Least Tern and Piping Plover Monitoring Protocol Implementation Report for 2002

Prepared for:
Technical Committee

Prepared by:
Executive Director's Office

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INTRODUCTION

The Cooperative Agreement's Technical Committee agreed to implement the protocol for "Monitoring Reproductive Success and Reproductive Habitat Parameters of Least Terns and Piping Plovers in the Central Platte River valley" (Tern and Plover Monitoring Protocol) dated May 1, 2002 in 2002 for the purpose of documenting the reproductive efforts of least terns and piping plovers. Existing cooperator staff and equipment was used to conduct the fieldwork. The Executive Director's office (EDO) was tasked to compile data and write the report. This report summarizes the data collected in the 2002 season and provides recommendations from the EDO for implementing the protocol.

METHODS

Three surveys of the Platte River were conducted to locate active nests and individual birds (component 1 of the protocol design). Surveys were conducted of all channels wider than 75m that could safely be navigated. Two airboats were used during the May, June and July surveys. Personnel from the Grand Island Field Office, U.S. Fish and Wildlife Service (USFWS) attempted to conduct the river survey from Chapman upstream to the Kearney Diversion Canal (near Elm Creek) on May 21 and 23, June 17 and 19, and July 22 and 23. Due to low water conditions this entire reach could not be surveyed. Nebraska Public Power District (NPPD), Central Nebraska Public Power and Irrigation District (Central), and Central Platte Natural Resources District (CPNRD) personnel conducted the river survey from the Kearney Diversion Canal upstream to Lexington on May 15, June 17, and July 16. The lengths of river surveyed for the May, June, and July surveys are in Table 1. The daily average in-stream (provisional) flows and stage levels for the Overton, Kearney and Grand Island gages during the river survey are in Table 2 and during the months of May, June and July are in Figures 1-6.

Three surveys of sandpits and islands constructed for tern and plover reproductive habitat were conducted to locate active nests and individual birds (component 2 of the protocol design). NPPD personnel surveyed 6 sandpits and 3 constructed islands from the Lexington bridge to the Odessa bridge. CPNRD personnel surveyed 13 sandpits from Odessa to the Chapman bridge. Several small pits between the Kearney bridge and the Odessa bridge as well as the Leach owned pit just East of the Minden bridge were not surveyed because permission to access was not obtained.

With the exception of three sites (see below), nests located during the river survey, or sandpit and constructed island survey were monitored throughout the nesting period. Nests were visited every 3 days until the nest failed or until the nestlings fledged. Nest level habitat

characteristics were measured at most nests after the birds had left the colony area. Colony level characteristics were measured in a geographic information system using the spatially referenced 1998 color infra-red photographs and updated maps prepared by monitoring personnel. Access to three pits owned by Broadfoot Sand and Gravel in the Kearney area was granted to conduct the three monthly surveys to locate nests, though access was not granted to monitor nests every three days.

The data were entered into the Program's Microsoft Access database. The database contains 11 data tables (Appendix B). Three tables contain information about the river survey, 4 tables document the nest monitoring, 1 table documents the nest habitat, 1 table lists the names and phone numbers for observers cited in the data tables, and 1 table documents all the sandpit and constructed islands considered for the survey. The database also contains 4 data entry forms corresponding to the 4 datasheets. Raw data sheets are housed at the EDO.

RESULTS

Survey Results

River surveys required 3 days to complete in each of May, June and July. There were 0 least tern nests and 0 piping plover nests detected during the river surveys. The most birds detected during one river survey period were 31 least tern adults, 5 piping plover adults, 7 least tern juveniles, and 5 piping plover juveniles (Table 3). Counts of birds detected during the river survey were not adjusted to account for the birds assumed to be reproducing at the nearby sandpits. The locations of each river survey observation and the distance to the closest known nesting colony are in Tables 4 and 5.

Nineteen sandpits and three constructed islands were surveyed during each of the three survey periods. There were 49 least tern and 21 piping plover nests located on sandpits in 2002. The number of adults, nests, chicks and fledglings detected on the site visit nearest to May 15, June 15, and July 15 were summed across the sites surveyed (Table 6). The most birds detected during one of these surveys to sandpits and constructed islands were 90 least tern adults, 34 piping plover adults, 29 least tern juveniles, and 22 piping plover juveniles.

Least tern and/or piping plover nests were located at 6 of the 22 sandpits/constructed islands surveyed (Table 7; Figures 7 and 8). Four of these sites were visited every three days while nests were active. Two sites were not accessible for nest monitoring.

There were 49 least tern nests located in 2002, 17 nests at Blue Hole, 5 nests at Broadfoot-Kearney South Pit, 5 nests at Broadfoot-Newark Pit, 2 nests at Bruner-Shelton Pit, 3 nests at Johnson Pit, and 17 nests at Lexington Pit (Table 8). Twenty-six of the 39 nests monitored successfully fledged at least 1 least tern for a total of 59 least tern fledglings.

There were 21 piping plover nests located in 2002, 8 nests at Blue Hole, 5 nests at Broadfoot-Kearney South Pit, 1 nest at Broadfoot-Newark Pit, 1 nest at Johnson Pit, and 6 nests at Lexington Pit (Table 9). Twelve of the 15 nests monitored successfully fledged at least 1 piping plover for a total of 28 piping plover fledglings.

The numbers of piping plover and least tern individuals and nests documented at the Broadfoot-Kearney South Pit represent minimums present. Surveys to determine exact counts of birds were hindered by the number of birds present and the size of the area.

Reproductive Parameters

Reproductive parameters listed in the protocol were estimated with the data collected in 2002. Formulas for reproductive habitat calculations are located in the protocol.

Total Nests Initiated

The total nests initiated are the number of nests detected during the site surveys. There were 49 least tern and 21 piping plover nest initiations documented in 2002. There were 39 least tern nest and 15 piping plover nests monitored until the nest failed or the fledglings departed the colony (Tables 10 and 11). The reproductive parameters calculated for this report were based only on the nests monitored in 2002.

Nest-based Hatching Success

Nest-based hatching success was estimated to be 1.67 for least terns (65 eggs/39 nests) and 2.53 for piping plovers (38 eggs/15 nests) monitored in 2002. This estimate is calculated as the number of hatched eggs divided by the number of nests initiated. The number of eggs that hatched was estimated as the maximum of number of chicks initially observed or number of chicks 15 days old (fledged by protocol definition).

Nesting Loss

Nesting loss was estimated to be 0.31 for least terns (12 nests lost/39 nests) and 0.13 for piping plovers (2 nests lost/15 nests) monitored in 2002. This estimate is calculated as the number of unsuccessful nests divided by the number of nests initiated. A nest is unsuccessful if no eggs hatch.

Nesting Success

Nesting success was estimated to be 0.69 for least terns (27 successful nests/39 nests) and 0.87 for piping plovers (13 successful nests/15 nests) monitored in 2002. This estimate is calculated as the number of successful nests divided by the number of nests initiated. A nest is successful if at least 1 chick is observed initially or 1 chick 15 days old is observed.

Number of Pairs

Number of pairs was estimated to be 33 for least terns and 12 for piping plovers at sites monitored in 2002. This estimate is calculated as the maximum number of nests and number of broods detected during one survey. An alternative estimate is one-half of the number of adults detected during one survey. Using this method, the number of pairs was estimated to be 40 for least terns and 11 for piping plovers for sites monitored in 2002.

The number of pairs estimated as the maximum number of nests and number of broods detected during one survey was 43 for least terns and 17 for piping plovers at all sites visited in 2002. The alternative estimate, one-half of the number of adults detected during one survey, was 45 for least terns and 17 for piping plovers for all sites visited in 2002.

Nest-based Fledgling Success

Nest-based fledgling success was estimated to be 1.51 for least terns (59 fledglings/39 nests) and 1.87 for piping plovers (28 fledglings/15 nests) monitored in 2002. This estimate is calculated as the number of fledglings divided by the number of nests initiated. The number of fledglings for each nest was estimated as the maximum of the number of chicks 15 days old or observed flying.

Pair-based Fledgling Success

Pair-based fledgling success for 2002 was estimated to be 1.79 for least terns (59 fledglings/33 pair) and 2.33 for piping plovers (28 fledglings/12 pair) using the first estimate of pairs above and 1.48 for least terns (59 fledglings/40 pair) and 2.55 for piping plovers (28 fledglings/11 pair) using the second estimate of pairs above. This estimate is calculated as the number of fledglings divided by the number of pairs.

