Least Tern and Piping Plover Monitoring Protocol Implementation Report for 2003

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 2003 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 2003 season.

METHODS

Two 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 and June survey. The July survey was not conducted due to low water conditions. Personnel from the Grand Island Field Office, U.S. Fish and Wildlife Service (USFWS) conducted the river survey from Chapman upstream to the Kearney Canal headgates (near Elm Creek) on May 21, 22 and 23; and June 18, 19, and 24. 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 23, and June 23. 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.

Between two and 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 4 constructed islands from the Lexington bridge to the Odessa bridge. CPNRD personnel surveyed 10 sandpits from ~1 mile West of the Kearney bridge 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 two 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 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 two 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 4 days to complete in May and June. 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 28 least tern adults and 10 piping plover adults (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.

Sixteen sandpits and four constructed islands were surveyed during the May and June survey periods. Thirteen sandpits and four constructed islands were surveyed during the July survey period. There were 71 least tern and 18 piping plover nests located on sandpits in 2003. 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 87 least tern adults, 23 piping plover adults, 33 least tern juveniles, and 6 piping plover juveniles.

Least tern and/or piping plover nests were located at 6 of the 20 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 71 least tern nests located in 2003, 21 nests at Blue Hole, 16 nests at Broadfoot-Kearney South Pit, 6 nests at Broadfoot-Newark Pit, 2 nests at Bruner-Shelton Pit, 7 nests at Johnson Pit, and 19 nests at Lexington Pit (Table 8). Twenty-seven of the 49 nests monitored successfully fledged at least 1 least tern for a total of 53 least tern fledglings.

There were 18 piping plover nests located in 2003, 6 nests at Blue Hole, 2 nests at Broadfoot-Kearney South Pit, 1 nest at Broadfoot-Newark Pit, 3 nests at Johnson Pit, and 6 nests at Lexington Pit (Table 9). Ten of the 15 nests monitored successfully fledged at least 1 piping plover for a total of 22 piping plover fledglings.

The numbers of piping plover and least tern individuals and nests documented at the Broadfoot-Kearney South Pit and the Broadfoot-Newark 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 2003. 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 71 least tern and 18 piping plover nest initiations documented in 2003. There were 49 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 2003.

Nest-based Hatching Success

Five nests were eliminated from the estimate of nest-based hatching success for least terns. Due to the timing of the loss of nests 21, 23, 24, 26, and 27 at Blue Hole, it could not be determined if these nests hatched. Nest-based hatching success was estimated to be 1.41 for least terns (62 eggs/44 nests) and 2.87 for piping plovers (43 eggs/15 nests) monitored in 2003. 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 0.37 for least terns (18 nests lost/49 nests) and 0.13 for piping plovers (2 nests lost/15 nests) monitored in 2003. 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 0.63 for least terns (31 successful nests/49 nests) and 0.87 for piping plovers (13 successful nests/15 nests) monitored in 2003. 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 31 for least terns and 12 for piping plovers at sites monitored in 2003 for reproductive success (every 3 days). 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 31.5 for least terns and 11 for piping plovers for sites monitored in 2003.

The number of pairs estimated as the maximum number of nests and number of broods detected during one survey was 46 for least terns and 16 for piping plovers at all sites visited in 2003. The alternative estimate, one-half of the number of adults detected during one survey, was 43.5 for least terns and 11.5 for piping plovers for all sites visited in 2003. These estimates include sites visited during the monthly surveys but not monitored for reproductive success.

Nest-based Fledgling Success

Nest-based fledgling success was estimated to be 1.08 for least terns (53 fledglings/49 nests) and 1.47 for piping plovers (22 fledglings/15 nests) monitored in 2003. 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 2003 was estimated to be 1.71 for least terns (53 fledglings/31 pair) and 1.83 for piping plovers (22fledglings/12 pair) using the first estimate of pairs above and 1.68 for least terns (53 fledglings/31.5 pair) and 2.00 for piping plovers (22 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 0.9778 (95% CI: 0.9674, 0.9881) for least terns (1-(18 nests/810 days)) and 0.9940 (95% CI: 0.9857, 1.0024) for piping plovers (1-(2 nests/336 days)) monitored in 2003 (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 24 of the least tern and 3 piping plover nests located in 2003 (Tables 14 and 15).

Distance to Nearest Bank

There were no least tern nests or piping plover nests monitored in the river channel in 2003.

Nest Elevation

The nest elevation averaged 1.48 meters (95% CI: 1.11, 1.86) over the 24 least tern nests visually estimated on sandpits and 1.70 meters (95% CI: 1.50, 1.90) over the 3 piping plover nests visually estimated on sandpits.

Nest Management

The owner/operators were notified of the location of the two nests located at the Bruner-Shelton pit.

Vegetation Composition

The average cover visually estimated within the 1 m^2 area over the 24 least tern nests was 0.21% grass, 1.25% forb, and 0% woody. The average cover estimated within the 1 m^2 area over the 3 piping plover nests was 0% grass, 0.33% forb, and 0% woody. The average cover estimated within the 5 m^2 area over the 24 least tern nests was 0.71% grass, 2.38% forb, and 0% woody. The average cover estimated within the 5 m^2 area over the 3 piping plover nests was 0% grass, 0.33% forb, and 0% woody.

