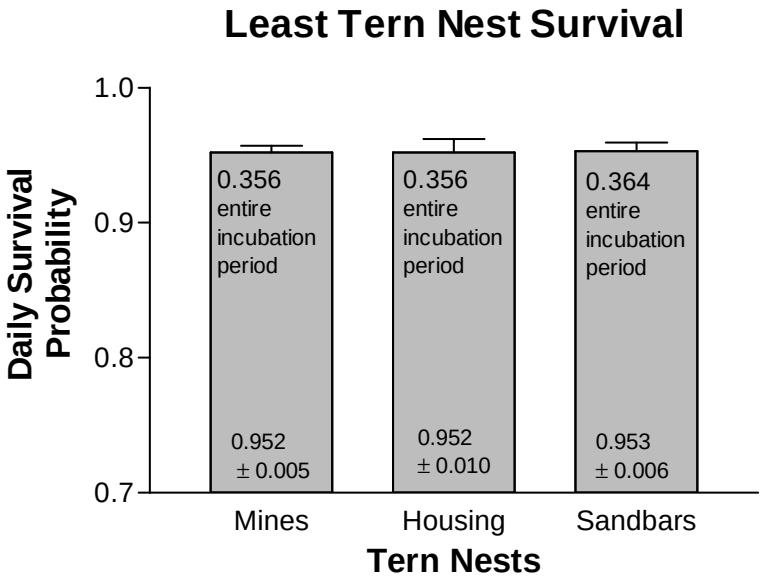

Figure 24. Least Tern nest daily survival and incubation period survival.

Least Tern Chick Survival: We based our estimate of Least Tern chick daily survival on a population of 136 chicks at on-river sites only. We estimate that tern chicks have a daily survival probability of 0.961 ± 0.026. When that daily survival probability is extended over the 21 day period from hatching to fledging, we estimate that tern chicks have a 0.434 probability of fledging. See Figure 25.

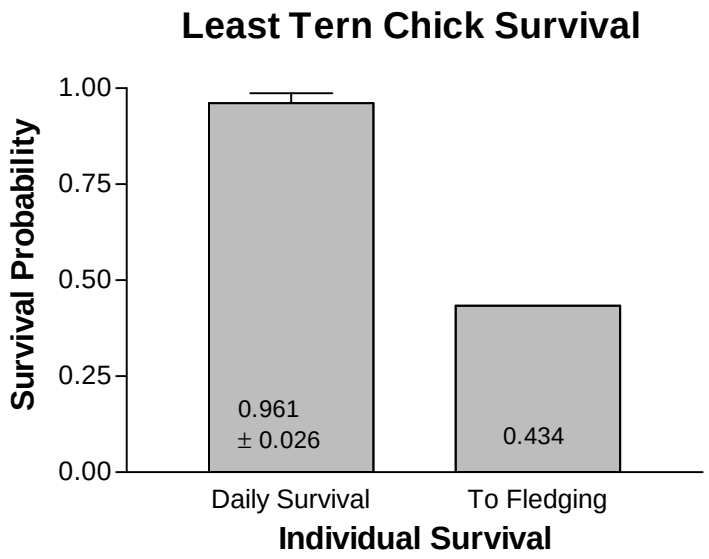

Figure 25. Least Tern chick daily survival probability and probability of survival to fledging.

Least Tern Chick Growth Curve: We based the calculation of our Least Tern chick growth curve on our population of 136 banded tern chicks produced at on-river sites. The curve that best fits our data suggests that tern chicks grow at a fairly constant rate for the first two weeks of life. Our data also suggests that tern chicks reach their fledging body mass at about 15 days and remain at that mass until fledging at 21 days of age (see Figure 26).

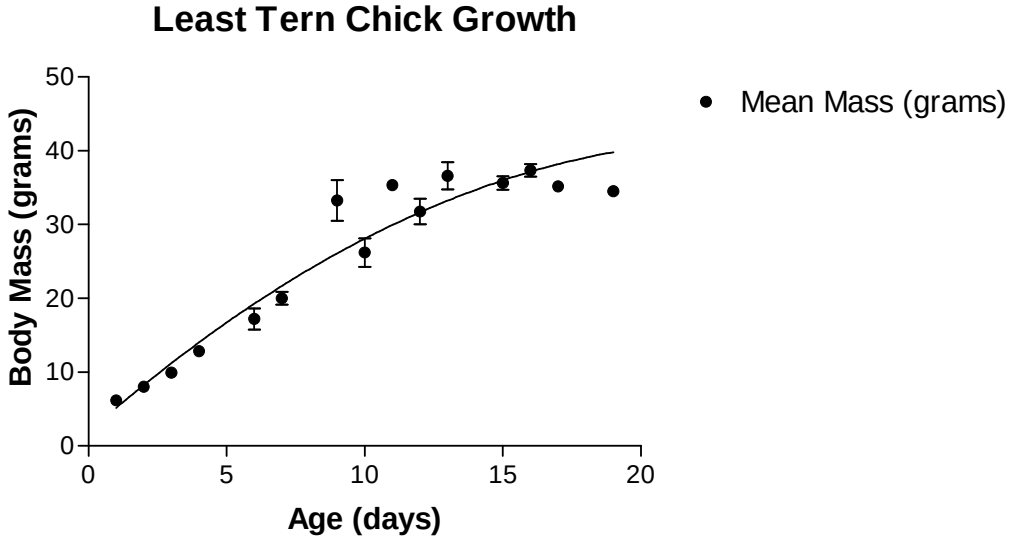

Figure 26. On-river Least Tern chick growth rate (r^2 = 0.987)

Comparison of Off-river and On-river nesting success: Table 6 summarizes the reproductive success of terns and plovers nesting at off-river and on-river sites.

The traditional index of nesting success of terns and plovers that is reported, and used for comparison between sites, is 'fledge ratio'. Fledge ratio is calculated as the number of fledglings per nest over a defined spatial or temporal area. The number of fledglings used in the calculation is based on numbers of birds directly observed. Unless these birds are individually marked, the errors of repeat and incomplete observations (only a proportion of chicks at a colony are detected during a visit) are introduced into the calculation. Using fledge ratios with inherent errors can lead to inappropriate management decisions. We calculated fledge ratios in two ways and compared the two results. We used the traditional 'fledglings per nest' method and the survival analyses method based on our capture-recapture dataset and program MARK.

At off-river sites, the traditional method of calculation suggests a Piping Plover fledge ratio of 1.53 chicks per nest and a Least Tern fledge ratio of 0.74 chicks per nest. The survival analysis method suggests a plover fledge ratio of 1.95 chicks per nest and a tern fledge ratio of 1.44 chicks per nest. At on-river sites, the traditional method of calculation suggests a Piping Plover fledge ratio of 1.00 chicks per nest and a Least Tern fledge ratio of 1.07 chicks per nest. The survival analysis method suggests a plover fledge ratio of 2.00 chicks per nest and 0.93 chicks per nest. The calculation of plover fledge ratios is based on the off-river adult plover survival rate of 0.584 for the brood rearing period. The calculation of tern fledge ratios is based on the on-river chick survival rate of 0.434 for the brood rearing period. As we accumulate a larger capture-recapture dataset that will allow us to do more sophisticated survival analyses, these survival estimates will become more refined and robust.

Synchrony:

Piping plover off-river, Least Tern off-river and Least Tern on-river nest initiation and hatching synchrony patterns are illustrated in Figure 27. The nests found in the +3 SD categories are most likely second nesting attempts by birds that lost their nests earlier in the season.

Two Least Tern chicks being banded and weighed

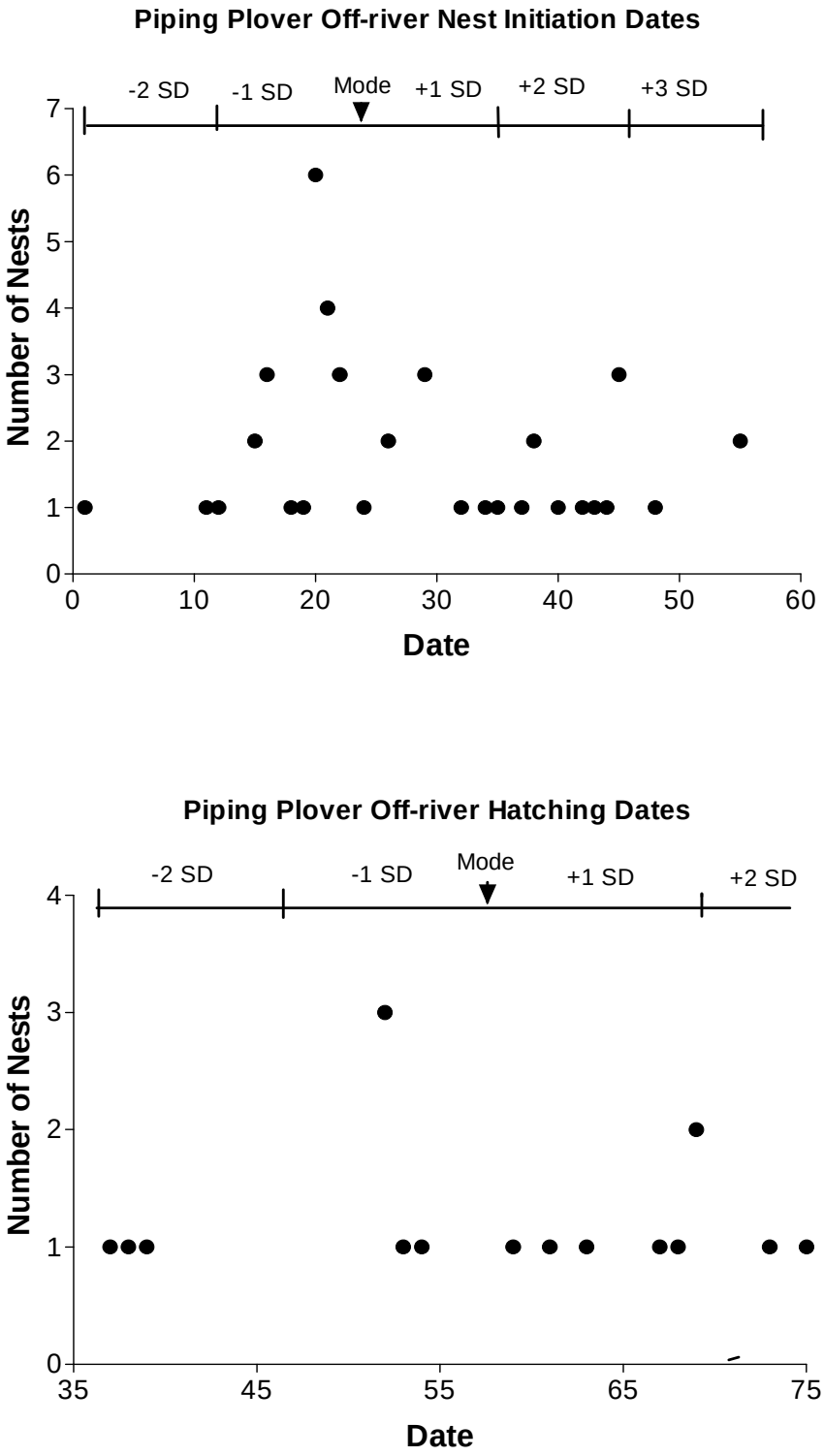

Figure 27. Piping Plover nest initiation and hatching synchrony at on-river nesting sites (day 1 = 26 April, day 30 = 25 May, day 60 = 24 June).