Mayfield Daily Survival Rate

Mayfield daily nest survival rate was estimated to be 0.9833 (95% CI: 0.9737, 0.9928) for least terns (1-(12 nests/717 days)) and 0.9899 (95% CI: 0.9757, 1.0041) for piping plovers (1-(2 nests/198 days)) monitored in 2002 (Tables 12 and 13). This estimate is calculated as one minus the quantity: number of nest failures divided by the number of days nests were monitored (exposure days).

Trend Detection

Trends of reproductive parameters through time were not estimated with the data. As the monitoring data is collected throughout the first increment, these analyses will be possible.

Before-After Program Analysis

A before-after analysis of reproductive parameters was not estimated for this year of monitoring data. As the monitoring data is collected throughout the first increment, these analyses will be possible.

Nest-level Habitat Characteristics

Nest characteristics were visually estimated at most of the 49 least tern and 21 piping plover nests located in 2002 (Tables 14 and 15). Nesting colony characteristics were estimated at the 6 pits with active nests in 2002 (Table 16).

Distance to Nearest Bank

There were no least tern nests or piping plover nests monitored in the river channel in 2002.

Nest Elevation

The nest elevation averaged 2.00 meters (95% CI: 1.74, 2.26) over the 32 least tern nests visually estimated on sandpits and 1.88 meters (95% CI: 1.41, 2.35) over the 12 piping plover nests estimated on sandpits.

Nest Management

One nest (Broadfoot-Kearney South pit nest #2.02) on the periphery of the parking lot for the Tri-City Storm Arena received management in the form of restricted access by cars and people.

Vegetation Composition

The average cover visually estimated within the 1 m^2 area over the 32 least tern nests was 0% grass, 0.63% forb, and 0% woody. The average cover estimated within the 1 m^2 area over the

12 piping plover nests was 0% grass, 0.42% forb, and 1.67% woody. The average cover estimated within the 5 m^2 area over the 32 least tern nests was 0% grass, 1.25% forb, and 0% woody. The average cover estimated within the 5 m^2 area over the 12 piping plover nests was 0% grass, 0% forb, and 1.67% woody.

Vegetation Density

The average density of stems visually estimated within the 1 m^2 area over the 32 least tern nests was 0% grass, 0.75% forb, and 0% woody. The average density estimated within the 1 m^2 area over the 12 piping plover nests was 0% grass, 0.83% forb, and 0.42% woody. The average density estimated within the 5 m^2 area over the 32 least tern nests was 0% grass, 2.59% forb, and 0% woody. The average density estimated within the 5 m^2 area over the 12 piping plover nests was 0% grass, 0% forb, and 2.50% woody.

Vegetation Height

The average height of stems visually estimated within the 1 m^2 area over the 32 least tern nests was 0.02 meters. The average height estimated within the 1 m^2 area over the 12 piping plover nests was 0.05 meters. The average height estimated within the 5 m^2 area over the 32 least tern nests was 0.04 meters. The average height estimated within the 5 m^2 area over the 12 piping plover nests was 0.04 meters.

Colony-level Habitat Characteristics

Nesting colony characteristics were measured at the 6 pits with active nests in 2002 (Table 16).

Colony management

Three of the pits with active least tern or piping plover nests were managed for nesting activities through the use of predator fences, predator trapping, and herbicide spraying. The three other pits received no management for nesting activities.

Adjacent Land Use

This colony habitat characteristic was not recorded for any colonies in 2002.

Bare Sand Area

This colony habitat characteristic was not estimated for any colonies in 2002.

Pond Size

The size of the pond adjacent to the colony averaged 16.15 hectares (95% CI: 10.14, 22.16) over the 6 least tern colonies located at sandpits and 16.43 hectares (95% CI: 9.10, 23.75) over the 5 piping plover colonies located at sandpits. The data for pond size at each colony was estimated using tools in ArcView and the 1998 color infra-red photographs for Blue Hole, Lexington Pit, and Johnson Pit. Estimates for Bruner-Shelton, Broadfoot-Kearney South, and Broadfoot-Newark were made with June 21, 2001 photographs and estimates of 2002 water area. The estimate for Broadfoot-Kearney South was the sum over 3 ponds.

Distance from Colony to River

The distance from the colony to nearest active river channel averaged 913 meters (95% CI: 195, 1631) over the 6 least tern colonies located at sandpits and 598 meters (95% CI: 149, 1048) over the 5 piping plover colonies located at sandpits. The data for distance from each colony to river was estimated using tools in ArcView and the 1998 color infra-red photographs.

Sandbar/Island Height

There were no least tern nests or piping plover nests monitored in the river channel in 2002.

Channel Width

There were no least tern nests or piping plover nests monitored in the river channel in 2002.

Habitat Associations with Reproductive Parameters

Nest level associations use the nest as the sample size and assume the nests are independent. Correlations between each of the nest habitat characteristics and the number of eggs hatched, an indicator of nest success, and the number of chicks fledged were calculated by species (Tables 17 and 18). Positive correlations indicate an increase in the habitat parameter associated with an increase in the reproductive parameter. Negative correlations indicate a decrease in the habitat parameter associated with a decrease in the reproductive parameter.

Colony level associations use the colony as the sample size and assume the colonies are independent. Correlations between each of the colony habitat characteristics and the reproductive parameters were calculated by species (Table 19).

INCIDENTAL OBSERVATIONS

There were no incidental observations of least terns or piping plovers reported in the study area for 2002.

IMPLEMENTATION COSTS

There were 47 people-days worked to implement the current protocol during the 2002 implementation (Table 20). Each cooperator contributed their time under existing budgets, and no credit was given against the Cooperative Agreement. The estimate is lower than would be expected if a private contractor implemented the protocol because not all the pits were surveyed, and some surveyors were able to monitor nests on the way to or from other job responsibilities in the area.

RECOMMENDATIONS FOR FUTURE IMPLEMENTATION OF THE PROTOCOL

The EDO is again recommending the following changes in the implementation of the protocol. These recommendations were not implemented in 2002 and represent changes that could improve the data collected with this protocol.

1. Recommend random assignment of surveyors to river sections. The different surveyor abilities and seating design in the two airboats amount to different chances of observing terns and plovers by the two survey crews. If the number of nests is to be compared throughout the river system, the biases associated with each airboat crew should be spread throughout the river

system. Otherwise, the estimates of bird nest numbers by sections are confounded with survey crew.

2. Riverine surveys should use GPS to track the survey route. Documenting the length of river surveyed would allow comparisons of survey parameters through time to be standardized by effort.

APPENDICIES

A. Protocol: Monitoring reproductive success and reproductive habitat parameters of least terns and piping plovers in the central Platte River valley – dated May 1, 2002

B. Data Tables:

- Daily Survey Counts
- Daily Survey Header
- Intensive Survey
- Nest Habitat
- Nest Header
- Nest Observations
- Observers
- River Survey Bird Observations
- River Survey Channel Obs
- River Survey Header
- Sites

TABLES

Table 1. Length of river surveyed based on river miles.

Survey	From	To	River Miles
May 2002	Chapman	Gibbon	45
May 2002	Kearney Diversion	J2 Return	17.3
		Total	62.3
June 2002	Wood River	Odessa	36.7
June 2002	Kearney Diversion	J2 Return	17.3
		Total	54
July 2002	Hwy 34	Alda	6.8
July 2002	Wood River	Kearney Diversion	42
July 2002	Kearney Diversion	J2 Return	17.3
		Total	66.1

Table 2. Daily average discharge (cfs) and stage (feet) at Overton, Nebraska (USGS Gage No. 06768000), Kearney, Nebraska (USGS Gage No. 06770200) and Grand Island, Nebraska (USGS Gage No. 06770500) during river survey dates.

	Overton		Kearney		Grand Island	
Date	Discharge	Stage	Discharge	Stage	Discharge	Stage
5/15/2002	436	1.17	293	2.52	536	1.6
5/21/2002	234	0.93	113	2.19	377	1.52
5/23/2002	142	0.75	103	2.15	361	1.51
6/17/2002	422	1.25	463	2.74	290	1.42
6/19/2002	108	0.76	240	2.48	290	1.43
7/16/2002	722	1.64	313	2.57	108	1.18
7/22/2002	602	1.52	451	2.73	98	1.16
7/23/2002	552	1.47	402	2.67	172	1.28

Table 3. The number of adults, nests, chicks, and fledgling least terns and piping plovers observed during each monthly airboat survey of the river, 2001-2002.