Vegetation Density

The average density of stems visually estimated within the 1 m^2 area over the 24 least tern nests was 0.42 stems of grass per m^2, 1.67 stems of forb per m^2, and 0 stems of woody per m^2. The average density estimated within the 1 m^2 area over the 3 piping plover nests was 0 stems of grass per m^2, 0.83 stems of forb per m^2, and 0.42 stems of woody per m^2. The average density estimated within the 5 m^2 area over the 24 least tern nests was 6.71 stems of grass per 5 m^2, 11.92 stems of forb per 5 m^2, and 0 stems of woody per 5 m^2. The average density estimated within the 5 m^2 area over the 3 piping plover nests was 0 stems of grass per 5 m^2, 1.67 stems of forb per 5 m^2, and 0 stems of woody per 5 m^2.

Vegetation Height

The average height of stems visually estimated within the 1 m^2 area over the 24 least tern nests was 0.04 meters. The average height estimated within the 1 m^2 area over the 3 piping plover nests was 0.03 meters. The average height estimated within the 5 m^2 area over the 24 least tern nests was 0.09 meters. The average height estimated within the 5 m^2 area over the 3 piping plover nests was 0.03 meters.

Colony-level Habitat Characteristics

Nesting colony characteristics were measured at the 6 pits with active nests in 2003 (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 electric predator fences, predator trapping by USDA from late May to August, and pre-emergent herbicide application in March. The three other pits received no management for nesting activities.

Adjacent Land Use

Three of the pits with active least tern or piping plover nests were adjacent to active sandpits in 2003.

Bare Sand Area

This colony habitat characteristic was not estimated for any colonies in 2003.

Pond Size

The size of the pond adjacent to the colony averaged 16.17 hectares (95% CI: 11.23, 23.11) over the 6 least tern colonies located at sandpits and 16.26 hectares (95% CI: 10.21,

22.31) 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 early June 2003 photographs and estimates of 2003 water area.

Distance from Colony to River

The distance from the colony to nearest active river channel averaged 886 meters (95% CI: 217, 1555) over the 6 least tern colonies located at sandpits and 600 meters (95% CI: 152, 1049) 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 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 2003 water area.

Sandbar/Island Height

There were no least tern nests or piping plover nests monitored in the river channel in 2003.

Channel Width

There were no least tern nests or piping plover nests monitored in the river channel in 2003.

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 2003.

IMPLEMENTATION COSTS

There were 55 people-days worked to implement the protocol during the 2003 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.

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 Observations**
- **River Survey Header**
- **Sites**

TABLES

Table 1. Length of river surveyed in 2003 based on river miles.

Survey	From	To	River Miles
May 2003	Chapman	Kearney Diversion	72.3
May 2003	Kearney Diversion	J2 Return	17.3
		Total	89.6
June 2003	Chapman	Kearney Diversion	72.3
June 2003	Kearney Diversion	J2 Return	17.3
		Total	89.6
July 2003			0
		Total	0

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
5/21/2003	423	1.28	105	2.3	579	3.6
5/22/2003	440	1.31	82	2.24	507	3.55
5/23/2003	474	1.35	73	2.21	448	3.5
6/18/2003	217	1.04	83	2.04	252	3.24
6/19/2003	199	1.01	80	2.02	274	3.27
6/23/2003	143	0.88	120	2.18	243	3.22
6/24/2003	380	1.25	121	2.19	279	3.26

Table 3. The number of adults, nests, chicks, and fledgling least terns and piping plovers observed during each monthly airboat survey of the river, 2001-2003.

	Least Tern				Piping Plover			
Survey	# Adults	# Nests	# Chicks	# Fledglings	# Adults	# Nests	# Chicks	# Fledglings
May 2003	28	0	0	0	10	0	0	0
June 2003	17	0	0	0	9	0	0	0
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)
5/21/2003	471709	4503766	2	0	Loafing and foraging	1.85
5/21/2003	472015	4503646	2	0	Loafing	2.05
5/21/2003	472363	4503557	1	0	Loafing	2.27
5/21/2003	473876	4503169	2	0	Loafing	3.18
5/21/2003	474103	4503102	1	0	Flying	3.31
5/21/2003	484874	4501447	2	0	Loafing	4.84
5/21/2003	492375	4500776	3	0	Loafing	0.36
5/21/2003	492769	4500751	2	0	Courtship	0.34
5/21/2003	504738	4501073	3	0	Loafing	1.53
5/21/2003	506243	4501441	2	0	Foraging	1.82
5/21/2003	511494	4503081	2	0	Loafing and Foraging	4.58
5/23/2003	461751	4503897	1	0	Flying	4.34
5/23/2003	467591	4503328	1	0	Flying	0.84
5/23/2003	469249	4503677	2	0	Loafing	0.39
5/23/2003	521465	4507168	2	0	Foraging	1.43
6/19/2003	470988	4504038	3	0	Loafing and Foraging	1.40
6/19/2003	471637	4503851	1	0	Flying	1.81
6/19/2003	471637	4503851	3	0	Foraging	1.81
6/19/2003	473166	4503461	1	0	Foraging	2.78
6/19/2003	492230	4500797	1	0	Foraging	0.40
6/19/2003	494227	4500727	1	0	Flying	1.03
6/19/2003	504495	4501093	2	0	Foraging by pit	1.49
6/19/2003	504840	4501035	1	0	Flying by pit	1.57
6/19/2003	506712	4501625	1	0	Foraging	1.97
6/23/2003	461751	4503897	1	0	Foraging	4.34
6/23/2003	469249	4503677	2	0	Foraging	0.39