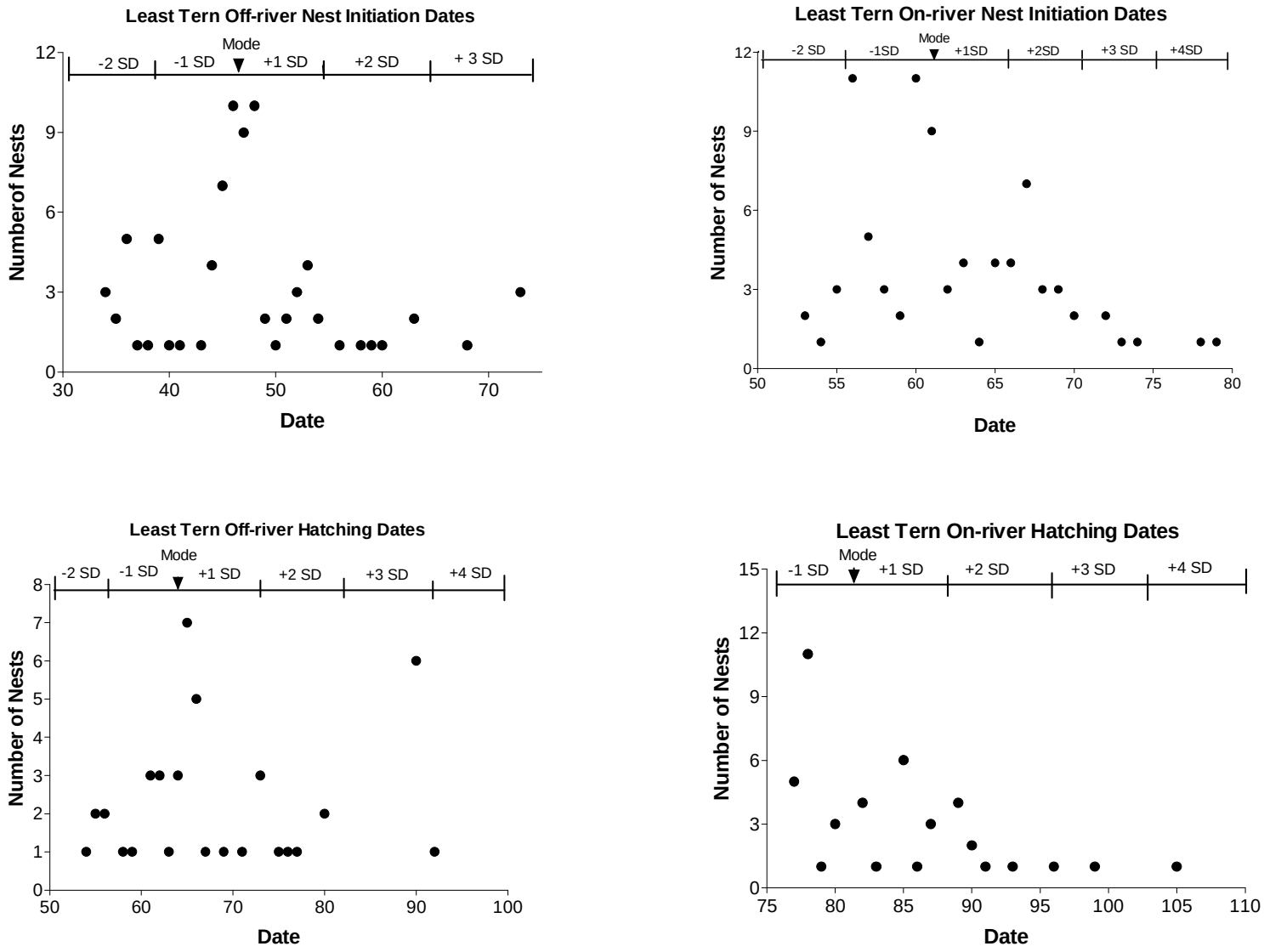

Figure 28. Least Tern nest initiation and hatching synchrony at on-river and off-river nesting sites (day 1 = 26 April, day 30 = 25 May, day 60 = 24 June, day 90 = 23 July, day 106 = 7 August).

Table 6. Summary of reproductive success of Least Tern and Piping Plover nesting at on-river and off river nesting areas in 2008.

Off-River Nesting Areas (sand and gravel mines and housing developments combined)

Number of Least Tern adults observed = 422
Number of Piping Plover adults observed = 153

Number of Least Tern nests (24 nesting areas) = 274
Number of Least Tern eggs (in the 16 assessable areas; 108 nests) = 358
Number of Least Tern chicks observed = 80
Expected[1] number of Least Tern chicks = 155 (358 eggs * 0.434 survival rate)
Expected[1] number of Least Tern chicks/nest = 1.44
Number of Least Tern eggs/nest (observed) = 3.31 (358 eggs / 108 nests)
Number of Least Tern chicks/nest (observed) = 0.74 (80 chicks / 108 nests)

Number of Piping Plover nests (24 nesting areas) = 60
Number of Piping Plover eggs (in the19 assessable areas) = 211
Number of Piping Plover chicks observed = 97
Expected[1] number of Piping Plover chicks = 123 (211 eggs * 0.584 survival rate)
Expected[1] number of Piping Plover chicks/nest = 1.95
Number of Piping Plover eggs/nest (observed) = 3.52 (211 eggs / 60 nests)
Number of Piping Plover chicks/nest (observed) = 1.62 (97 chicks / 60 nests)

On-River Nesting Areas (sandbars in the lower Platte River)

Number of Least Tern nests (16 nesting areas) = 150
Number of Least Tern eggs (in the 14 assessable areas) = 323
Number of Least Tern chicks observed = 161
Expected[1] number of Least Tern chicks = 140 (323 eggs * 0.434 survival rate)
Expected[1] number of Least Tern chicks/nest = 0.93
Number of Least Tern eggs/nest (observed) = 2.15 (323 eggs / 150 nests)
Number of Least Tern chicks/nest (observed) = 0.44 ± 0.11

Number of Piping Plover nests (3 nesting areas) = 3
Number of Piping Plover eggs = 10
Number of Piping Plover chicks observed = 4
Expected[1] number of Piping Plover chicks = 6 (10 eggs * 0.584 survival rate)
Expected[1] number of Piping Plover chicks/nest = 2.00
Number of Piping Plover eggs/nest (observed) = 3.33 (10 eggs / 3 nests)
Number of Piping Plover chicks/nest (observed) = 1.00 (3 chicks / 3 nests)

[1] See results section for discussion of this calculation

OBJECTIVE 3: ASSESSING RIVER NESTING HABITAT

We assessed the amount and quality of sandbar habitat available to the birds by systematically measuring the physical characteristics of sandbars with nesting birds and, for comparison, a sample of sandbars without nesting birds. We planned to measure habitat availability on the entire 103-mile length of the lower Platte River, but high water flows early in the season limited our access to the river. As a result, habitat assessment was done only downstream from RM 57, near Fremont, Dodge County, to the confluence with the Missouri River near Plattsmouth, Cass County.

Methods

Nesting colonies were defined as any sandbar with one or more active nests. The comparison sandbars were selected systematically at every third river mile as measured from our starting point at RM 57. The sandbar located closest to the selected river mile, with a surface area of greater than 0.2 ha and without nests, was selected for measurement. If there was no such sandbar within one half mile of the river mile point, then "no suitable habitat" was recorded.

We measured the size of each sandbar; we define size as a composite of the surface area of the sandbar and its elevation above the water line. We measured sandbar surface area by walking the perimeter with a handheld GPS unit and marking waypoints at approximately 10 meter intervals. In cases where the perimeter of the sandbar was irregular, more waypoints were recorded so a more accurate area could be calculated. Waypoints were downloaded and imported in ArcMap (ESRI Inc 2006, Version 9.2, Redlands, CA, www.esri.com). We then created a shape file in ArcCatalog and imported it into ArcMap. The GPS unit, waypoint file, and ArcMap were set to the same projection (North American Datum 1983, UTM Zone 14). The perimeter of each sandbar was digitized using the outline established by the waypoints to create individual polygons in the shape file. We used an ArcMap utility to estimate the size of each polygon; we used this estimate as the surface area of the sandbar.

The elevation of each sandbar was measured using an automatic level (CST Berget® PAL/SAL "N" Series) and stadia. The automatic level was positioned in the middle of the sandbar to minimize error. The waterline was measured at 3 – 6 points around the perimeter of the sandbar. To measure the maximum height of each sandbar, several measurements were taken in the portion of the sandbar with the highest elevation. We also took measurements in the areas where tern and plover nests were located. This was done because our interest was not in providing a complete topographic summary of the sandbar, but in identifying the highest portion of the sandbar and the area that was used by nesting Least Terns and Piping Plovers. Sandbars had 'table top' topography and by taking multiple measurements of the table top area we captured a representative summary of the sandbar height. Elevations were calculated by subtracting the waterline measurements from the sandbar measurements. All automatic level measurements were taken by one person (JGJ) to minimize measurement error. In order to minimize disturbance to nesting birds, we limited the time we spent at and around nesting colonies.

Sandbar elevations and surface area are dependent on the river flow at the time the measurements are taken. River flow measurements from gauge stations can be used to show the relationship between flow changes and whether a sandbar and the nests on it are inundated or remain dry. River flow, at the time the sandbars were measured, was taken from the relevant gauge stations (http://waterdata.usgs.gov/ne/nwis/rt). See Figure 1 for gauge locations. The sandbars located below the Salt Creek confluence were referenced to the Louisville gauge. The sandbars above the Salt Creek confluence, but below the Elkhorn River confluence, were referenced to the Ashland gauge. The sandbars above the Elkhorn River confluence were referenced to either the North Bend or the Ashland gauge. Several sandbars in this reach of the river were referenced to both gauges to capture the complete range in flow variation.

The primary purpose of the following analysis was to assess the relationship between sandbar habitat and subsequent risk of inundation. The probability that a nesting colony on a sandbar will be inundated is determined by sandbar height and water level.

We identified the highest and lowest river flow measurements at the reference gauge within the 24 hour period when the sandbar was measured. These measurements provided the upper and lower limits of water elevation on the day the sandbar was measured. We used the difference between the sandbar elevation and changes in the river flow at the gauge station to determine whether a sandbar was inundated during the nesting season. All height measurements were recorded in feet and are reported in that unit to be consistent with gauge station measurements. We based our calculations on the following metrics.

24-hr minimum height: The minimum water height measured at the reference gauge on the day the sandbar was measured (minimum river depth).

24-hr maximum height: The maximum water height measured at the reference gauge on the day the sandbar was measured (maximum river depth).