	Least Tern				Piping Plover			
Survey	# Adults	# Nests	# Chicks	# Fledglings	# Adults	# Nests	# Chicks	# Fledglings
May 2002	4	0	0	0	0	0	0	0
June 2002	18	0	0	0	1	0	0	0
July 2002	31	0	0	7	5	0	0	5
May 2001	16	0	0	0	2	0	0	0
June 2001	23	0	0	0	5	0	0	0
July 2001	16	0	0	5	17	0	0	12

Table 4. Locations of least terns observed during the river survey. The distance to nearest constructed island or sandpit with nesting least terns was estimated as the strait-line distance using the location reported for each site.

Date	UTM x	UTM y	# Adults	# Juveniles	Activity	Distance to Closest Known Nesting Area (miles)
5/15/2002	469815	4503769	1	0	Flying	0.69
5/21/2002	.	.	1	0	Foraging	.
5/23/2002	521800	4507158	2	0	Foraging	1.41
5/23/2002	536664	4511231	1	0	Loafing	9.23
6/17/2002	468868	4503694	3	0	Foraging	0.23
6/17/2002	470173	4504103	2	0	Foraging	0.89
6/17/2002	492363	4500750	2	0	Loafing	0.38
6/17/2002	497208	4501262	1	0	Flying	2.83
6/17/2002	504258	4503664	2	0	Foraging	0.14
6/19/2002	496931	4501233	1	0	Foraging	2.65
6/19/2002	504758	4501068	1	0	Foraging	1.54
6/19/2002	505429	4501225	2	0	Foraging	1.61
6/19/2002	506607	4501673	2	0	Loafing	1.90
6/19/2002	506968	4501767	1	0	Loafing	2.05
6/19/2002	511390	4503011	1	0	Foraging	4.52
7/16/2002	468868	4503716	7	2	Foraging	0.21
7/16/2002	469522	4503694	2	0	Foraging	0.53
7/23/2002	470465	4503980	3	0	Foraging	1.07
7/23/2002	471639	4503785	1	0	Foraging	1.81
7/23/2002	472695	4503514	3	0	Foraging	2.48
7/23/2002	491525	4500623	1	0	Flying	0.82
7/23/2002	492392	4500743	1	0	Loafing	0.37
7/23/2002	492443	4500779	10	4	Loafing	0.34
7/23/2002	493064	4500805	1	1	Foraging	0.39
7/23/2002	505553	4501297	2	0	Flying/Loafing	1.61

Table 5. Locations of piping plovers observed during the river survey. The distance to nearest constructed island or sandpit with nesting piping plovers was estimated as the strait-line distance using the location reported for each site.

Date	UTM x	UTM y	# Adults	# Juveniles	Activity	Distance to Closest Known Nesting Area (miles)
6/19/2002	504826	4501164	1	0	Foraging	1.49
7/16/2002	468868	4503716	1	0	Loafing	0.21
7/16/2002	469139	4503696	1	3	Foraging	0.33
7/23/2002	471639	4503785	0	1	Foraging	1.81
7/23/2002	472695	4503514	2	0	Foraging	2.48
7/23/2002	492443	4500779	1	0	Foraging	0.34
7/23/2002	508197	4501943	0	1	Foraging	2.70

Table 6. The number of adults, nests, chicks, and fledgling least terns and piping plovers observed during each monthly survey at sand pits and constructed islands in 2001 and 2002. Sites between Gibbon and just east of the Kearney bridge were not visited in 2001.

Survey	# Sites	Least Tern				Piping Plover			
		# Adults	# Nests	# Chicks	# Fledglings	# Adults	# Nests	# Chicks	# Fledglings
May 2002	22	3	0	0	0	18	4	0	0
June 2002	22	90	41	3	0	34	7	22	2
July 2002	22	82	9	22	29	16	0	0	5
May 2001	23	6	0	0	0	11	3	0	0
June 2001	23	27	14	0	0	15	1	20	0
July 2001	23	21	0	15	14	2	1	0	1

Table 7. Sandpits and constructed islands monitored for least tern and piping plover reproduction in 2002. Number of adults, pairs, and nests is the maximum observed on one day for all the surveys at the site.

					Least Tern			Piping Plover			
Site	Site type	# Surveys	UTM x	UTM y	# adults	# pairs	# nests	# adults	# pairs	# nests	Site management
Blue Hole	sandpit	35	468735.9	4504032	37	15	13	14	7	6	Predator fences, trapping, herbicide
Lexington Pit	sandpit	35	438763.2	4509268	34	14	13	6	4	4	Predator fences, trapping, herbicide
Johnson Pit	sandpit	31	468880.5	4502069	5	2	2	2	1	1	Predator fences, trapping, herbicide
Bruner-Shelton	sandpit	9	521924	4509427	4	2	2	0	0	0	none
Lexington Island	constructed island	7			1	0	0	0	0	0	Spraying
Elm Creek Island	constructed island	6	469434	4503790	0	0	0	0	0	0	Spraying
Overton Island	constructed island	6	452603.8	4503365	0	0	0	0	0	0	Spraying
Broadfoot-Kearney SE	sandpit	3	493882	4502240	0	0	0	0	0	0	none
Broadfoot-Newark	sandpit	3	54135	4503466	10	5	5	2	1	1	none
Broadfoot-Kearney South[1]	sandpit	3	492659	4501284	26	11	11	16	7	4	none
Hooker Bros -GI South	sandpit	3	555613	4525340	0	0	0	0	0	0	none
Hooker Bros - GI West	sandpit	3	551433	4526439	0	0	0	0	0	0	none
Island Landhandlers- GI	sandpit	3	552343	4524639	0	0	0	0	0	0	none
JIL Asphalt - GI	sandpit	3	551127	4524821	0	0	0	0	0	0	none
Deweese-Alda	sandpit	3	548759	4521648	0	0	0	0	0	0	none
Knight-Chapman	sandpit	3	565680	4537371	0	0	0	0	0	0	none
Lilley-Wood River	sandpit	3	536428	4509875	0	0	0	0	0	0	none
Central Sand &Gravel -GI	sandpit	3	555873	4527165	0	0	0	0	0	0	none
TF Odessa	sandpit	3	479146.6	4501179	0	0	0	0	0	0	None
Paulsen's Lexington Pit	sandpit	3			0	0	0	0	0	0	None
OSG Overton Pit	sandpit	3			0	0	0	0	0	0	None
Alda – South	sandpit	3	544294	4520374	0	0	0	0	0	0	none

[1] Numbers of piping plover and least tern individuals and nests represent minimums present.

Table 8. Least tern nests located in the Cooperative Agreement study area in 2002. Nests at all sites except the Broadfoot-Kearney South Pit and Broadfoot-Newark Pit were monitored every three days.

Site	Nest #	First Date Observed	# Eggs	Date Hatched	# Chicks Initially Observed	# Chicks Fledged	Date Fledged	Final Status	Nest Management
Blue Hole	5.02	5/28/02		6/17/02	3	3	7/11/02	Fledged	
Blue Hole	6.02	5/28/02		6/18/02	3	3	7/11/02	Fledged	
Blue Hole	9.02	6/3/02		6/22/02	3	3	7/11/02	Fledged	
Blue Hole	10.02	6/3/02		6/22/02	3	2	7/11/02	Fledged	
Blue Hole	11.02	6/5/02		6/29/02	2	2	7/17/02	Fledged	
Blue Hole	12.02	6/5/02		6/28/02	3	3	7/15/02	Fledged	
Blue Hole	13.02	6/5/02		6/29/02	2	2	7/17/02	Fledged	
Blue Hole	14.02	6/5/02		6/29/02	3	3	7/17/02	Fledged	
Blue Hole	15.02	6/12/02		7/1/02	2	2	7/19/02	Fledged	
Blue Hole	16.02	6/14/02		7/6/02	2	2	7/26/02	Fledged	
Blue Hole	17.02	6/14/02		6/30/02	1	1	7/19/02	Fledged	
Blue Hole	19.02	6/18/02		7/1/02	2	2	7/26/02	Fledged	
Blue Hole	20.02	6/21/02						Failed- Predated	
Blue Hole	21.02	6/21/02		7/11/02	2	2	8/5/02	Fledged	
Blue Hole	22.02	6/21/02			2	2	8/5/02	Fledged	
Blue Hole	24.02	7/4/02						Failed- Other	
Blue Hole	25.02	7/15/02						Failed- Unknown	
Broadfoot-Kearney S.	6.02	6/13/02	3					Unknown Outcome	
Broadfoot-Kearney S.	7.02	6/13/02	3					Unknown Outcome	
Broadfoot-Kearney S.	8.02	6/13/02	3					Unknown Outcome	
Broadfoot-Kearney S.	9.02	6/13/02	3					Unknown Outcome	
Broadfoot-Kearney S.	10.02	7/15/02	1					Unknown Outcome	
Broadfoot-Newark	1.02	6/13/02	3					Unknown Outcome	
Broadfoot-Newark	2.02	6/13/02	3					Unknown Outcome	
Broadfoot-Newark	3.02	6/13/02						Unknown Outcome	
Broadfoot-Newark	4.02	6/13/02						Unknown Outcome	
Broadfoot-Newark	5.02	6/13/02						Unknown Outcome	
Bruner-Shelton	1.02	7/15/02	2					Failed- Predated	