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)
5/21/2003	506243	4501441	2	0	Foraging	1.82
5/21/2003	506471	4501508	1	0	Foraging	1.89
5/22/2003	540709	4512402	3	0	Foraging	23.39
5/23/2003	469249	4503677	4	0	Foraging	0.39
6/19/2003	470988	4504038	3	0	Foraging	1.40
6/19/2003	471637	4503851	3	0	Foraging	1.81
6/19/2003	492230	4500797	1	0	Foraging	0.40
6/23/2003	469249	4503677	2	0	Foraging	0.39

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, 2001-2003.

Survey	# Sites	Least Tern				Piping Plover			
		# Adults	# Nests	# Chicks	# Fledglings	# Adults	# Nests	# Chicks	# Fledglings
May 2003	20	40	0	0	0	22	10	0	0
June 2003	20	87	46	0	0	23	6	23	0
July 2003	17	79	15	16	33	9	1	0	6
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 2003. Number of adults, pairs, and nests is the maximum observed on one day for all the surveys at the site.

Site	Site type	# Surveys	UTM x	UTM y	Least Tern			Piping Plover			Site management
					# adults	# pairs	# nests	# adults	# pairs	# nests	
Johnson Pit	sandpit	33	468880.5	4502069	8	4	4	4	2	2	Electric fence, Predator trapping by USDA from late May-August, Pre-emergent herbicide application in March
Blue Hole	sandpit	32	468735.9	4504032	29	16	13	9	6	6	Electric fence, Predator trapping by USDA from late May-August, Pre-emergent herbicide application in March
Lexington Pit	sandpit	31	438763.2	4509268	22	9	9	9	4	3	Electric fence, Predator trapping by USDA from late May-August, Pre-emergent herbicide application in March
Bruner-Shelton	sandpit	16	521924	4509427	4	2	1	1	0	0	none
Cottonwood Ranch	constructed island	8	460254	4503961	0	0	0	1	0	0	Pre-emergent herbicide application in March
Overton Island	constructed island	8	452603.8	4503365	2	0	0	0	0	0	Pre-emergent herbicide application in March
Lexington Island	constructed island	5			0	0	0	0	0	0	Pre-emergent herbicide application in March
Elm Creek Island	constructed island	5	469434	4503790	0	0	0	0	0	0	Pre-emergent herbicide application in March
Central Sand &Gravel -GI	sandpit	3	555873	4527165	0	0	0	0	0	0	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
Deweese-Alda	sandpit	3	548759	4521648	0	0	0	0	0	0	none
Lilley-Wood River	sandpit	3	536428	4509875	0	0	0	0	0	0	none
Knight-Chapman	sandpit	3	565680	4537371	0	0	0	0	0	0	none
Broadfoot-Kearney South	sandpit	3	492659	4501284	28	0	14	8	3	2	none
Broadfoot-Newark	sandpit	3	504135	4503466	12	0	6	2	1	1	none
TF Odessa	sandpit	2	479146.6	4501179	0	0	0	0	0	0	Pre-emergent herbicide application in March
Paulsen's Lexington Pit	sandpit	2			0	0	0	0	0	0	Pre-emergent herbicide application in March
OSG Overton Pit	sandpit	2			0	0	0	0	0	0	Pre-emergent herbicide application in March

Table 8. Least tern nests located in the Cooperative Agreement study area in 2003. Nests at all sites except the Broadfoot-Kearney S. and Broadfoot-Newark 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	7.03	5/27/2003		6/18/2003	3	3	7/17/2003	Fledged	None
Blue Hole	8.03	5/27/2003		6/19/2003	3	3	7/17/2003	Fledged	None
Blue Hole	9.03	6/2/2003		6/23/2003	2	2	7/17/2003	Fledged	None
Blue Hole	10.03	6/2/2003		6/23/2003	2	2	7/21/2003	Fledged	None
Blue Hole	11.03	6/2/2003		6/23/2003	2	2	7/21/2003	Fledged	None
Blue Hole	12.03	6/4/2003		6/26/2003	2	2	7/21/2003	Fledged	None
Blue Hole	13.03	6/8/2003		6/25/2003	3	3	7/21/2003	Fledged	None
Blue Hole	14.03	6/8/2003		6/23/2003	2	2	7/21/2003	Fledged	None
Blue Hole	15.03	6/11/2003		7/9/2003				Failed- Abandoned	None
Blue Hole	16.03	6/16/2003		7/5/2003	3	3	7/27/2003	Fledged	None
Blue Hole	17.03	6/16/2003		6/27/2003	2	2	7/27/2003	Fledged	None
Blue Hole	18.03	6/16/2003		6/30/2003	3	3	7/27/2003	Fledged	None
Blue Hole	19.03	6/18/2003		7/2/2003	2	2	7/27/2003	Fledged	None
Blue Hole	20.03	6/30/2003		7/20/2003	2	2	8/6/2003	Fledged	None
Blue Hole	21.03	7/7/2003					8/1/2003	Failed- Predated	None
Blue Hole	22.03	7/7/2003		7/28/2003	2	2	8/14/2003	Fledged	None
Blue Hole	23.03	7/9/2003					7/29/2003	Failed- Predated	None
Blue Hole	24.03	7/9/2003					7/29/2003	Failed- Predated	None
Blue Hole	25.03	7/12/2003		7/24/2003	1	1	8/11/2003	Fledged	None
Blue Hole	26.03	7/12/2003					7/29/2003	Failed- Predated	None
Blue Hole	27.03	7/12/2003					7/29/2003	Failed- Unknown	None
Broadfoot-Kearney S.	3.03	6/17/2003						Unknown Outcome	None
Broadfoot-Kearney S.	4.03	6/17/2003						Unknown Outcome	None
Broadfoot-Kearney S.	5.03	6/17/2003						Unknown Outcome	None
Broadfoot-Kearney S.	6.03	6/17/2003						Unknown Outcome	None
Broadfoot-Kearney S.	7.03	6/17/2003						Unknown Outcome	None
Broadfoot-Kearney S.	8.03	6/17/2003						Unknown Outcome	None
Broadfoot-Kearney S.	9.03	6/17/2003						Unknown Outcome	None