24-hr minimum discharge: The minimum water discharge (in cfs) measured at the reference gauge on the day the sandbar was measured (minimum water flow).

24-hr maximum discharge: The maximum water discharge (in cfs) measured at the reference gauge on the day the sandbar was measured (maximum water flow).

highest sandbar elevation: The maximum difference between the waterline and top of the sandbar (maximum sandbar height).

mean sandbar elevation: The mean difference between the waterline and the top of the sandbar. This is not the true mean sandbar elevation, it is the mean of the measurements we took.

subsequent seasonal peak: Maximum water height measured at the reference gauge during the remainder of the nesting season; this occurred on 17–19 July in 2008 (river depth on this date).

minimum differential: The difference between the subsequent seasonal peak and the 24-hr maximum height. The value represents the minimum water depth increase expected at the sandbar from the time it was measured to the subsequent peak.

maximum differential: The difference of the subsequent seasonal peak and the 24-hr minimum height. The value represents the maximum water depth increase expected at the sandbar from the time it was measured to the subsequent peak.

Using the nine values listed above, we calculated four metrics to determine whether a sandbar colony was inundated during the nesting season: 1) Maximum Sandbar Height at Peak Flow, which is the difference between the highest sandbar elevation and the minimum differential, 2) Minimum Sandbar Height at Peak Flow, which is the difference between the highest sandbar elevation and the maximum differential, 3) Average Sandbar Height at Peak Flow - Maximum, which is the difference between average sandbar elevation and the minimum differential, and 4) Average Sandbar Height at Peak Flow – Minimum, which is the difference between the average sandbar elevation and the maximum differential. If all four metrics for a sandbar remained positive during the nesting season, it is unlikely that it was inundated and nests lost. The closer the four values were to 0 or were negative, it is increasingly likely that the sandbar was inundated and nests lost.

Sandbars with nests were visited during nest checks and monitored to determine whether nests, or the entire sandbar, had been inundated by river flow rises.

Results

We assessed habitat metrics at nine sandbars with nesting colonies and 15 sandbars without nesting colonies (12 sandbars and 3 sites with "no habitat") from 28 June 2008 through 3 July 2008. The "no habitat" measurements are relevant when considering habitat availability, but are not considered further in describing sandbar habitat. We also measured the perimeter of one additional sandbar nesting colony, but did not take height measurements. Our sandbar habitat metrics are summarized in Table 7.

Table 7. Mean, maximum, and minimum values of selected habitat metrics for sandbars with nests and those without nests.

Sandbar	Size (ha)	Highest sandbar elevation (ft)	Average Sandbar Elevation (ft)	Maximum Sandbar Height at Peak (ft)	Minimum Sandbar Height at Peak Flow (ft)	Average Sandbar Height at Peak Flow – max (ft)	Average Sandbar Height at Peak Flow – min (ft)
Mean							
With nests	4.93	2.83	2.29	2.12	1.71	1.57	1.16
Without nests	4.44	2.57	1.98	1.77	1.05	1.17	0.45
Maximum							
With nests	3.41	3.41	2.92	2.81	2.42	2.32	1.93
Without nests	3.50	3.50	2.77	2.68	2.23	1.83	1.38
Minimum							
With nests	1.94	1.94	1.28	1.23	0.74	0.65	0.19
Without nests	1.69	1.40	1.35	0.46	-0.10	0.64	-0.95

No negative values were calculated for Maximum Sandbar Height at Peak Flow or Average Sandbar Height at Peak Flow – Maximum in 2008. Negative values were recorded for Minimum Sandbar Height at Peak Flow at two sites (RM 51 and RM 57) and Average Sandbar Height at Peak Flow – Minimum at three sites (RM 51, RM 54, and RM 57). All negative values were recorded on sandbars without colonies and upstream from river mile 50 (see Figure 18). The only metric that was significantly different between sandbars with nests (1.16 ± 0.22) and those sandbars without nests (0.45 ± 0.21) was "Average Sandbar Height at Peak Flow – Minimum" (Kruskall-Wallis X^2, = 4.253, df = 1, P = 0.0392).

Our nest checking data validated the calculations of which sandbar colonies were or were not inundated during the nesting season. Even though there was a notable river rise on 18 July 2008, primarily below Salt Creek (5.92 ft, 19,500 cfs recorded at the Louisville gauge station on 18 July 2008), no Least Tern nests were inundated. Only one Piping Plover nest, placed at a relatively low elevation at West Cedar Creek was inundated in 2008.

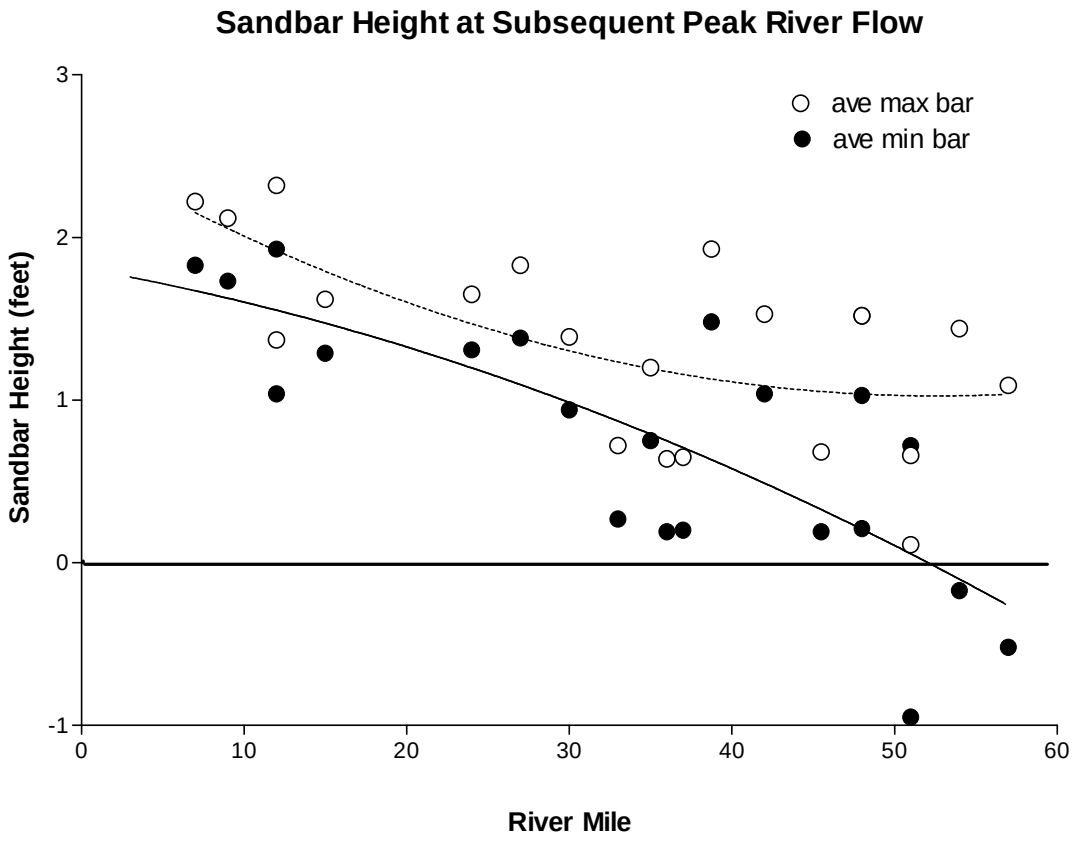

Figure 29. Relationship between sandbar height, subsequent peak flow, and risk of inundation after sandbars were colonized by nesting terns and plovers. The relationship is based on *Average Sandbar Height at Peak Flow – Maximum* (open circles, broken line) and *Average Sandbar Height at Peak Flow – Minimum* (closed circles, solid line). The minimum and maximum values of the same metric were used because of uncertainties associated with real time sandbar height measurements relative to gauge stations. The actual sandbar heights lie between the Minimum and Maximum values. Positive values (y-axis) of represent sandbars that were not inundated by subsequent peaks flow. Negative values (y-axis) represent sandbars that were inundated by subsequent peaks flow. Risk of inundation is dictated by both initial sandbar height and water level. Any variable that decreases initial sandbar height or increases subsequent peaks flows once nests are initiated increases the risk of inundation. RM 0 is located at the confluence with the Missouri River and RM 70 is west of North Bend, NE. Average Sandbar Height at Peak Flow – Minimum ($F_{1,18} = 2.23$, $P < 0.001$, $r^2 = 0.61$), Average Sandbar Height at Peak Flow – Minimum ($F_{1,18} = 14.71$, $P < 0.001$, $r^2 = 0.41$).

Least Tern and Piping Plovers that nest on sandbars are at risk of inundation from mid-summer river rises, even rises that last for very short periods. Sandbar habitat elevation is determined by the previous 1.5 year peak flow (*sensu* Parham 2007. Report prepared for the Nebraska Game and Parks Commission, 138 pgs) and flows during the nesting season are determined by a number of variables. Weather events (thunderstorms) that produce extreme amounts of precipitation and run-off often result in river flow rises that increase the risk of inundation. While it is difficult to anticipate extreme weather events, it is clear that reductions in the intensity and regularity of "habitat-forming" flows will reduce sandbar height, which will increase the probability of inundation. Anything that reduces the difference between sandbar height and peak flows (sandbar habitat -

waterline compression), such as water diversion or hydropeaking, after nests have been initiated increases the probability that colonies will be inundated.

Figure 295 illustrates the relationship between sandbar height and peak flows after nest initiation. The graphic also shows that the risk of inundation increased from downstream areas to upstream areas even though subsequent peak flows were different above and below Salt Creek (~9,500 cfs at North Bend and 19,500 cfs at Louisville on 18-19 July). While habitat forming flows were also markedly different, the relationship also potentially points to the increased risk of inundation due to hydropeaking.

We did not calculate changes in sandbar surface area due to increases in river flow. We did observe notable changes in surface area due to the 18 July 2008 flow increase at our East Cedar Creek colony where the sandbar area was reduced by 79% (Figure 30). Even though the surface area was reduced, none of the nine Least Tern nests was inundated by the rise in water level.