Bruner-Shelton	2.02	7/15/02	1					Failed- Unknown	
Johnson Pit	2.02	5/28/02		6/17/02	3	1	7/11/02	Fledged	
Johnson Pit	3.02	5/28/02		6/17/02				Failed- Unknown	
Johnson Pit	4.02	6/11/02		7/7/02	2	2	7/25/02	Fledged	
Lexington Pit	4.02	5/28/02		6/18/02	3			Failed- Predated	
Lexington Pit	5.02	5/28/02		6/24/02	3	3	7/18/02	Fledged	
Lexington Pit	7.02	5/31/02		6/18/02	3	3	7/8/02	Fledged	
Lexington Pit	8.02	5/31/02		6/19/02	3	3	7/10/02	Fledged	
Lexington Pit	9.02	6/3/02		6/24/02	2	2	7/10/02	Fledged	
Lexington Pit	10.02	6/10/02		6/27/02	2	2	7/18/02	Fledged	
Lexington Pit	11.02	6/10/02						Failed- Predated	
Lexington Pit	12.02	6/10/02		6/27/02				Failed- Unknown	
Lexington Pit	13.02	6/10/02		6/27/02				Failed- Predated	
Lexington Pit	14.02	6/10/02		7/3/02	3	3	7/23/02	Fledged	
Lexington Pit	15.02	6/10/02		6/24/02	3	3	7/12/02	Fledged	
Lexington Pit	16.02	5/31/02						Failed- Unknown	
Lexington Pit	17.02	6/14/02						Failed- Predated	
Lexington Pit	18.02	6/18/02		7/7/02	2	2	8/5/02	Fledged	
Lexington Pit	19.02	6/18/02		7/5/02				Unknown Outcome	
Lexington Pit	21.02	7/15/02		7/26/02	2	2	8/15/02	Fledged	
Lexington Pit	22.02	7/15/02		7/30/02	1	1	8/19/02	Fledged	

Table 9. Piping plover nests located in the Cooperative Agreement study area in 2002. Nests at all sites except the Broadfoot-Kearney South Pit and Broadfoot-Newark Pit were monitored every three days.

Site	Nest #	First Date Observed	# Eggs	Date Hatched	# Chicks Initially Observed	# Chicks Fledged	Date Fledged	Final Status	Nest Management
Blue Hole	1.02	5/14/02	4	6/5/02		2	6/27/02	Fledged	
Blue Hole	2.02	5/18/02	4	5/31/02	4	2	6/27/02	Fledged	
Blue Hole	3.02	5/23/02	4	6/1/02	4	3	6/27/02	Fledged	
Blue Hole	4.02	5/23/02	4	6/1/02	4	2	7/1/02	Fledged	
Blue Hole	7.02	5/31/02	4	6/3/02	4	4	6/27/02	Fledged	
Blue Hole	8.02	5/31/02		6/3/02	3	1	6/27/02	Fledged	
Blue Hole	18.02	6/14/02		6/26/02	2	2	7/15/02	Fledged	
Blue Hole	23.02	6/21/02	4	7/16/02	4	3	8/9/02	Fledged	
Broadfoot-Kearney S.	1.02	5/14/02	3					Unknown Outcome	
Broadfoot-Kearney S.	2.02	6/13/02	4					Unknown Outcome	cordoned off from cars
Broadfoot-Kearney S.	3.02	6/13/02	4					Unknown Outcome	
Broadfoot-Kearney S.	4.02	6/13/02	4					Unknown Outcome	
Broadfoot-Kearney S.	5.02	6/13/02	4					Unknown Outcome	
Broadfoot-Newark	6.02	6/13/02						Unknown Outcome	
Johnson Pit	1.02	5/14/02		6/2/02	3	3	6/24/02	Fledged	
Lexington Pit	1.02	5/14/02		5/30/02	4	2	6/24/02	Fledged	
Lexington Pit	2.02	5/23/02		6/18/02				Failed- Unknown	
Lexington Pit	3.02	5/28/02						Failed- Unknown	
Lexington Pit	6.02	5/28/02		6/9/02	4	3	7/8/02	Fledged	
Lexington Pit	20.02	6/18/02		7/2/02	1			Unknown Outcome	
Lexington Pit	23.02	8/8/02			1	1	8/19/02	Fledged	

Table 10. Least tern reproductive parameter estimates for the 2002 nesting season. These estimates are based on nests monitored.

Site	# Pairs[1]	# Pairs[2]	# Nests Initiated	# Chicks Initially Observed	# Successful Nests	# Unsuccessful Nests	# Eggs Hatched	# Fledglings	Nest-based Hatch Success	Nesting Loss	Nesting Success	Nest-based Fledging Success	Pair-based[1] Fledging Success	Pair-based[2] Fledging Success
Blue Hole	15	18.5	17	33	14	3	33	32	1.94	0.18	0.82	1.88	2.13	1.73
Bruner-Shelton	2	2	2	0	0	2	0	0	0.00	1.00	0.00	0.00	0.00	0.00
Johnson Pit	2	2.5	3	5	2	1	5	3	1.67	0.33	0.67	1.00	1.50	1.20
Lexington Pit	14	17	17	27	11	6	27	24	1.59	0.35	0.65	1.41	1.71	1.41
All sites	33	40	39	65	27	12	65	59	1.67	0.31	0.69	1.51	1.79	1.48

Table 11. Piping plover reproductive parameter estimates for the 2002 nesting season. These estimates are based on nests monitored.

Site	# Pairs[1]	# Pairs[2]	# Nests Initiated	# Chicks Initially Observed	# Successful Nests	# Unsuccessful Nests	# Eggs Hatched	# Fledglings	Nest-based Hatch Success	Nesting Loss	Nesting Success	Nest-based Fledging Success	Pair-based[1] Fledging Success	Pair-based[2] Fledging Success
Blue Hole	7	7	8	25	8	0	25	19	3.13	0.00	1.00	2.38	2.71	2.71
Johnson Pit	1	1	1	3	1	0	3	3	3.00	0.00	1.00	3.00	3.00	3.00
Lexington Pit	4	3	6	10	4	2	10	6	1.67	0.33	0.67	1.00	1.50	2.00
All sites	12	11	15	28	13	2	38	28	2.53	0.13	0.87	1.87	2.33	2.55

Table 12. Mayfield daily nest survival rate and incubation survival rate for least terns in 2002. Incubation survival rate is the daily rate times itself for every day of incubation (21 times). These estimates are based on nests monitored.

Site	# Nests	# Nests Lost	Exposure Days	Mayfield Daily Nest Survival Rate	Mayfield Daily Nest Survival Rate Variance	Mayfield Daily Nest Survival Rate 95% CI		Incubation Period Survival Rate	Incubation Period Survival Rate 95% CI	
						Lower	Upper		Lower	Upper
Blue Hole	17	3	293	0.9898	0.0000	0.9780	1.0015	0.8056	0.6268	1.0325
Bruner-Shelton	2	2	26	0.9231	0.0027	0.8186	1.0276	0.1862	0.0149	1.7712
Johnson Pit	3	1	66	0.9848	0.0002	0.9548	1.0149	0.7257	0.3784	1.3648
Lexington Pit	17	6	332	0.9819	0.0001	0.9673	0.9965	0.6818	0.4976	0.9300
All Sites	39	12	717	0.9833	0.0000	0.9737	0.9928	0.7016	0.5712	0.8600

Table 13. Mayfield daily nest survival rate and incubation survival rate for piping plovers in 2002. Incubation survival rate is the daily rate times itself for every day of incubation (28 times). These estimates are based on nests monitored.