Broadfoot-Kearney S.	10.03	6/17/2003						Unknown Outcome	None
Broadfoot-Kearney S.	11.03	6/17/2003						Unknown Outcome	None
Broadfoot-Kearney S.	12.03	6/17/2003						Unknown Outcome	None
Broadfoot-Kearney S.	13.03	6/17/2003						Unknown Outcome	None
Broadfoot-Kearney S.	14.03	6/17/2003						Unknown Outcome	None
Broadfoot-Kearney S.	15.03	6/17/2003						Unknown Outcome	None
Broadfoot-Kearney S.	16.03	6/17/2003						Unknown Outcome	None
Broadfoot-Kearney S.	17.03	7/22/2003	2					Unknown Outcome	None
Broadfoot-Kearney S.	18.03	7/22/2003						Unknown Outcome	None
Broadfoot-Newark	2.03	6/17/2003	3					Unknown Outcome	None
Broadfoot-Newark	3.03	6/17/2003						Unknown Outcome	None
Broadfoot-Newark	4.03	6/17/2003						Unknown Outcome	None
Broadfoot-Newark	5.03	6/17/2003						Unknown Outcome	None
Broadfoot-Newark	6.03	6/17/2003						Unknown Outcome	None
Broadfoot-Newark	7.03	6/17/2003						Unknown Outcome	None
Bruner-Shelton	1.03	6/17/2003		6/22/2003	2	2	7/10/2003	Fledged	Notified owner/operator
Bruner-Shelton	2.03	6/27/2003		7/17/2003	2	2	8/6/2003	Fledged	None
Johnson Pit	2.03	5/27/2003		6/19/2003	1			Failed- Unknown	None
Johnson Pit	3.03	5/27/2003		6/19/2003	2	2	7/9/2003	Fledged	None
Johnson Pit	4.03	5/27/2003		6/19/2003	2	2	7/9/2003	Fledged	None
Johnson Pit	5.03	5/27/2003		6/19/2003	2			Failed- Unknown	None
Johnson Pit	8.03	6/27/2003	3	7/15/2003	2	2		Fledged	None
Johnson Pit	9.03	7/12/2003						Failed- Abandoned	None
Johnson Pit	10.03	7/12/2003						Failed- Abandoned	None
Lexington Pit	4.03	5/28/2003						Failed- Other	None
Lexington Pit	5.03	5/28/2003						Failed- Other	None
Lexington Pit	6.03	6/2/2003						Failed- Other	None
Lexington Pit	7.03	6/2/2003						Failed- Other	None
Lexington Pit	8.03	6/2/2003						Failed- Other	None
Lexington Pit	10.03	6/9/2003		6/30/2003	2	2	7/22/2003	Fledged	None
Lexington Pit	11.03	6/13/2003						Failed- Predated	None
Lexington Pit	12.03	6/13/2003		7/3/2003	2	2	7/27/2003	Fledged	None
Lexington Pit	13.03	6/15/2003						Failed- Predated	None
Lexington Pit	14.03	6/15/2003						Failed- Predated	None

Lexington Pit	15.03	6/13/2003		7/4/2003	2	2	7/27/2003	Fledged	None
Lexington Pit	17.03	6/13/2003		7/3/2003	2	2	7/27/2003	Fledged	None
Lexington Pit	18.03	6/26/2003		7/5/2003	2	2	7/27/2003	Fledged	None
Lexington Pit	19.03	6/26/2003		7/16/2003	1	1	8/4/2003	Fledged	None
Lexington Pit	20.03	7/3/2003						Failed- Unknown	None
Lexington Pit	21.03	7/3/2003		7/25/2003	2	2	8/16/2003	Fledged	None
Lexington Pit	23.03	7/7/2003		7/28/2003	1			Failed- Predated	None
Lexington Pit	24.03	7/7/2003						Failed- Unknown	None
Lexington Pit	25.03	7/17/2003		8/2/2003	1			Unknown Outcome	None