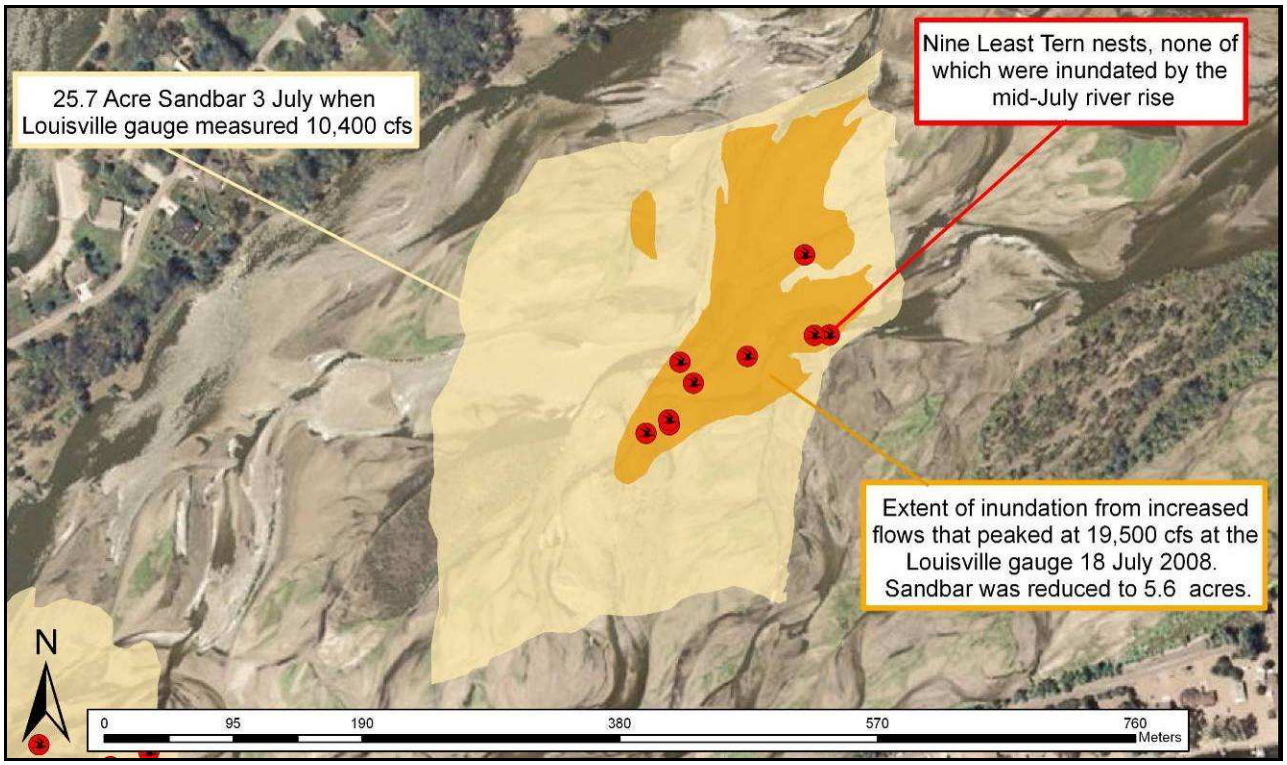

Figure 30. East Cedar Creek sandbar. Pale yellow shows size of the sandbar on 3 July 2008. Orange shows the reduced area as a result of the 18 July 2008 river flow rise.

MANAGEMENT

Management actions were only implemented at off-river sites. The TPCP uses a voluntary, proactive approach to avoid and minimize conflicts and reduce or eliminate the need for law enforcement personnel to be directly involved in tern and plover management. Zero conflicts were recorded in 2008. Before the birds returned to Nebraska and the field season began, TPCP met with the production managers of all area sand and gravel mines. See Table 1 for the list of active and inactive mines. At these meetings, we discussed the mines' production plans for the season, safety regulations, and site access. We paid particular attention to concerns mine personnel had regarding previous on-site activities of the TPCP and changes to MSHA (Mine Safety and Health Administration) policy as it applies to non-mine personnel.

We also met with homeowners associations at the lakeshore housing developments. See Table 1 for the list of housing developments. At these meetings, we discussed the construction plans for the area and site access. We paid particular attention to property owners' concerns regarding previous on-site activities of the TPCP.

The primary result of each these meeting were site-specific management and monitoring plans. An equally valuable result was becoming acquainted with the people living and working at these sites. As the season progressed, this made our management efforts easier to implement. Throughout the season, we maintained close contact with these individuals so we could respond to any on-site changes that developed as the season progressed.

PROTECTING TERN AND PLOVER NESTS

In order to protect the tern and plover nests, we put up "Keep Out" signs around the perimeter of the nesting areas (Figure 31). In areas where a lot of human foot or vehicle traffic was expected, additional 'psychological' barriers were added. These barriers consisted of a black cord tied between all of the Keep Out sign posts. In order to make the cord more visible, we tied red-silver Mylar streamers to it.

Based on our pre-nesting season conversations with mine production managers and homeowners' associations, we mapped out the areas where it would be best if the terns and plovers did not nest. These were the areas within the mine property that were going to be dredged during the nesting season or where heavy equipment was going to be operating. At the housing developments, these were the areas where buildings were scheduled to be constructed or utilities were to be installed. We know that terns and plovers will not nest in areas where the substrate is disturbed by raking, where there is any surface vegetation, where the substrate particle size is "wrong" or where there is any physical disturbance (Marcus, Dinan, Johnson, Blakenship, and Lackey 2007. Waterbirds 30: 251 – 258 for details). Planting any vegetation,

Figure 31. Design of "Keep Out" sign used to protect tern and plover nesting areas.

resurfacing the substrate and raking the substrate are labor intensive, so we opted for the physical disturbance method of discouraging the birds from nesting in an area. In areas where we do not want the birds to nest, we put up grids of three foot tall poles with 16 foot long streamers of red-silver Mylar® flagging attached to them. The poles are set up 16 feet apart. When the streamers blow in the wind, they make a crackling, rustling sound and sweep the ground which dissuades the birds from attempting to nest in the area.

We erected nest exclosures around most plover nests (Figure 32). We were not able to 'exclose' all plover nests, as several property owners specifically asked us not to and in several instances, the topography made exclosures impractical to set up. We did not put exclosures around tern nests, as they will not accept any structures around their nests.

Figure 32. Mary Bomberger Brown erecting a nest exclosure around a Piping Plover nest at the Socorro Lake housing development near Schuyler, NE. The potential for unintentional nest destruction by humans is high at housing developments. The perimeter of the nesting area was also marked with "Keep Out" signs.

TPCP personnel communicated with homeowners before and during the nesting season to prevent conflicts between endangered species and residents. Due to the proactive efforts of the TPCP, no bird-people conflicts developed in 2008 at any housing development or sand and gravel mine.

LPPD BIRD MANAGEMENT AREA

In March 2008, the USFWS, NGPC, and Preferred Rocks of Genoa LLC entered into a Memorandum of Understanding (MOU) outlining the management of the Interior Least Terns and Piping Plovers nesting on the North Sand Management Zone (NSMZ) adjacent to LPPD's settling basin near Genoa, NE. The TPCP and LPPD are cooperators, not signatories, to the MOU. Preferred Rocks of Genoa constructed a 315 acre 'bird management area' on top of the NSMZ (see Figures 33 and 34). This area was surrounded by a 10 – 15 foot tall sand berm to protect it from slurry outflow water from LPPD's dredging operation at the settling basin. The sand outside of the berm was windrowed by Preferred Rocks of Genoa to discourage the birds from nesting in

unsafe areas. The TPCP monitored the birds nesting at the NSMZ. On 21 May 2008, the berm was breached by slurry outflow water which endangered several tern and plover nests. The TPCP directed the reconstruction of the berm.

Figure 33. From left to right, Mary Bomberger Brown, Martha Tacha (USFWS), and Peter Melcher (Preferred Rocks of Genoa) discuss tern and plover management at the Preferred Rocks of Genoa industrial site located at the Loup Public Power District diversion canal dredge spoil pile. In 2008, Preferred Rocks, U.S. Fish and Wildlife Service, and the Nebraska Game and Parks Commission entered into a memorandum of understanding (MOU) to proactively minimize and avoid endangered species-industry conflict. The TPCP is a cooperator to the MOU and conducted monitoring at the site.

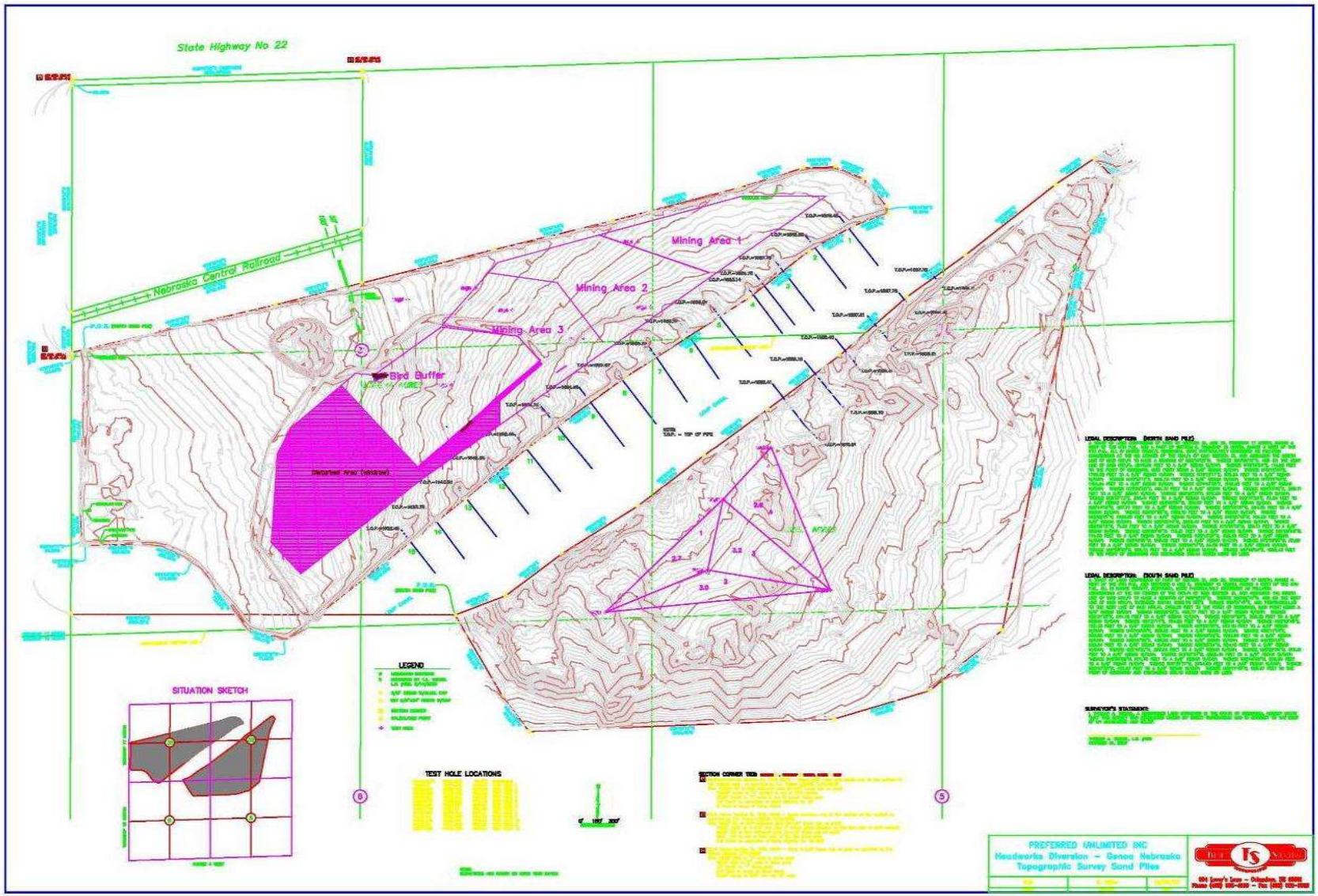

Figure 34. Schematic diagram of the “bird management area” or “bird buffer” at the LPPD-Preferred Rocks of Genoa Sand Management Zone. The solid pink area was windrowed to discourage nesting birds.