Site	# Nests	# Nests Lost	Exposure Days	Mayfield Daily Nest Survival Rate	Mayfield Daily Nest Survival Rate Variance	Mayfield Daily Nest Survival Rate 95% CI		Incubation Period Survival Rate	Incubation Period Survival Rate 95% CI	
						Lower	Upper		Lower	Upper
Blue Hole	8	0	96	1.0000	Undef.	Undef.	Undef.	1.0000	Undef.	Undef.
Johnson Pit	1	0	19	1.0000	Undef.	Undef.	Undef.	1.0000	Undef.	Undef.
Lexington Pit	6	2	83	0.9759	0.0003	0.9422	1.0096	0.5051	0.1890	1.3056
All Sites	15	2	198	0.9899	0.0001	0.9757	1.0041	0.7526	0.5020	1.1218

Table 14. Nest level habitat characteristics estimated at least tern nests monitored in 2002 (estimations were not made at all nests as indicated by sample size).

Habitat Parameter	Site Type	Sample Size	Mean	95% CI		Minimum Value	Maximum Value
				Lower Bound	Upper Bound		
Nest Elevation	sandpit	32	2.00	1.74	2.26	0.61	3.66
Cover of Grass in 1 m^2 area	sandpit	32	0.00	0.00	0.00	0	0
Cover of Forb in 1 m^2 area	sandpit	32	0.63	-0.10	1.35	0	10
Cover of Woody in 1 m^2 area	sandpit	32	0.00	0.00	0.00	0	0
Density of Grass in 1 m^2 area	sandpit	32	0.00	0.00	0.00	0	0
Density of Forb in 1 m^2 area	sandpit	32	0.75	-0.13	1.63	0	10
Density of Woody in 1 m^2 area	sandpit	32	0.00	0.00	0.00	0	0
Height of Vegetation in 1 m^2 area	sandpit	32	0.02	0.00	0.04	0	0.3
Cover of Grass in 5 m^2 area	sandpit	32	0.00	0.00	0.00	0	0
Cover of Forb in 5 m^2 area	sandpit	32	1.25	-0.07	2.57	0	20
Cover of Woody in 5 m^2 area	sandpit	32	0.00	0.00	0.00	0	0
Density of Grass in 5 m^2 area	sandpit	32	0.00	0.00	0.00	0	0
Density of Forb in 5 m^2 area	sandpit	32	2.59	-0.18	5.37	0	30
Density of Woody in 5 m^2 area	sandpit	32	0.00	0.00	0.00	0	0
Height of Vegetation in 5 m^2 area	sandpit	32	0.05	0.00	0.10	0	0.5

Table 15. Nest level habitat characteristics estimated at piping plover nests monitored in 2002 (estimations were not made at all nests as indicated by sample size).

Habitat Parameter	Site Type	Sample Size	Mean	95% CI		Minimum Value	Maximum Value
				Lower Bound	Upper Bound		
Nest Elevation	sandpit	12	1.88	1.41	2.35	0.3	3.05
Cover of Grass in 1 m^2 area	sandpit	12	0.00	0.00	0.00	0	0
Cover of Forb in 1 m^2 area	sandpit	12	0.42	-0.40	1.23	0	5
Cover of Woody in 1 m^2 area	sandpit	12	1.67	-1.60	4.93	0	20
Density of Grass in 1 m^2 area	sandpit	12	0.00	0.00	0.00	0	0
Density of Forb in 1 m^2 area	sandpit	12	0.83	-0.80	2.47	0	10
Density of Woody in 1 m^2 area	sandpit	12	0.42	-0.40	1.23	0	5
Height of Vegetation in 1 m^2 area	sandpit	12	0.04	-0.04	0.12	0	0.5
Cover of Grass in 5 m^2 area	sandpit	12	0.00	0.00	0.00	0	0
Cover of Forb in 5 m^2 area	sandpit	12	0.00	0.00	0.00	0	0
Cover of Woody in 5 m^2 area	sandpit	12	1.67	-1.60	4.93	0	20
Density of Grass in 5 m^2 area	sandpit	12	0.00	0.00	0.00	0	0
Density of Forb in 5 m^2 area	sandpit	12	0.00	0.00	0.00	0	0
Density of Woody in 5 m^2 area	sandpit	12	2.50	-2.40	7.40	0	30
Height of Vegetation in 5 m^2 area	sandpit	12	0.04	-0.04	0.12	0	0.5

Table 16. Colony level habitat characteristics for each sandpit with least tern (LETE) or piping plover (PIPL) nests in 2002.

Site name	Nesting Species	Colony Management	Adjacent Land Use	Pond Size (m^2)	Distance to River (m)
Blue Hole	LETE PIPL	Predator fences, trapping,herbicide	Inactive pit	99,719	226
Johnson Pit	LETE PIPL	Predator fences, trapping,herbicide	Inactive pit	120,523	1,446
Lexington Pit	LETE PIPL	Predator fences, trapping,herbicide	Inactive pit	145,526	719
Bruner-Shelton	LETE	None	Active sandpit surrounded by grassland	147,682	2,488
Broadfoot-Kearney South	LETE PIPL	None	Large active sandpit	309,789	268
Broadfoot-Newark	LETE PIPL	None	Active pit	145,774	333

Table 17. Correlations between habitat parameters and reproductive parameters for the least tern nests monitored in 2002 (measurements were not done at all nests as indicated by sample size). Correlations cannot be calculated for habitat parameters with constant values at all nests (indicated by missing values).

	# Eggs Hatched		Nest Success		# Young Fledged	
Habitat Parameter	n	Correlation	n	Correlation	n	Correlation
Nest Elevation	22	0.1475	22	0.1484	22	0.1455
Cover of Grass in 1 m^2 area	22	.	22	.	22	.
Cover of Forb in 1 m^2 area	22	-0.3525	22	-0.3801	22	-0.3128
Cover of Woody in 1 m^2 area	22	.	22	.	22	.
Density of Grass in 1 m^2 area	22	.	22	.	22	.
Density of Forb in 1 m^2 area	22	-0.3525	22	-0.3801	22	-0.3128
Density of Woody in 1 m^2 area	22	.	22	.	22	.
Height of Vegetation in 1 m^2 area	22	-0.3525	22	-0.3801	22	-0.3128
Cover of Grass in 5 m^2 area	22	.	22	.	22	.
Cover of Forb in 5 m^2 area	22	-0.3525	22	-0.3801	22	-0.3128
Cover of Woody in 5 m^2 area	22	.	22	.	22	.
Density of Grass in 5 m^2 area	22	.	22	.	22	.
Density of Forb in 5 m^2 area	22	-0.3525	22	-0.3801	22	-0.3128
Density of Woody in 5 m^2 area	22	.	22	.	22	.
Height of Vegetation in 5 m^2 area	22	-0.3122	22	-0.3366	22	-0.2770

Table 18. Correlations between habitat parameters and reproductive parameters for the piping plover nests monitored in 2002 (measurements were not done at all nests as indicated by sample size). Correlations can not be calculated for habitat parameters with constant values at all nests (indicated by missing values).

	# Eggs Hatched		Nest Success		# Young Fledged	
Habitat Parameter	n	Correlation	n	Correlation	n	Correlation
Nest Elevation	6	-0.2097	6	-0.2568	6	-0.4429
Cover of Grass in 1 m^2 area	6	.	6	.	6	.
Cover of Forb in 1 m^2 area	6	.	6	.	6	.
Cover of Woody in 1 m^2 area	6	.	6	.	6	.
Density of Grass in 1 m^2 area	6	.	6	.	6	.
Density of Forb in 1 m^2 area	6	.	6	.	6	.
Density of Woody in 1 m^2 area	6	.	6	.	6	.
Height of Vegetation in 1 m^2 area	6	.	6	.	6	.
Cover of Grass in 5 m^2 area	6	.	6	.	6	.
Cover of Forb in 5 m^2 area	6	.	6	.	6	.
Cover of Woody in 5 m^2 area	6	.	6	.	6	.
Density of Grass in 5 m^2 area	6	.	6	.	6	.
Density of Forb in 5 m^2 area	6	.	6	.	6	.
Density of Woody in 5 m^2 area	6	.	6	.	6	.
Height of Vegetation in 5 m^2 area	6	.	6	.	6	.