Table 9. Piping plover nests located in the Cooperative Agreement study area in 2003. Nests at all sites except the Broadfoot-Kearney S. and Broadfoot-Newark 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	1.03	5/5/2003		5/31/2003	4	3	6/22/2003	Fledged	None
Blue Hole	2.03	5/5/2003	4	6/2/2003	4	2	6/25/2003	Fledged	None
Blue Hole	3.03	5/5/2003		6/2/2003	4	3	6/22/2003	Fledged	None
Blue Hole	4.03	5/5/2003		5/30/2003	4	3	6/22/2003	Fledged	None
Blue Hole	5.03	5/15/2003		6/10/2003	3	3	7/9/2003	Fledged	None
Blue Hole	6.03	5/27/2003		6/24/2003	2	2	7/17/2003	Fledged	None
Broadfoot-Kearney S.	1.03	5/15/2003						Unknown Outcome	None
Broadfoot-Kearney S.	2.03	6/17/2003						Unknown Outcome	None
Broadfoot-Newark	1.03	5/15/2003	4					Unknown Outcome	None
Johnson Pit	1.03	5/5/2003						Failed- Other	None
Johnson Pit	6.03	6/9/2003	4	7/4/2003	4			Failed- Unknown	None
Johnson Pit	7.03	6/11/2003	4	7/9/2003	3			Failed- Unknown	None
Lexington Pit	1.03	5/14/2003		6/3/2003	3	1	7/1/2003	Fledged	None
Lexington Pit	2.03	5/21/2003		5/27/2003	4	2	6/25/2003	Fledged	None
Lexington Pit	3.03	5/21/2003		6/2/2003	3	2	6/25/2003	Fledged	None
Lexington Pit	9.03	6/4/2003		6/23/2003	3			Unknown Outcome	None
Lexington Pit	16.03	6/13/2003		7/9/2003				Failed- Unknown	None
Lexington Pit	22.03	7/7/2003		7/24/2003	2	1	8/16/2003	Fledged	None

Table 10. Least tern reproductive parameter estimates for the 2003 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[3]	Nesting Loss	Nesting Success	Nest-based Fledging Success	Pair-based[1] Fledging Success	Pair-based[2] Fledging Success
Blue Hole	16	14.5	21	34	15	6	34	34	2.13	0.29	0.71	1.62	2.13	2.34
Bruner-Shelton	2	2	2	4	2	0	4	4	2	0	1	2	2	2
Johnson Pit	4	4	7	9	5	2	9	6	1.29	0.29	0.71	0.86	1.5	1.5
Lexington Pit	9	11	19	15	9	10	15	13	0.79	0.53	0.47	0.68	1.44	1.18
All sites	31	31.5	49	62	31	18	62	57	1.41	0.37	0.63	1.16	1.84	1.81

[3] Estimate at Blue Hole based on 16 nests.

Table 11. Piping plover reproductive parameter estimates for the 2003 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	6	4.5	6	21	6	0	21	16	3.50	0.00	1.00	2.67	2.67	3.56
Johnson Pit	2	2	3	7	2	1	7	0	2.33	0.33	0.67	0.00	0.00	0.00
Lexington Pit	4	4.5	6	15	5	1	15	6	2.50	0.17	0.83	1.00	1.50	1.33
All sites	12	11	15	43	13	2	43	22	2.87	0.13	0.87	1.47	1.83	2.00

Table 12. Mayfield daily nest survival rate and incubation survival rate for least terns in 2003. 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	21	6	400	0.9850	0.0000	0.9728	0.9972	0.7280	0.5609	0.9419
Bruner-Shelton	2	0	25	1.0000	Undef.	Undef.	Undef.	1.0000	Undef.	Undef.
Johnson Pit	7	2	156	0.9872	0.0001	0.9692	1.0052	0.7626	0.5180	1.1149
Lexington Pit	19	10	229	0.9563	0.0002	0.9293	0.9833	0.3915	0.2145	0.7027
All Sites	49	18	810	0.9778	0.0000	0.9674	0.9881	0.6238	0.4988	0.7783

Table 13. Mayfield daily nest survival rate and incubation survival rate for piping plovers in 2003. 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	6	0	161	1.0000	Undef.	Undef.	Undef.	1.0000	Undef.	Undef.
Johnson Pit	3	1	75	0.9867	0.0002	0.9602	1.0132	0.6867	0.3205	1.4419
Lexington Pit	6	1	100	0.9900	0.0001	0.9701	1.0099	0.7547	0.4274	1.3176
All Sites	15	2	336	0.9940	0.0000	0.9857	1.0024	0.8461	0.6673	1.0706