EDUCATION AND OUTREACH

A substantial part of our mission to protect Least Terns and Piping Plovers involves education and outreach. The TPCP has become an important entity in Nebraska's conservation and environmental education community. We are now frequently called upon to give presentations, assist with workshops and festivals, participate in workgroups, and serve on committees. While the majority of our efforts are directly focused on terns and plovers, we understand that we have a role in improving environmental literacy in general. We take advantage of every opportunity to reach as many different constituencies as possible with our message of common sense conservation.

We are helping develop science and environmental curricula for K–12 students and to present these curricula to classroom teachers and other education professionals. Some of these curricula are in the form of classroom lesson plans, others as distance learning modules, children's books, and classroom lectures. All curricula are designed to meet the State of Nebraska Department of Education standards.

We promote the TPCP model of a partnership between conservation and business by participating in state and national professional conferences. The novelty of the TPCP, coupled with our success in protecting terns and plovers, attracts a great deal of interest at conferences. We solicit opportunities to speak at special interest group meetings, such as off-road vehicle clubs and real estate-construction associations.

The TPCP is a part of the wider network of agencies and NGOs working on conservation and environmental issues. We cooperate with other members of this network and serve on committees and workgroups with them.

TPCP was invited to participate in the Federal Energy Regulatory Commission's (FERC) re-licensing process for the Loup Public Hydroelectric Project (LPPD). Our role is to serve as experts on threatened and endangered species, conservation, land use, and environmental aesthetics. We also provide advice as requested by FERC, LPPD, and the other state and federal agencies involved in the re-licensing process.

Every five years, the USFWS reviews the status of all species listed under the Endangered Species Act. Reviews of both Least Terns and Piping Plovers were initiated this year. We are working with the USFWS by providing data summaries and advising the biologists working directly on the review process.

The following list is a summary of our current education and outreach program.

General Public Education

Nebraska State Parks Campfire Program Series (Two Rivers, Platte River, and Mahoney)
Family Nature Nights (Lincoln Public Schools): Clinton, Randolph, Hartley Schools
Earth Wellness Festival, SCC, Lincoln, NE
Weatherfest and Severe Weather Symposium, UNL, Lincoln, NE
Arlington, NE Middle School Field Day, Gretna, NE
Keep Fremont Beautiful Ecofair, Fremont, NE
Kearney Expo, Kearney, NE
Earth Day Celebrations, UNL and City of Lincoln, Lincoln, NE
Groundwater Festival, Grand Island, NE
Waterfest, Holmes Lake, Lincoln, NE
Trail Trek, Lincoln, NE

Whispering Cedars Camp, Genoa NE
Service-Learning Fair, UNL, Lincoln, NE
Volunteer Partners, Lincoln, NE
Volunteer Fair, UNL, Lincoln, NE
Volunteer Big Event, UNL, Lincoln, NE
Sensory Safari for Blind and Handicapped Children, Children's Zoo, Lincoln, NE
Toyota Tailgate Party, UNL, Lincoln, NE
Nebraska Academy of Science Junior Science Fair judging, Lincoln, NE
Nebraska State Fair 4-H Science-Environment project judging, Lincoln, NE
Career Night, UNL, Lincoln, NE
Water Quality Open Golf Tournament, Lower Platte River Corridor Alliance, North Bend, NE
Wildcat Hills Audubon Society, Scottsbluff, NE
Lincoln Public Libraries after school programming
Maxey School Nature Club, Lincoln, NE
McPhee School Nature Club, Lincoln, NE
Community Learning Center, McPhee School, Lincoln, NE

Education/Curriculum Development

NIH-SEPA program to develop science and environmental curricula for Native American K-12 schools (program administered through the University of Nebraska Medical Center)
Informal Educators of Lincoln Network (IEN; working group of educators from area museums, galleries, non-profit groups, and agencies)
Teacher's Night Out, Lincoln, NE (sponsored by IEN to introduce area classroom teachers to additional resources available to them)
Durham Museum-Smithsonian Institution Teacher's Night Out, Omaha, NE (see above)
"Discover the Waters of Nebraska" Project WET children's book, project writer-reviewer (to be published in September 2009)
Rowe Audubon Sanctuary Distance Education Program Partner, Gibbon, NE (threatened and endangered species experts, role may expand in the future)
Iowa Western Community College, undergraduate biology course lectures, Council Bluff, IA
High School Student Professional Job Shadowing program (introduce students to what a career in conservation biology involves)
Nebraska Alliance of Conservation and Environment Educators

Conferences and Meetings
Lower Platte River Corridor Alliance, Lincoln, NE
North American Bluebird Society-Bluebirds across Nebraska, Kearney, NE
Rivers and Wildlife Celebration, Kearney, NE
Nebraska Chapter of the Wildlife Society, Kearney, NE
Conservation Strategies and Implementation Workgroup (NPABC), Kearney, NE
Science Advisory Workgroup (NPABC), Kearney, NE
Communication Workgroup (NPABC), Kearney, NE
Capacity Building Workgroup (NPABC), Kearney, NE
Education Workgroup (NPABC), Kearney, NE
Nebraska Invasive Species Conference, Lincoln, NE (discussion facilitators)
Missouri River Biological Opinion/Natural Resources Conference, Nebraska City, NE
Lower Platte River Summit, Lower Platte River Corridor Alliance, Fremont, NE
American Ornithologists' Union, Portland, OR (Elective Member and holds a seat on Council)
Nebraska Partnership for All-Bird Conservation (NPABC), St. Paul, NE
Nebraska Sustainable Agriculture Society-Healthy Farms Conference, Omaha, NE
Wilson Ornithological Society and Association of Field Ornithologists', Mobile, AL (TPCP is hosting this conference in 2011; holds a seat on Council)

PACE (Planning, Aggregate, Community, Environment), Lincoln, Kearney, Alda, NE
Nebraska Alliance of Conservation and Environment Educators, Ponca, NE

Nebraska Least Tern and Piping Plover Meeting

We organized the 2nd Annual Nebraska Least Tern and Piping Plover Meeting which was held at University of Nebraska-Lincoln on 25 February 2008 (see Figure 35). Even though foul weather conditions resulted in a few late cancellations, 40 people (an increase from 20 in 2007) from six states attended. Representatives from the Nebraska Environmental Trust, Nebraska Public Power District, US Fish and Wildlife Service, Virginia Tech University, American Bird Conservancy, National Park Service, USGS Northern Prairie Wildlife Research Center, Central Nebraska Public Power and Irrigation District, Central Platte Natural Resources District, University of Nebraska-Lincoln, University Nebraska-Kearney, Iowa State University, Nebraska Cooperative Fish and Wildlife Research Unit, Lower Platte South Natural Resources District, Lower Platte River Corridor Alliance, Headwaters Corporation, HDR, US Army Corps of Engineers, Platte River Recovery Implementation Program, and Nebraska Game and Parks Commission attended. See Appendix B for a list of meeting attendees and Appendix C for the meeting schedule.

Figure 35. Mary Bomberger Brown presenting results from the previous breeding season during the 2008 Nebraska Least Tern and Piping Plover meeting held 25 February 2008 at UNL.

Professional Committees and Workgroups:
SNR Sustainability Committee, UNL
SNR 5-year review Ecological Issues, Education, Human Dimensions of Natural Resources, Water Resources, Infrastructure, Administration, and Community listening groups, UNL
SNR Staff Advisory and Professional Development committee, UNL
SNR Social Event committee, UNL

Rivers and Wildlife Celebration planning committee, NPABC
PACE (Partnership, Aggregates, Community and Environment) workgroup
Teaming with Wildlife steering committee, NGPC
NPABC Education, Capacity Building, Communication, Science Advisory, and Conservation Strategies and Implementation workgroups

Miscellaneous:
Joint IANR, SNR, NGPC reception for Nebraska State Senators
Featured in USFWS Wildlife and Sport Fish Restoration September 2008 publication
"Tern and Plover Conservation Partnership Exemplifies a New Paradigm in Cooperative Wildlife Conservation in Nebraska"
Featured on Ecological Society of America web page
"Tern and Plover Conservation Partnership", Bulletin of the Ecological Society of America: Ecology on the Web, 89(3): 251 – 252, July
Featured in media
"$270,000 grant will benefit tern, plover conservation", Keith County News 5 May, 2008.
"Grant to aid tern, piping plover conservation efforts", Scarlet, 18(16) 8 May, 2008
"$270,000 grant to aid conservation", Lincoln Journal Star, 7 May, 2008.
Cedar Point Biological Station's newsletter, UNL. Spring 2008
School of Natural Resources web page
"Ethanol: Salvation or damnation?", joint UNL School of Journalism and Mass Media and Nebraska Educational Television project, October 2008.
Homeowners' Association presentations (Lake Socorro, Riverview Shores, Cedar Creek)
Interviewed on Nebraska Public Radio news broadcast, 29 April 2008, Nebraska News with Clay Masters
Metro Omaha Builders' Association contacted for presentation
Nebraska Off-Highway Vehicle Association contacted for presentation (2 groups contacted)
Rapid Prototyping Tern and Plover Adaptive Management Plan initiated
Manuscript accepted for publication in *Journal of Extension*
Thody, C.M., R.J. Held, R.J. Johnson, J.F. Marcus, and M.B. Brown. Grassroots conservation: volunteers contribute to threatened and endangered species projects and foster a supportive public
Manuscript accepted for publication in *Nebraska Bird Review*
Brown, M.B., J.G. Jorgensen, and S. Rehme. Endangered species responses to natural habitat declines: Nebraska's Interior Least Terns (*Sternula antillarum athalassos*) and Piping Plovers (*Charadrius melodus*) nesting in a novel habitat
Manuscript prepared for publication in *Nebraska Bird Review*
Brown, M.B., and J.G. Jorgensen. in review. Lower Platte River flow characteristics suitable for Interior Least Tern (*Sternula antillarum athalassos*) and Piping Plover (*Charadrius melodus*) nesting in Nebraska
Memorandum of Understanding between Preferred Rocks of Genoa, USFWS, NGPC cooperator
Project Learning Tree & Project WET certification
Nebraska Environmental Trust (NET) general operating funds grant awarded
Advancing Tern and Plover Common Sense Conservation into the Future
Nebraska Partnership for All-Bird Conservation (NPABC) capacity building grant awarded
A Common Sense Approach to Interior Least Tern and Piping Plover Conservation in Nebraska
Nebraska Game and Parks Commission State Wildlife Grant awarded
Advancing Least Tern and Piping Plover Common Sense Conservation into the Future
Platte River Recovery Implementation Program (PRRIP) grant proposal submitted
Foraging Habitats and Energetics of Interior least Terns (*Sternula antillarum athalassos*) and Piping Plovers (*Charadrius melodus*) Nesting along the Central Platte River
Nebraska Environmental Trust (NET) Public Information and Education grant proposal submitted
Talking About Terns and Plovers: the Nebraska Least Tern and Piping Plover Meeting

Designed threatened and endangered species protection signs for use at nesting areas (adopted for range wide use by NGPC, USFWS, USACE, and NPS)

Designed threatened and endangered species protection signs for use at boat ramps and other public river access points (to be deployed in 2009)

All inquiries about birds to SNR and UNL Extension now directed to the TPCP

Produced 'YouTube' video about Least Terns and Piping Plovers-released on 28 October 2008 (Figure 36). http://www.youtube.com/watch?v=hxLEfqYTxD4

Asked by Girl Scout's Camp Catron to help develop environmental education program and to serve as 'role models' for young women

Member of Lincoln's Wachiska Audubon Society chapter speakers' bureau (serve on Board of Directors)

Collected data for use in the Nebraska Breeding Bird Atlas. The Atlas is being assembled by the Nebraska Ornithologists' Union.