Table 19. Correlations between colony level habitat parameters and reproductive parameters for the 4 least tern and 3 piping plover colonies monitored in 2002.

Habitat Parameter	# Nests Initiated	# Chicks Initially Observed	# Successful Nests	# Unsuccessful Nests	# Eggs Hatched	# Fledglings	Nest-based Hatch Success	Nesting Loss	Nesting Success	Nest-based Fledging Success	Pair-based[1] Fledging Success	Pair-based[2] Fledging Success	Mayfield Daily Nest Survival Rate	Incubation Period Survival Rate
Least Tern (n)	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Distance to River	-0.90	-0.95	-0.95	-0.51	-0.95	-0.93	-0.91	0.92	-0.92	-1.00	-0.96	-0.97	-0.88	-0.90
Size of Pond	-0.32	-0.47	-0.49	0.32	-0.47	-0.49	-0.69	0.71	-0.71	-0.69	-0.69	-0.67	-0.65	-0.70
Piping Plover (n)	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Distance to River	-0.99	-0.95	-0.98	-0.11	-0.95	-0.90	0.03	-0.11	0.11	0.41	0.29	0.38	0.11	0.11
Size of Pond	-0.23	-0.63	-0.53	0.89	-0.63	-0.73	-0.92	0.89	-0.89	-0.71	-0.80	-0.73	-0.89	-0.89

Table 20. Time (people-days) used to implement least tern and piping plover monitoring protocol in 2002.

Cooperator	Riverine Survey (people/days)	Nest Monitoring (people/days)
NPPD	3	10
CPNRD	3	10
CNPPID	3	0
USFWS	18	0
EDO	0	0
Total	27	20

Figure 1. Discharge (cfs) at Overton, Nebraska (USGS Gage No. 06768000) from May 1 through August 31, 2002.

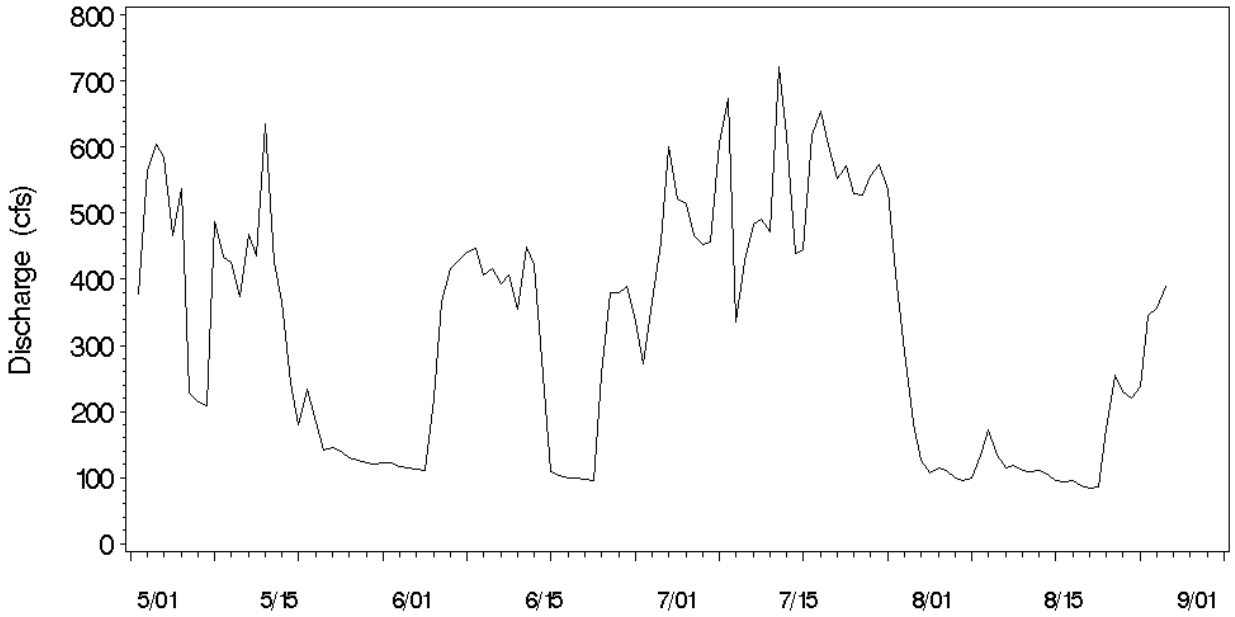


Figure 2. Stage (ft) at Overton, Nebraska (USGS Gage No. 06768000) from May 1 through August 31, 2002.

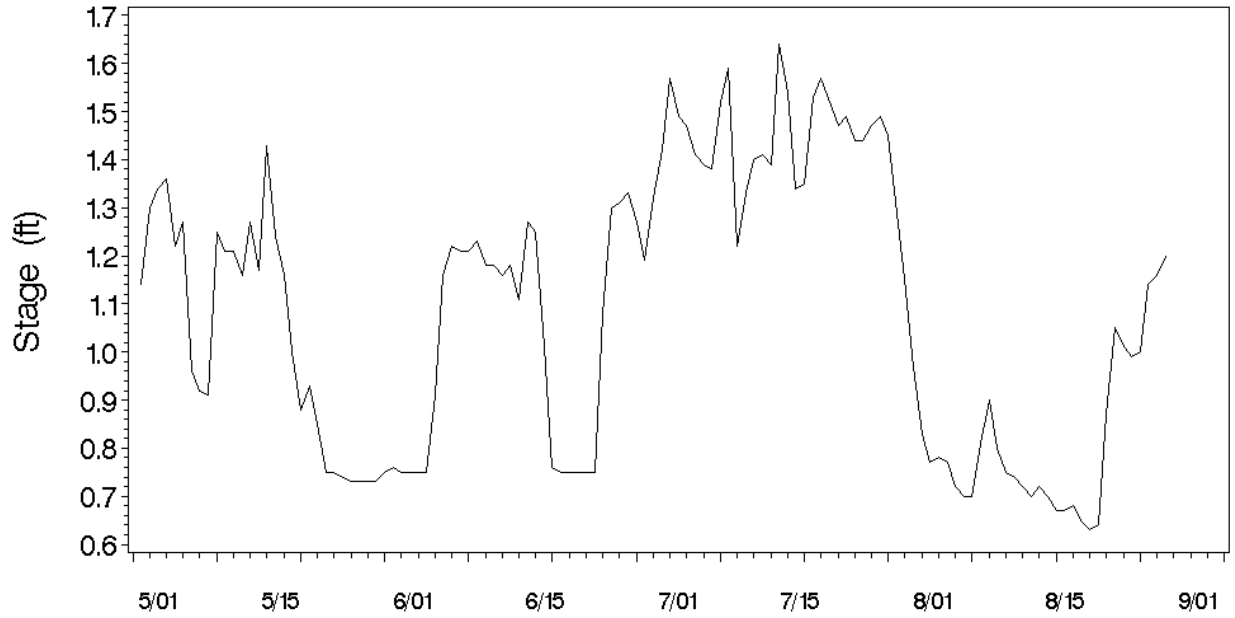


Figure 3. Discharge (cfs) at Kearney, Nebraska (USGS Gage No. 06770200) from May 1 through August 31, 2002.