Table 14. Nest level habitat characteristics estimated at least tern nests in 2003 (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	24	1.48	1.11	1.86	0.60	4.60
Cover of Grass in 1 m2 area	sandpit	24	0.21	-0.20	0.62	0.00	5.00
Cover of Forb in 1 m2 area	sandpit	24	1.25	0.45	2.05	0.00	5.00
Cover of Woody in 1 m2 area	sandpit	24	0.00	0.00	0.00	0.00	0.00
Density of Grass in 1 m2 area	sandpit	24	0.42	-0.40	1.23	0.00	10.00
Density of Forb in 1 m2 area	sandpit	24	1.67	0.35	2.98	0.00	10.00
Density of Woody in 1 m2 area	sandpit	24	0.00	0.00	0.00	0.00	0.00
Height of Vegetation in 1 m2 a	sandpit	24	0.04	0.02	0.06	0.00	0.10
Cover of Grass in 5 m2 area	sandpit	24	0.71	0.04	1.38	0.00	5.00
Cover of Forb in 5 m2 area	sandpit	24	2.38	1.45	3.30	0.00	5.00
Cover of Woody in 5 m2 area	sandpit	24	0.00	0.00	0.00	0.00	0.00
Density of Grass in 5 m2 area	sandpit	24	6.71	-0.03	13.44	0.00	50.00
Density of Forb in 5 m2 area	sandpit	24	11.92	4.82	19.01	0.00	50.00
Density of Woody in 5 m2 area	sandpit	24	0.00	0.00	0.00	0.00	0.00
Height of Vegetation in 5 m2 a	sandpit	24	0.09	0.06	0.12	0.00	0.30

Table 15. Nest level habitat characteristics estimated at piping plover nests in 2003 (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	3	1.70	1.50	1.90	1.50	1.80
Cover of Grass in 1 m^2 area	sandpit	3	0.00	0.00	0.00	0.00	0.00
Cover of Forb in 1 m^2 area	sandpit	3	0.33	-0.32	0.99	0.00	1.00
Cover of Woody in 1 m^2 area	sandpit	3	0.00	0.00	0.00	0.00	0.00
Density of Grass in 1 m^2 area	sandpit	3	0.00	0.00	0.00	0.00	0.00
Density of Forb in 1 m^2 area	sandpit	3	0.33	-0.32	0.99	0.00	1.00
Density of Woody in 1 m^2 area	sandpit	3	0.00	0.00	0.00	0.00	0.00
Height of Vegetation in 1 m^2 area	sandpit	3	0.03	-0.03	0.10	0.00	0.10
Cover of Grass in 5 m^2 area	sandpit	3	0.00	0.00	0.00	0.00	0.00
Cover of Forb in 5 m^2 area	sandpit	3	0.33	-0.32	0.99	0.00	1.00
Cover of Woody in 5 m^2 area	sandpit	3	0.00	0.00	0.00	0.00	0.00
Density of Grass in 5 m^2 area	sandpit	3	0.00	0.00	0.00	0.00	0.00
Density of Forb in 5 m^2 area	sandpit	3	1.67	-1.60	4.93	0.00	5.00
Density of Woody in 5 m^2 area	sandpit	3	0.00	0.00	0.00	0.00	0.00
Height of Vegetation in 5 m^2 area	sandpit	3	0.03	-0.03	0.10	0.00	0.10

Table 16. Colony level habitat characteristics for each sandpit with least tern (LETE) or piping plover (PIPL) nests in 2003.

Site name	Nesting Species	Colony Management	Adjacent Land Use	Pond Size (m^2)	Distance to River (m)
Bruner-Shelton	LETE	None	Active sandpit surrounded by grassland	157,448	2,314
Broadfoot-Newark	LETE PIPL	None	Active sandpit	170,671	348
Broadfoot-Kearney South	LETE PIPL	None	Large active pit	276,438	263
Johnson Pit	LETE PIPL	Electric fence, Predator trapping by USDA from late May to August, Pre-emergent herbicide application in March		120,523	1,446
Lexington Pit	LETE PIPL	Electric fence, Predator trapping by USDA from late May to August, Pre-emergent herbicide application in March		145,526	719
Blue Hole	LETE PIPL	Electric fence, Predator trapping by USDA from late May to August, Pre-emergent herbicide application in March		99,719	226

Table 17. Correlations between habitat parameters and reproductive parameters for the least tern nests monitored in 2003 (measurements were not done at all nests as indicated by sample size). Correlations cannot be calculated for habitat or reproductive 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	2	.	2	.	2	.
Cover of Grass in 1 m^2 area	2	.	2	.	2	.
Cover of Forb in 1 m^2 area	2	.	2	.	2	.
Cover of Woody in 1 m^2 area	2	.	2	.	2	.
Density of Grass in 1 m^2 area	2	.	2	.	2	.
Density of Forb in 1 m^2 area	2	.	2	.	2	.
Density of Woody in 1 m^2 area	2	.	2	.	2	.
Height of Vegetation in 1 m^2 area	2	.	2	.	2	.
Cover of Grass in 5 m^2 area	2	.	2	.	2	.
Cover of Forb in 5 m^2 area	2	.	2	.	2	.
Cover of Woody in 5 m^2 area	2	.	2	.	2	.
Density of Grass in 5 m^2 area	2	.	2	.	2	.
Density of Forb in 5 m^2 area	2	.	2	.	2	.
Density of Woody in 5 m^2 area	2	.	2	.	2	.
Height of Vegetation in 5 m^2 area	2	.	2	.	2	.

Table 18. Correlations between habitat parameters and reproductive parameters for the piping plover nests monitored in 2003 (measurements were not done at any nests as indicated by sample size).