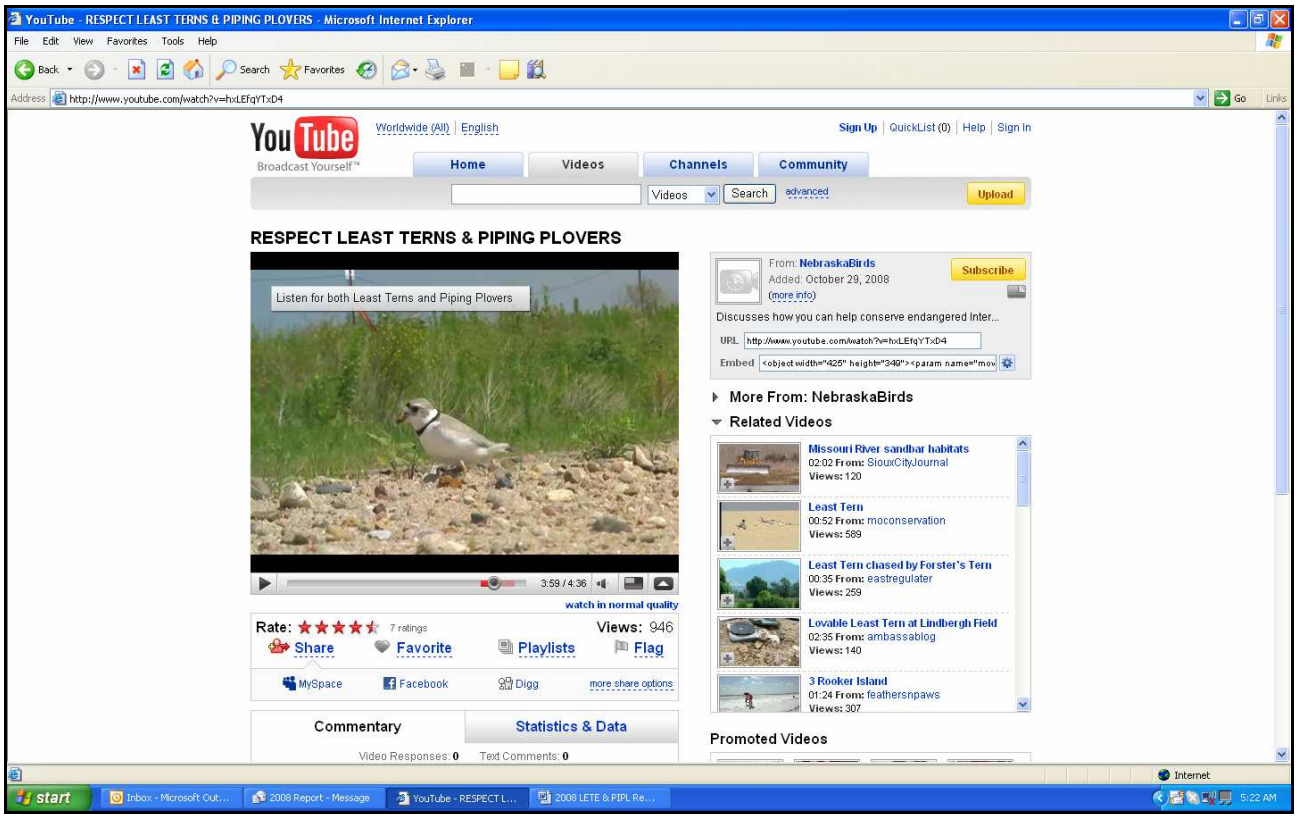

Figure 36. Interface of the Least Tern and Piping Plover YouTube Video released 28 October 2008.

Appendix A. Piping Plovers and Least Terns banded during the 2008 breeding season.

Date	Species	Band	Age	Upper Right Leg*	Lower Right Leg	Upper Left Leg	Lower Left Leg	Habitat Type	Site Captured	County Captured
5/30/2008	PIPL	1981-25701	Adult	LBF	Red	metal	Red	Housing Development	Socorro Lake	Colfax
6/2/2008	PIPL	1981-25702	Adult	LBF	Red	metal	Green	Sand & Gravel mine	Shady Lake Road	Platte
5/31/2008	PIPL	1981-25703	Adult	LBF	Red	metal	Yellow	Housing Development	Riverview Shores	Dodge
6/2/2008	PIPL	1981-25704	Adult	LBF	Green	metal	Green	Sand & Gravel mine	Riverside	Saunders
6/2/2008	PIPL	1981-25705	Adult	LBF	Green	metal	Orange	Housing Development	Big Sandy	Saunders
6/2/2008	PIPL	1981-25706	Adult	LBF	Green	metal	Black	Housing Development	Big Sandy	Saunders
6/3/2008	PIPL	1981-25707	Adult	LBF	Green	metal	Gray	Sand & Gravel mine	Lake Clagus	Douglas
6/3/2008	PIPL	1981-25708	Adult	LBF	Green	metal	Red/Red	Sand & Gravel mine	Lake Clagus	Douglas
6/3/2008	PIPL	1981-25709	Adult	LBF	Green	metal	Red/Yellow	Sand & Gravel mine	Pleasure Lake	Douglas
6/3/2008	PIPL	1981-25710	Adult	LBF	Green	metal	Red/Green	Sand & Gravel mine	Pleasure Lake	Douglas
6/5/2008	PIPL	1981-25711	Adult	LBF	Green	metal	Red/Orange	Housing Development	Riverview Shores	Dodge
6/5/2008	PIPL	1981-25712	Adult	LBF	Green	metal	Red/Black	Housing Development	Riverview Shores	Dodge
6/5/2008	PIPL	1981-25713	Adult	LBF	Green	metal	Red/Gray	Housing Development	Riverview Shores	Dodge
6/16/2008	PIPL	1981-25715	Adult	LBF	Green	metal	Yellow/Red	Housing Development	Socorro Lake	Colfax
6/16/2008	PIPL	1981-25716	Adult	LBF	Green	metal	Yellow/Yellow	Housing Development	Riverview Shores	Dodge
6/17/2008	PIPL	1981-25717	Adult	LBF	Green	metal	Yellow/Green	Sand & Gravel mine	N. Woodcliff	Dodge
6/19/2008	PIPL	1981-25718	Adult	LBF	Green	metal	Yellow/Orange	Housing Development	Big Sandy	Saunders
7/26/2008	PIPL	1981-25719	Adult	LBF	Green	metal	Yellow/Black	Sand & Gravel mine	Timber Lodge Lake	Douglas
7/26/2008	PIPL	1981-25720	Adult	LBF	Green	metal	Yellow/Gray	Sand & Gravel mine	Timber Lodge Lake	Douglas
7/5/2008	PIPL	1981-25725	Local - chick	LBF	Green		metal	Housing Development	Riverview Shores	Dodge
7/5/2008	PIPL	1981-25726	Local - chick	LBF	Green	metal	Green/Red	Housing Development	Riverview Shores	Dodge
7/7/2008	PIPL	1981-25731	Local - chick	LBF	Green	metal	Orange/Red	Sand & Gravel mine	Louisville Lakes	Sarpy
7/7/2008	PIPL	1981-25732	Local - chick	LBF	Green	metal	Orange/Yellow	Sand & Gravel mine	Louisville Lakes	Sarpy
7/7/2008	PIPL	1981-25733	Local - chick	LBF	Green	metal	Orange/Green	Sand & Gravel mine	Louisville Lakes	Sarpy
7/7/2008	PIPL	1981-25735	Local - chick	LBF	Green	metal	Orange/Orange	Sand & Gravel mine	Louisville Lakes	Sarpy
7/7/2008	PIPL	1981-25736	Adult	LBF	Green	metal	Black/Orange	Sand & Gravel mine	Melia	Sarpy
7/11/2008	PIPL	1981-25746	Adult	LBF	Green	metal	Orange/Black	Sand & Gravel mine	Louisville Lakes	Sarpy
7/11/2008	PIPL	1981-25748	Local - chick	LBF	Green	metal	Orange/Gray	Sand & Gravel mine	Lake Clagus	Douglas
7/14/2008	PIPL	1981-25758	Local - chick	LBF	Green	metal	Black/Red	Housing Development	Socorro Lake	Colfax
7/25/2008	PIPL	1981-25776	Local - chick	LBF	Green	metal	Black/Black	Sand & Gravel mine	Louisville Lakes	Sarpy
7/25/2008	PIPL	1981-25777	Local - chick	LBF	Green	metal	Black/Gray	Sand & Gravel mine	Louisville Lakes	Sarpy