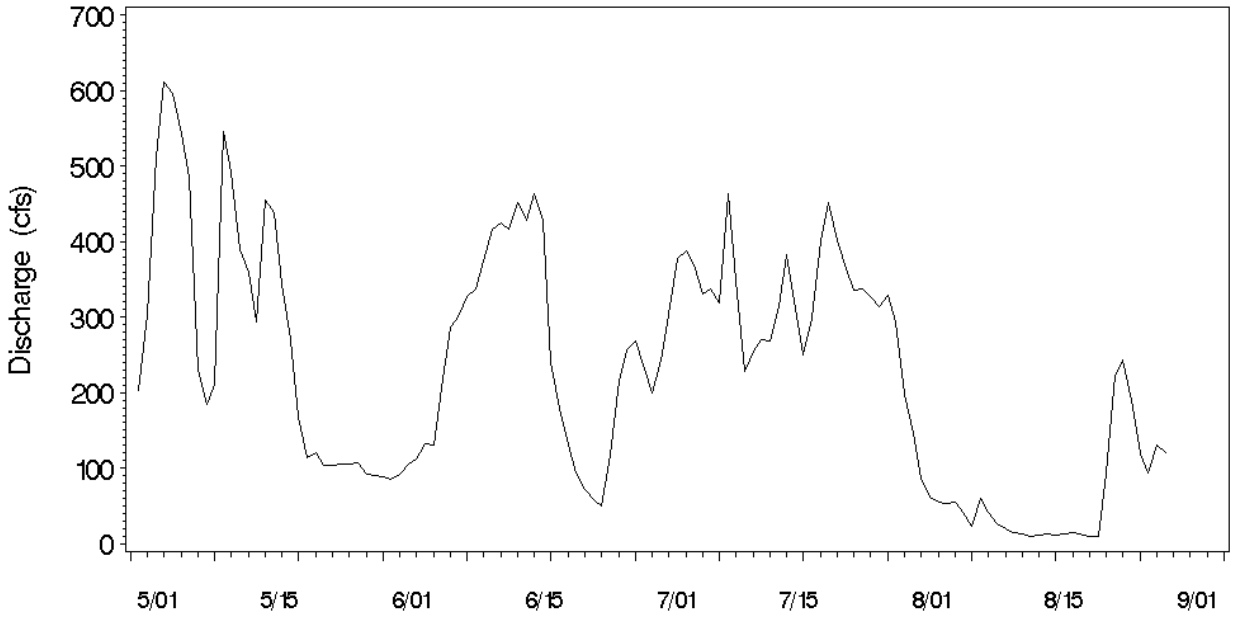


Figure 4. Stage (ft) at Kearney, Nebraska (USGS Gage No. 06770200) from May 1 through August 31, 2002.

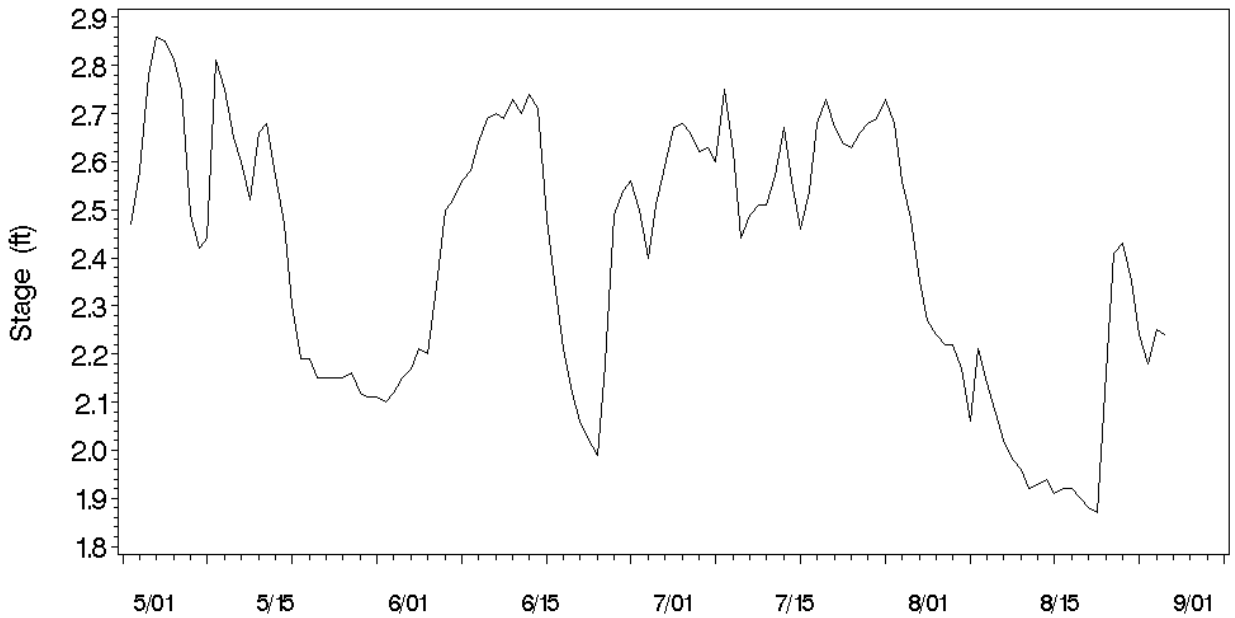


Figure 5. Discharge (cfs) at Grand Island, Nebraska (USGS Gage No. 06770500) from May 1 through August 31, 2002.

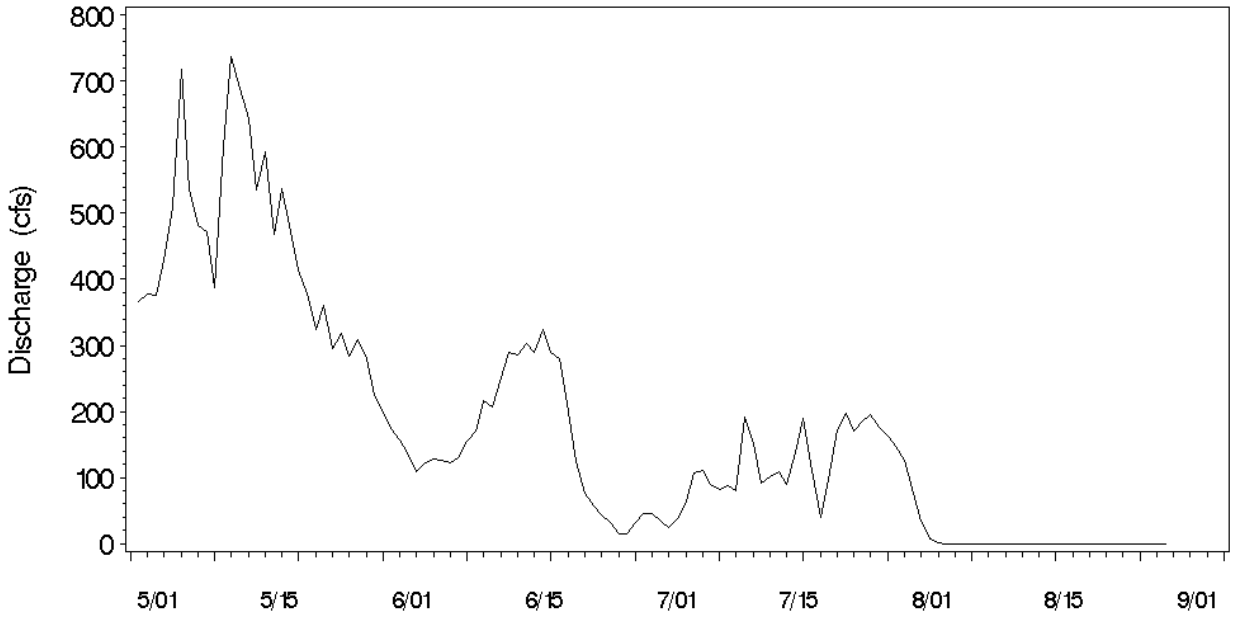


Figure 6. Stage (ft) at Grand Island, Nebraska (USGS Gage No. 06770500) from May 1 through August 31, 2002.

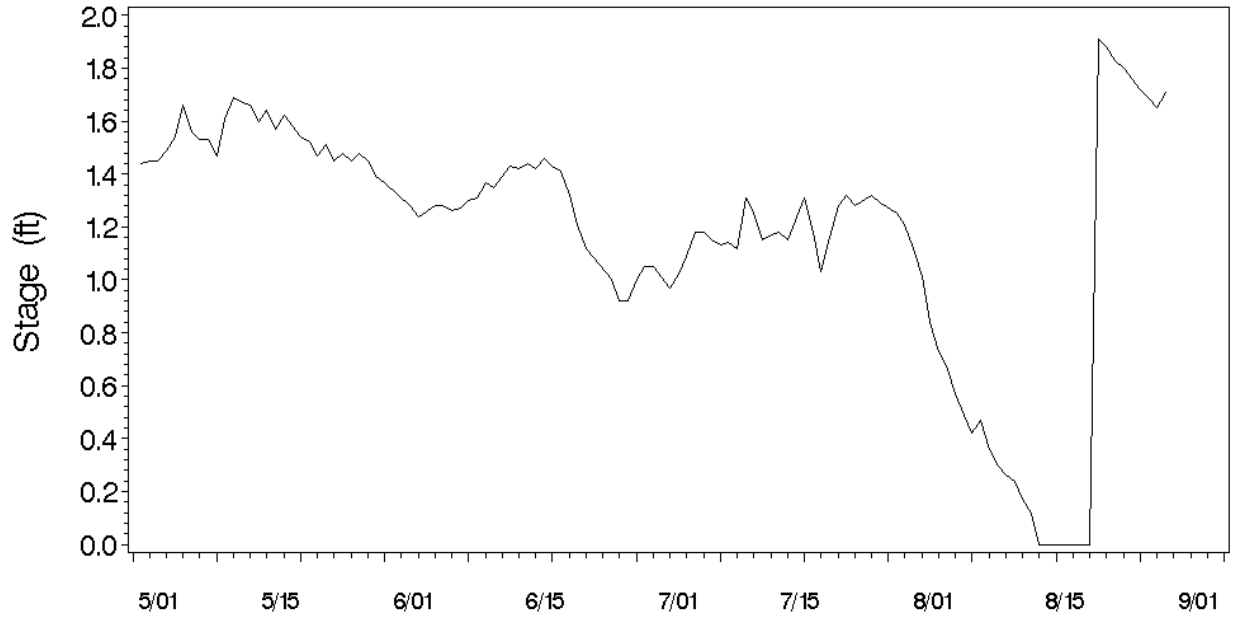


Figure 7. Sandpits and constructed islands surveyed for the 2002 season and locations of least tern sightings and nesting.