	# Eggs Hatched		Nest Success		# Young Fledged	
Habitat Parameter	n	Correlation	n	Correlation	n	Correlation
Nest Elevation	0	.	0	.	0	.
Cover of Grass in 1 m^2 area	0	.	0	.	0	.
Cover of Forb in 1 m^2 area	0	.	0	.	0	.
Cover of Woody in 1 m^2 area	0	.	0	.	0	.
Density of Grass in 1 m^2 area	0	.	0	.	0	.
Density of Forb in 1 m^2 area	0	.	0	.	0	.
Density of Woody in 1 m^2 area	0	.	0	.	0	.
Height of Vegetation in 1 m^2 area	0	.	0	.	0	.
Cover of Grass in 5 m^2 area	0	.	0	.	0	.
Cover of Forb in 5 m^2 area	0	.	0	.	0	.
Cover of Woody in 5 m^2 area	0	.	0	.	0	.
Density of Grass in 5 m^2 area	0	.	0	.	0	.
Density of Forb in 5 m^2 area	0	.	0	.	0	.
Density of Woody in 5 m^2 area	0	.	0	.	0	.
Height of Vegetation in 5 m^2 area	0	.	0	.	0	.

Table 19. Correlations between colony level habitat parameters and reproductive parameters for the 4 least tern and 3 piping plover colonies monitored in 2003.

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	-0.97	-0.90	-0.96	-0.80	-0.90	-0.86	0.14	-0.74	0.74	0.39	0.00	-0.06	0.61	0.69
Size of Pond	-0.55	-0.81	-0.76	-0.17	-0.81	-0.77	-0.30	-0.24	0.24	0.09	-0.26	-0.44	-0.03	0.10
Piping Plover (n)	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Distance to River	-0.92	-1.00	-0.99	0.81	-1.00	-0.97	-0.88	0.99	-0.99	-0.97	-1.00	-0.97	-0.92	-0.91
Size of Pond	0.05	-0.38	-0.19	0.84	-0.38	-0.58	-0.76	0.45	-0.45	-0.58	-0.39	-0.58	-0.68	-0.71

Table 20. Time (people-days) used to implement least tern and piping plover monitoring protocol in 2003.

Cooperator	Riverine Survey (people-days)	Nest Monitoring (people-days)
NPPD	2	21
CPNRD	2	10
CNPPID	2	0
USFWS	18	0
EDO	0	0
Total	24	31

Figure 1. Discharge (cfs) at Overton, Nebraska (USGS Gage No. 06768000) from May 1 through August 31, 2003.

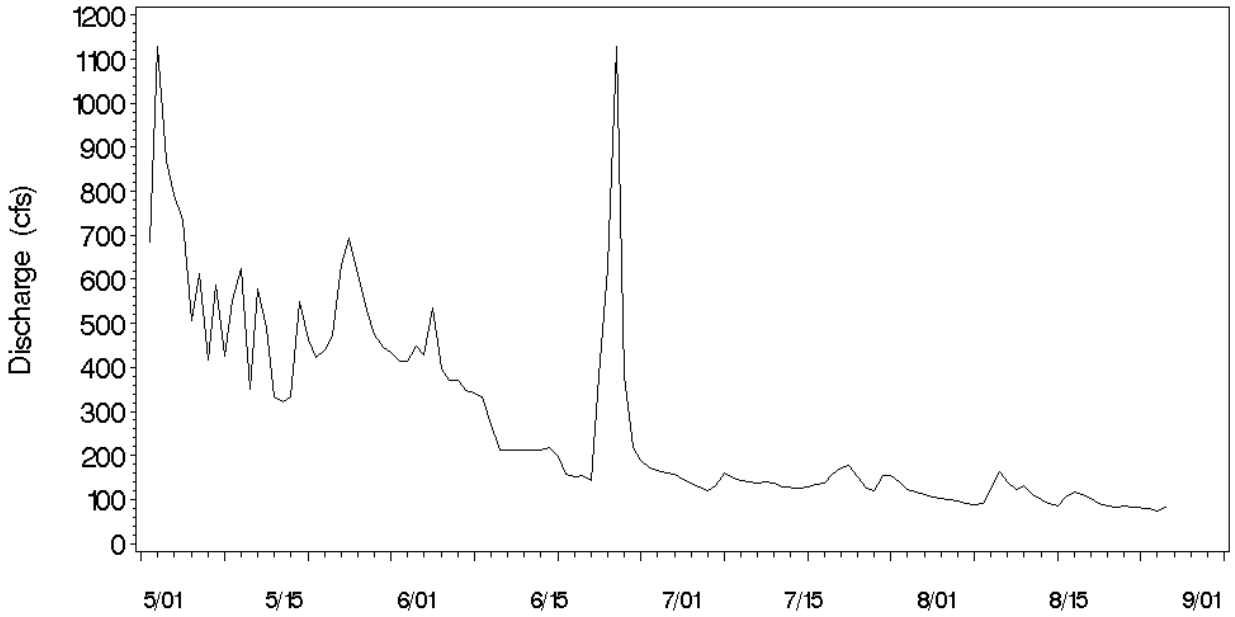


Figure 2. Stage (ft) at Overton, Nebraska (USGS Gage No. 06768000) from May 1 through August 31, 2003.