* LBF = Light Blue flag, designated for Platte River

Date	Species	Band	Right leg top	Right leg bottom	Left leg top	Left Leg bottom	Habitat Type	Site Captured	County Captured
7/23/2008	LETE	2301-93200		Metal		-	River Sandbar	RM 29	Sarpy
7/23/2008	LETE	2301-93199		Metal		-	River Sandbar	RM 29	Sarpy
7/23/2008	LETE	2301-93198		Metal		Green	River Sandbar	RM 37	Douglas
7/23/2008	LETE	2301-93197		Metal		Green	River Sandbar	RM 37	Douglas
7/23/2008	LETE	2301-93196		Metal		Green	River Sandbar	RM 37	Douglas
7/23/2008	LETE	2301-93195		Metal		Green	River Sandbar	RM 38.75	Douglas
7/23/2008	LETE	2301-93194		Metal		Green	River Sandbar	RM 38.75	Douglas
7/23/2008	LETE	2301-93193		Metal		Green	River Sandbar	RM 38.75	Douglas
7/23/2008	LETE	2301-93192		Metal		Green	River Sandbar	RM 38.75	Douglas
7/23/2008	LETE	2301-93191		Metal		Green	River Sandbar	RM 38.75	Douglas
7/21/2008	LETE	2301-93190		Metal		-	River Sandbar	RM 7	Sarpy
7/21/2008	LETE	2301-93189		Metal		-	River Sandbar	RM 7	Sarpy
7/21/2008	LETE	2301-93188		Metal		-	River Sandbar	RM 7	Sarpy
7/21/2008	LETE	2301-93187		Metal		-	River Sandbar	RM 7	Sarpy
7/21/2008	LETE	2301-93186		Metal		-	River Sandbar	RM 7	Sarpy
7/21/2008	LETE	2301-93185		Metal		-	River Sandbar	RM 7	Sarpy
7/21/2008	LETE	2301-93184		Metal		Green	River Sandbar	RM 9	Sarpy
7/21/2008	LETE	2301-93183		Metal		-	River Sandbar	RM 12.5	Sarpy
7/21/2008	LETE	2301-93182		Metal		Green	River Sandbar	RM 12.5	Sarpy
7/21/2008	LETE	2301-93181		Metal		Green	River Sandbar	RM 12.5	Sarpy
7/21/2008	LETE	2301-93180		Metal		-	River Sandbar	RM 12.5	Sarpy
7/21/2008	LETE	2301-93179		Metal		-	River Sandbar	RM 12.5	Sarpy
7/21/2008	LETE	2301-93178		Metal		Green	River Sandbar	RM 12.5	Sarpy
7/19/2008	LETE	2301-93177		Metal		-	River Sandbar	RM 7	Sarpy
7/19/2008	LETE	2301-93176		Metal		Green	River Sandbar	RM 9	Sarpy
7/19/2008	LETE	2301-93175		Metal		Green	River Sandbar	RM 9	Sarpy
7/19/2008	LETE	2301-93174		Metal		Green	River Sandbar	RM 9	Sarpy
7/19/2008	LETE	2301-93173		Metal		-	River Sandbar	RM 9	Sarpy
7/19/2008	LETE	2301-93172		Metal		-	River Sandbar	RM 9	Sarpy
7/19/2008	LETE	2301-93171		Metal		Green	River Sandbar	RM 9	Sarpy
7/19/2008	LETE	2301-93170		Metal		Green	River Sandbar	RM 9	Sarpy
7/19/2008	LETE	2301-93169		Metal		-	River Sandbar	RM 9	Sarpy
7/19/2008	LETE	2301-93168		Metal		Green	River Sandbar	RM 9	Sarpy
7/19/2008	LETE	2301-93167		Metal		Green	River Sandbar	RM 9	Sarpy
7/19/2008	LETE	2301-93166		Metal		Green	River Sandbar	RM 9	Sarpy
7/19/2008	LETE	2301-93165		Metal		Green	River Sandbar	RM 9	Sarpy
7/19/2008	LETE	2301-93164		Metal		Green	River Sandbar	RM 9	Sarpy
7/19/2008	LETE	2301-93163		Metal		Green	River Sandbar	RM 12.5	Sarpy
7/19/2008	LETE	2301-93162		Metal		-	River Sandbar	RM 12.5	Sarpy
7/19/2008	LETE	2301-93161		Metal		-	River Sandbar	RM 12.5	Sarpy
7/19/2008	LETE	2301-93160		Metal		Green	River Sandbar	RM 12.5	Sarpy

7/19/2008	LETE	2301-93159	Metal	-	River Sandbar	RM 12.5	Sarpy
7/17/2008	LETE	2301-93158	Metal	-	River Sandbar	RM 29	Douglas
7/17/2008	LETE	2301-93157	Metal	Green	River Sandbar	RM 37	Douglas
7/17/2008	LETE	2301-93156	Metal	Green	River Sandbar	RM 37	Douglas
7/17/2008	LETE	2301-93155	Metal	-	River Sandbar	RM 37	Douglas
7/17/2008	LETE	2301-93154	Metal	Green	River Sandbar	RM 37	Douglas
7/17/2008	LETE	2301-93153	Metal	-	River Sandbar	RM 37	Douglas
7/17/2008	LETE	2301-93152	Metal	-	River Sandbar	RM 38.75	Douglas
7/17/2008	LETE	2301-93151	Metal	-	River Sandbar	RM 38.75	Douglas
7/17/2008	LETE	2301-93150	Metal	Green	River Sandbar	RM 38.75	Douglas
7/17/2008	LETE	2301-93149	Metal	Green	River Sandbar	RM 38.75	Douglas
7/17/2008	LETE	2301-93148	Metal	-	River Sandbar	RM 38.75	Douglas
7/17/2008	LETE	2301-93147	Metal	-	River Sandbar	RM 38.75	Douglas
7/17/2008	LETE	2301-93146	Metal	-	River Sandbar	RM 38.75	Douglas
7/17/2008	LETE	2301-93145	Metal	Green	River Sandbar	RM 38.75	Douglas
7/17/2008	LETE	2301-93144	Metal	Green	River Sandbar	RM 38.75	Douglas
7/16/2008	LETE	2301-93143	Metal	-	River Sandbar	RM 7	Sarpy
7/16/2008	LETE	2301-93142	Metal	-	River Sandbar	RM 7	Sarpy
7/16/2008	LETE	2301-93141	Metal	-	River Sandbar	RM 7	Sarpy
7/16/2008	LETE	2301-93140	Metal	Green	River Sandbar	RM 9	Sarpy
7/16/2008	LETE	2301-93139	Metal	Green	River Sandbar	RM 9	Sarpy
7/16/2008	LETE	2301-93138	Metal	Green	River Sandbar	RM 9	Sarpy
7/16/2008	LETE	2301-93137	Metal	Green	River Sandbar	RM 9	Sarpy
7/16/2008	LETE	2301-93136	Metal	-	River Sandbar	RM 9	Sarpy
7/16/2008	LETE	2301-93135	Metal	Green	River Sandbar	RM 9	Sarpy
7/16/2008	LETE	2301-93134	Metal	-	River Sandbar	RM 9	Sarpy
7/16/2008	LETE	2301-93133	Metal	-	River Sandbar	RM 12.5	Sarpy
7/14/2008	LETE	2301-93132	Metal	Green	River Sandbar	RM 12.5	Sarpy
7/14/2008	LETE	2301-93131	Metal	-	River Sandbar	RM 12.5	Sarpy
7/14/2008	LETE	2301-93130	Metal	-	River Sandbar	RM 12.5	Sarpy
7/14/2008	LETE	2301-93129	Metal	-	River Sandbar	RM 12.5	Sarpy
7/14/2008	LETE	2301-93128	Metal	-	River Sandbar	RM 12.5	Sarpy
7/14/2008	LETE	2301-93127	Metal	-	River Sandbar	RM 12.5	Sarpy
7/14/2008	LETE	2301-93126	Metal	Green	River Sandbar	RM 12.5	Sarpy
7/12/2008	LETE	2301-93125	Metal	-	River Sandbar	RM 24.5	Sarpy
7/12/2008	LETE	2301-93124	Metal	-	River Sandbar	RM 37	Douglas
7/12/2008	LETE	2301-93123	Metal	Green	River Sandbar	RM 37	Douglas
7/12/2008	LETE	2301-93122	Metal	Green	River Sandbar	RM 37	Douglas
7/12/2008	LETE	2301-93121	Metal	Green	River Sandbar	RM 37	Douglas
7/12/2008	LETE	2301-93120	Metal	Green	River Sandbar	RM 37	Douglas
7/12/2008	LETE	2301-93119	Metal	Green	River Sandbar	RM 37	Douglas
7/12/2008	LETE	2301-93118	Metal	Green	River Sandbar	RM 37	Douglas
7/12/2008	LETE	2301-93117	Metal	Green	River Sandbar	RM 37	Douglas

7/12/2008	LETE	2301-93116	Metal	Green	River Sandbar	RM 37	Douglas
7/12/2008	LETE	2301-93115	Metal	Green	River Sandbar	RM 38.75	Douglas
7/12/2008	LETE	2301-93114	Metal	Green	River Sandbar	RM 38.75	Douglas
7/11/2008	LETE	2301-93113	Metal	-	River Sandbar	RM 9	Sarpy
7/11/2008	LETE	2301-93112	Metal	-	River Sandbar	RM 9	Sarpy
7/11/2008	LETE	2301-93111	Metal	-	River Sandbar	RM 9	Sarpy
7/11/2008	LETE	2301-93110	Metal	-	River Sandbar	RM 9	Sarpy
7/11/2008	LETE	2301-93109	Metal	-	River Sandbar	RM 9	Sarpy
7/11/2008	LETE	2301-93108	Metal	-	River Sandbar	RM 9	Sarpy
7/11/2008	LETE	2301-93107	Metal	Green	River Sandbar	RM 9	Sarpy
7/11/2008	LETE	2301-93106	Metal	Green	River Sandbar	RM 9	Sarpy
7/11/2008	LETE	2301-93105	Metal	-	River Sandbar	RM 9	Sarpy
7/11/2008	LETE	2301-93104	Metal	-	River Sandbar	RM 12.5	Sarpy
7/11/2008	LETE	2301-93103	Metal	Green	River Sandbar	RM 12.5	Sarpy
7/11/2008	LETE	2301-93102	Metal	Green	River Sandbar	RM 12.5	Sarpy
7/29/2008	LETE	1981-25800	Metal	Green	River Sandbar	RM 9	Sarpy
7/29/2008	LETE	1981-25799	Metal	-	River Sandbar	RM 9	Sarpy
7/29/2008	LETE	1981-25798	Metal	Green	River Sandbar	RM 9	Sarpy
7/29/2008	LETE	1981-25797	Metal	Green	River Sandbar	RM 9	Sarpy
7/29/2008	LETE	1981-25796	Metal	Green	River Sandbar	RM 9	Sarpy
7/29/2008	LETE	1981-25795	Metal	-	River Sandbar	RM 9	Sarpy
7/29/2008	LETE	1981-25794	Metal	-	River Sandbar	RM 9	Sarpy
7/29/2008	LETE	1981-25793	Metal	Green	River Sandbar	RM 9	Sarpy
7/29/2008	LETE	1981-25792	Metal	-	River Sandbar	RM 9	Sarpy
7/29/2008	LETE	1981-25791	Metal	Green	River Sandbar	RM 12.5	Sarpy
7/29/2008	LETE	1981-25790	Metal	Green	River Sandbar	RM 12.5	Sarpy
7/29/2008	LETE	1981-25789	Metal	-	River Sandbar	RM 12.5	Sarpy
7/29/2008	LETE	1981-25788	Metal	-	River Sandbar	RM 12.5	Sarpy
7/29/2008	LETE	1981-25787	Metal	-	River Sandbar	RM 12.5	Sarpy
7/26/2008	LETE	1981-25786	Metal	-	River Sandbar	RM 24.5	Sarpy
7/26/2008	LETE	1981-25785	Metal	-	River Sandbar	RM 24.5	Sarpy
7/26/2008	LETE	1981-25784	Metal	-	River Sandbar	RM 24.5	Sarpy
7/26/2008	LETE	1981-25783	Metal	-	River Sandbar	RM 24.5	Sarpy
7/26/2008	LETE	1981-25782	Metal	Green	River Sandbar	RM 35	Douglas
7/26/2008	LETE	1981-25781	Metal	Green	River Sandbar	RM 37	Douglas
7/26/2008	LETE	1981-25780	Metal	-	River Sandbar	RM 37	Douglas
7/26/2008	LETE	1981-25779	Metal	Green	River Sandbar	RM 37	Douglas
7/24/2008	LETE	1981-25778	Metal	-	River Sandbar	RM 7	Sarpy
7/25/2008	LETE	1981-25775	Metal	Yellow/Green Split	Sand & Gravel mine	Melia	Sarpy
7/25/2008	LETE	1981-25774	Metal	Yellow/Green Split	Sand & Gravel mine	Lake Clagus	Douglas
7/25/2008	LETE	1981-25773	Metal	Yellow/Green Split	Sand & Gravel mine	N. Woodcliff	Dodge
7/25/2008	LETE	1981-25772	Metal	Yellow/Green Split	Sand & Gravel mine	N. Woodcliff	Dodge
7/24/2008	LETE	1981-25771	Metal	-	River Sandbar	RM 7	Sarpy