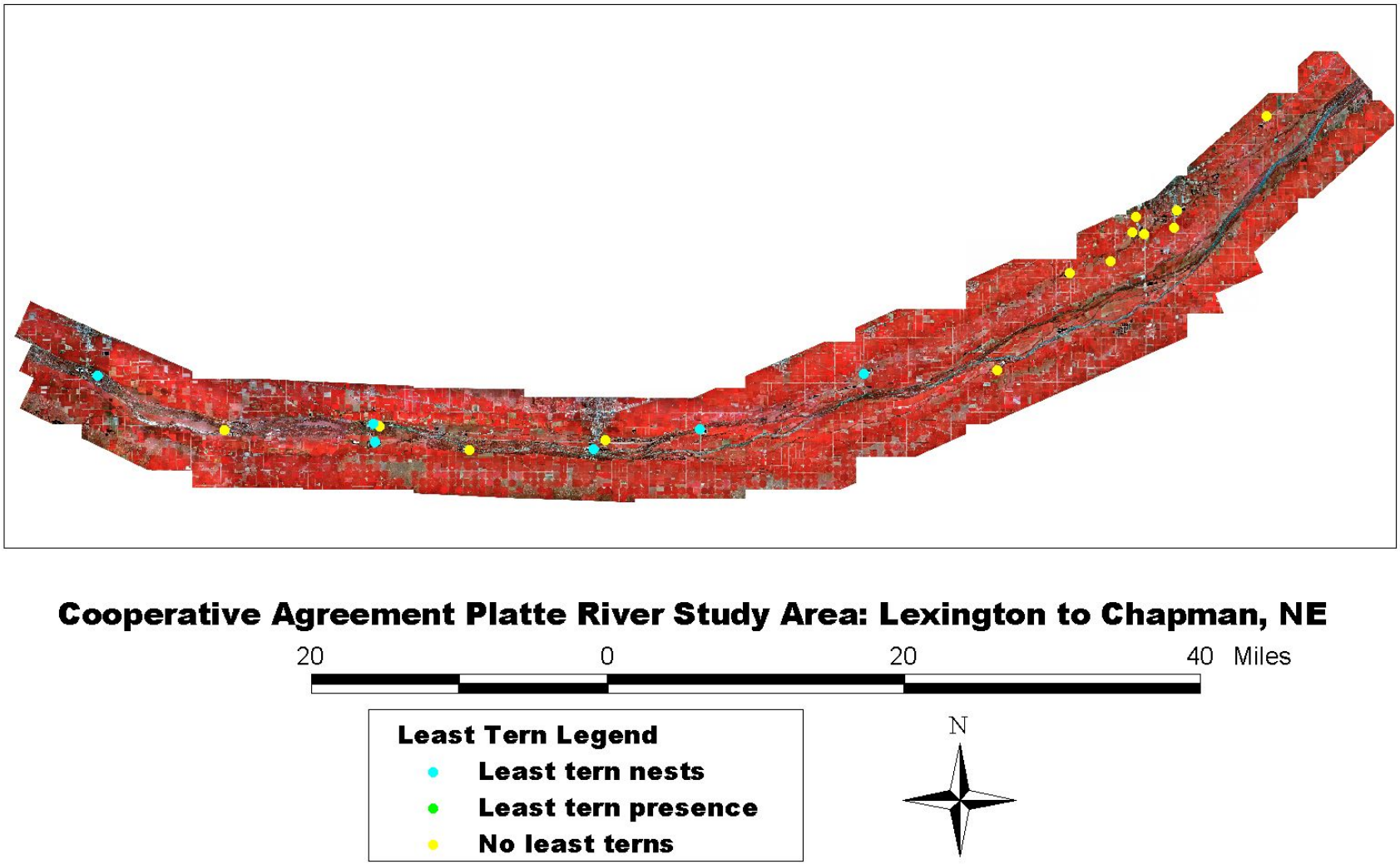
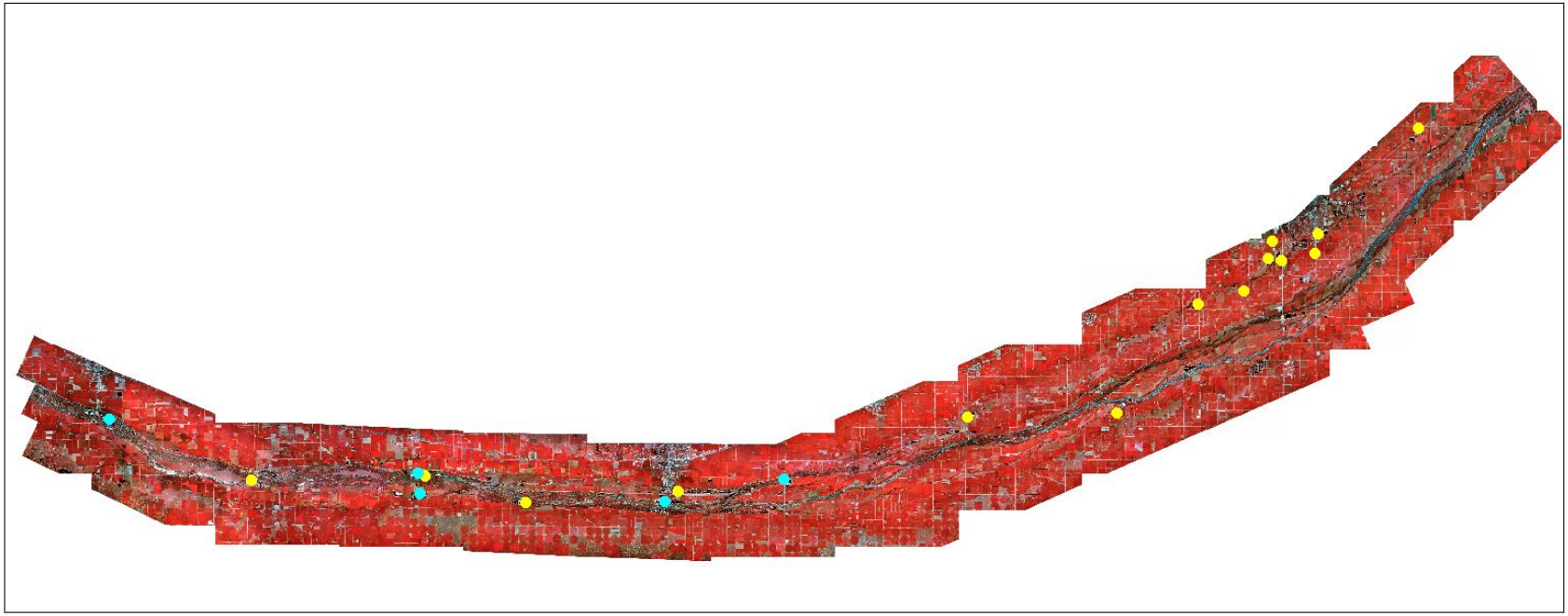


Figure 8. Sandpits and constructed islands surveyed for the 2002 season and locations of piping plover sightings and nesting.



Cooperative Agreement Platte River Study Area: Lexington to Chapman, NE

20 0 20 40 Miles

Piping Plover Legend
- **Piping plover nests**
- **No piping plovers**

N