7/24/2008	LETE	1981-25770		Metal		-	River Sandbar	RM 9	Sarpy
7/24/2008	LETE	1981-25769		Metal		-	River Sandbar	RM 9	Sarpy
7/24/2008	LETE	1981-25768		Metal		-	River Sandbar	RM 9	Sarpy
7/24/2008	LETE	1981-25767		Metal		Green	River Sandbar	RM 12.5	Sarpy
7/24/2008	LETE	1981-25766		Metal		-	River Sandbar	RM 12.5	Sarpy
7/24/2008	LETE	1981-25765		Metal		Green	River Sandbar	RM 12.5	Sarpy
7/23/2008	LETE	1981-25764		Metal		-	River Sandbar	RM 24.5	Sarpy
7/23/2008	LETE	1981-25763		Metal		-	River Sandbar	RM 24.5	Sarpy
7/23/2008	LETE	1981-25762		Metal		-	River Sandbar	RM 24.5	Sarpy
7/23/2008	LETE	1981-25761		Metal		-	River Sandbar	RM 24.5	Sarpy
7/23/2008	LETE	1981-25760		Metal		Green	River Sandbar	RM 24.5	Sarpy
7/23/2008	LETE	1981-25759		Metal		Green	River Sandbar	RM 24.5	Sarpy
7/14/2008	LETE	1981-25757	Orange	Metal	Light Blue	metal	Housing Development	Socorro Lake	Colfax
7/14/2008	LETE	1981-25756		Metal		Yellow/Green Split	Housing Development	Riverview Shores	Dodge
7/14/2008	LETE	1981-25755		Metal		Yellow/Green Split	Housing Development	Riverview Shores	Dodge
7/14/2008	LETE	1981-25754		Metal		Yellow/Green Split	Housing Development	Riverview Shores	Dodge
7/14/2008	LETE	1981-25753		Metal		Yellow/Green Split	Housing Development	Riverview Shores	Dodge
7/14/2008	LETE	1981-25752		Metal		Yellow/Green Split	Housing Development	Riverview Shores	Dodge
7/13/2008	LETE	1981-25751	Red	Metal	Green	Yellow/Green Split	Housing Development	Riverview Shores	Dodge
7/11/2008	LETE	1981-25750		Metal		Yellow/Green Split	Sand & Gravel mine	Lake Clagus	Douglas
7/11/2008	LETE	1981-25749		Metal		Yellow/Green Split	Sand & Gravel mine	Lake Clagus	Douglas
7/11/2008	LETE	1981-25747		Metal		Yellow/Green Split	Sand & Gravel mine	Lake Clagus	Douglas
7/11/2008	LETE	1981-25745		Metal		Yellow/Green Split	Sand & Gravel mine	Melia	Sarpy
7/11/2008	LETE	1981-25744		Metal		Yellow/Green Split	Housing Development	Big Sandy	Saunders
7/11/2008	LETE	1981-25743		Metal		Yellow/Green Split	Housing Development	Big Sandy	Saunders
7/11/2008	LETE	1981-25742		Metal		Yellow/Green Split	Housing Development	Big Sandy	Saunders
7/11/2008	LETE	1981-25741		Metal		Yellow/Green Split	Housing Development	Big Sandy	Saunders
7/7/2008	LETE	1981-25740	Yellow/Green Split	Metal	Dark Blue	Purple	Housing Development	Big Sandy	Saunders
7/7/2008	LETE	1981-25739		Metal		Yellow/Green Split	Sand & Gravel mine	Melia	Sarpy
7/7/2008	LETE	1981-25738		Metal		Yellow/Green Split	Sand & Gravel mine	Melia	Sarpy
7/7/2008	LETE	1981-25737	Yellow/Green Split	Metal	Dark Blue	Green	Sand & Gravel mine	Melia	Sarpy
7/7/2008	LETE	1981-25734		Yellow/Green		metal	Sand & Gravel mine	Louisville Lakes	Sarpy
7/6/2008	LETE	1981-25730		Metal		Yellow/Green Split	Housing Development	Riverview Shores	Dodge
7/5/2008	LETE	1981-25729		Metal		Yellow/Green Split	Housing Development	Big Sandy	Saunders
7/5/2008	LETE	1981-25728		Metal		Yellow/Green Split	Housing Development	Big Sandy	Saunders
7/5/2008	LETE	1981-25727		Metal		Yellow/Green Split	Housing Development	Riverview Shores	Dodge
7/5/2008	LETE	1981-25724		Metal		Yellow/Green Split	Housing Development	Riverview Shores	Dodge
7/5/2008	LETE	1981-25723		Metal		Yellow/Green Split	Housing Development	Riverview Shores	Dodge
7/5/2008	LETE	1981-25722		Metal		Yellow/Green Split	Housing Development	Riverview Shores	Dodge
7/5/2008	LETE	1981-25721		Metal		Yellow/Green Split	Housing Development	Riverview Shores	Dodge
						Green	River Sandbar	RM 9	Sarpy

Appendix B. People attending the 2008 Nebraska Least Tern and Piping Plover meeting.

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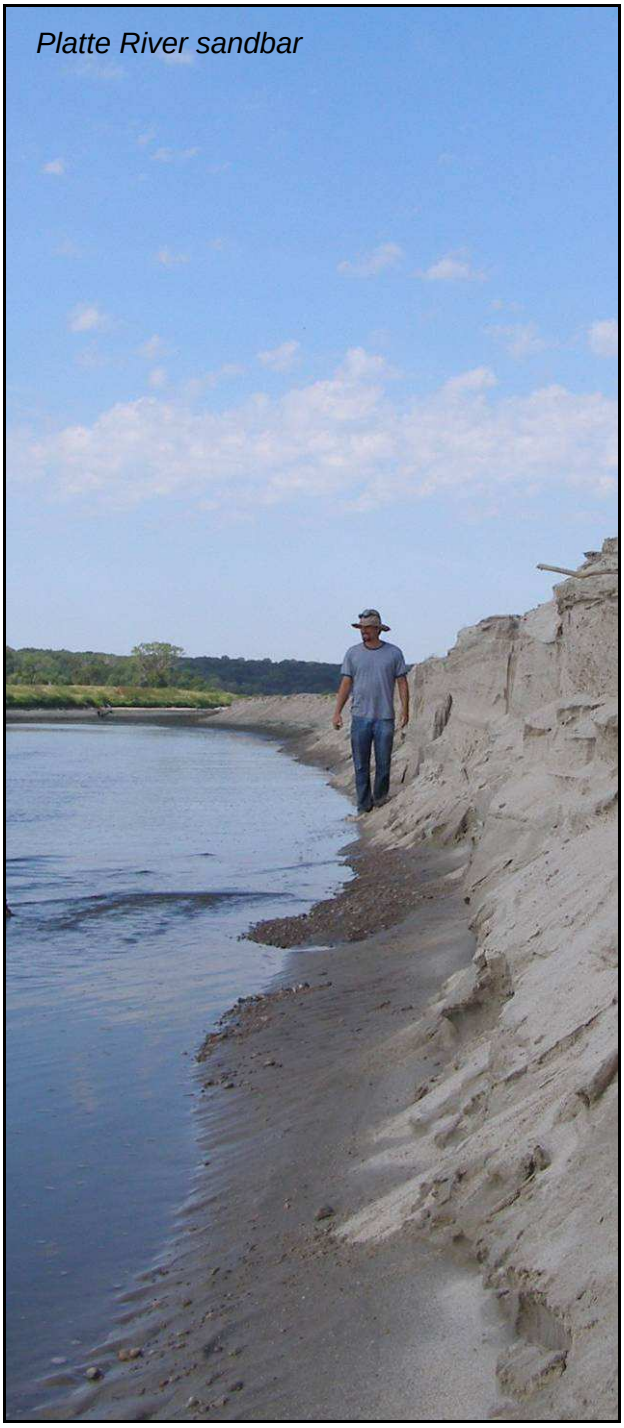

Platte River sandbar

2008 NEBRASKA LEAST TERN & PIPING PLOVER MEETING

Hosted by the Tern and Plover Conservation Partnership

February 25, 2008
University of Nebraska – Lincoln
Hardin Hall, Room 901
Lincoln, Nebraska

Time	Topic	Presenter
9:00–9:10	Welcome and Introductions	Kuzila/Jorgensen/all
9:10–9:35	Lake McConaughy/Upper Platte River	Gabe Wilson, CPPID
9:35–10:00	Central Platte River/Sandpits	Martha Tacha, FWS Jim Jenniges, NPPD Mark Czplewski, CPNRD
10:00–10:25	Lower Platte River, Sandpits and housing developments	Joel Jorgensen, NGPC Mary Brown, TPCP
10:25–10:40	Break	
10:40–10:50	Elkhorn and Loup River and Sandpits	Joel Jorgensen, NGPC Mary Brown, TPCP
10:50–11:15	Niobrara River	Stephen K. Wilson, NPS Jim Jenniges, NPPD
11:15–11:45	Missouri River	Greg Pavelka, USACE
11:45–12:30	Lunch	
12:30–1:20	"Beaches and Bars: Twenty-one Years of Piping Plover Research"	Jim Fraser, Virginia Tech University
1:20–1:50	"Chick Survival and Growth on Engineered and Natural Habitats: Can We Create Habitat?"	Dan Catlin, Virginia Tech University
1:50–2:10	"The role of density dependence in Piping Plover nesting ecology"	Joy Felio, Virginia Tech University
2:10–2:25	Break	
2:25–2:55	"Evaluating management efforts for Interior Least Terns within a metapopulation context."	Casey Lott, American Bird Conservancy
2:55-3:25	"Structured Decision Making, Rapid Prototyping, ESH and other jargon for terns and plovers"	Andrew Tyre, University of Nebraska-Lincoln
3:25-3:50	"Least Terns, Piping Plovers, and adaptive management on the Central Platte River"	Chad Smith, Headwaters Corp.
3:50–4:05	"Double observer approach to survey Least Terns on the Lower Platte River"	Sarah Rehme, UNL/NGPC
4:05-4:30	"Modeling Lower Platte River Sandbar Habitat"	Joel Jorgensen, NGPC
4:30– ?	Finish up, goodbyes, adjourn	all