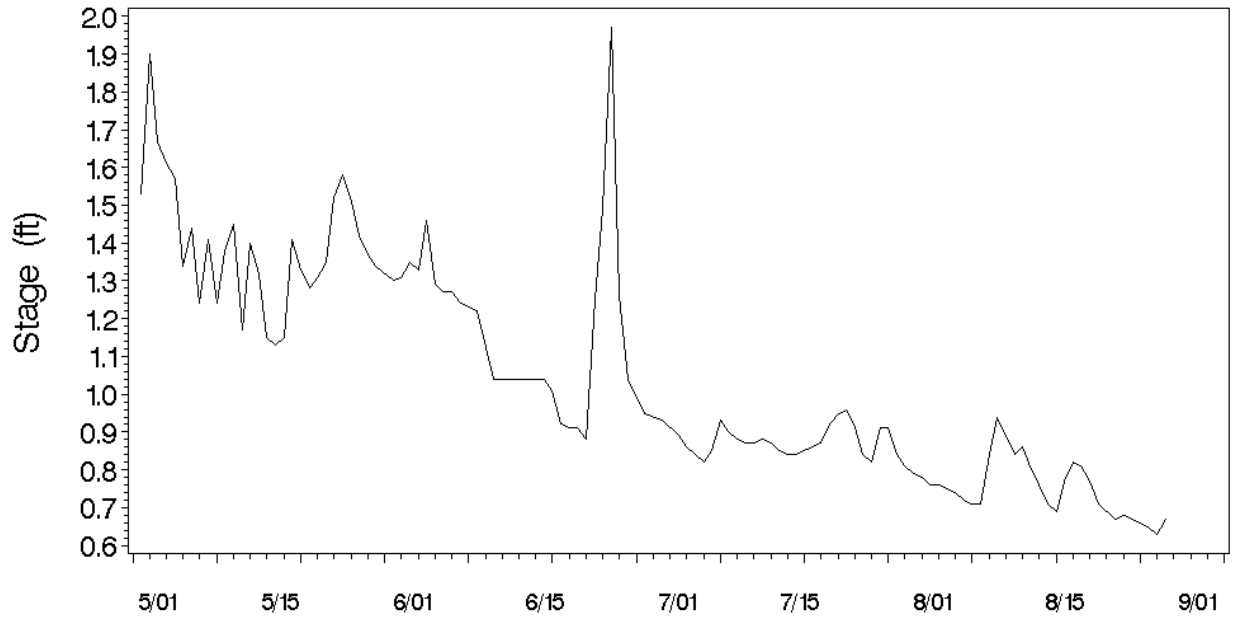


Figure 3. Discharge (cfs) at Kearney, Nebraska (USGS Gage No. 06770200) from May 1 through August 31, 2003.

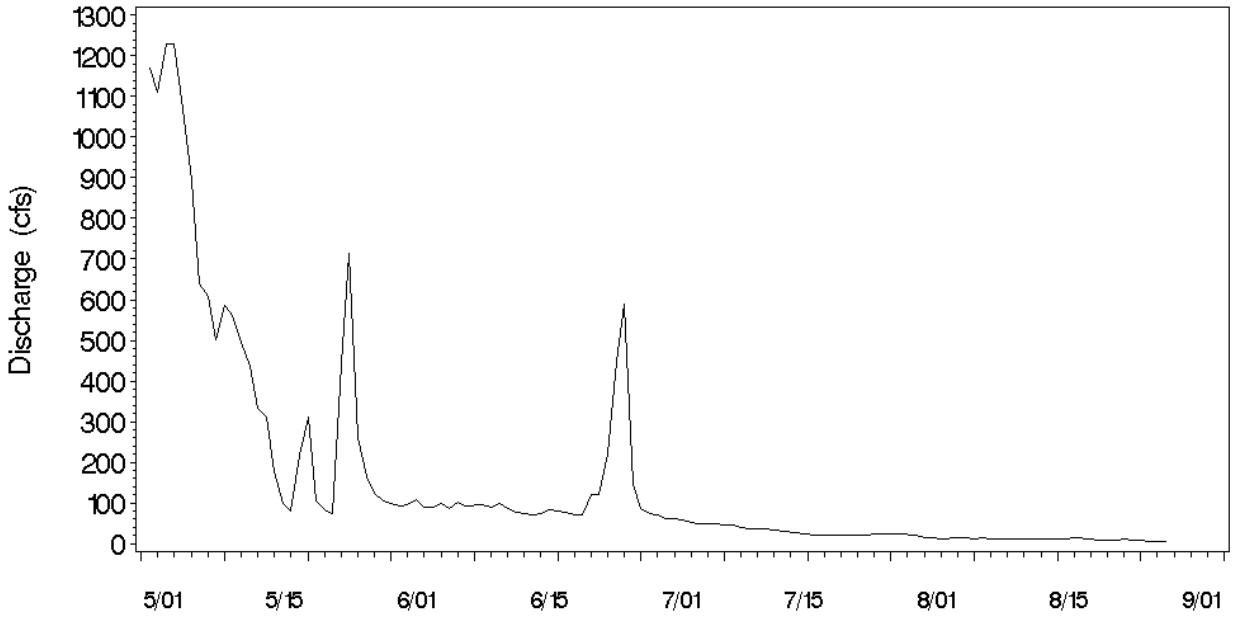


Figure 4. Stage (ft) at Kearney, Nebraska (USGS Gage No. 06770200) from May 1 through August 31, 2003.

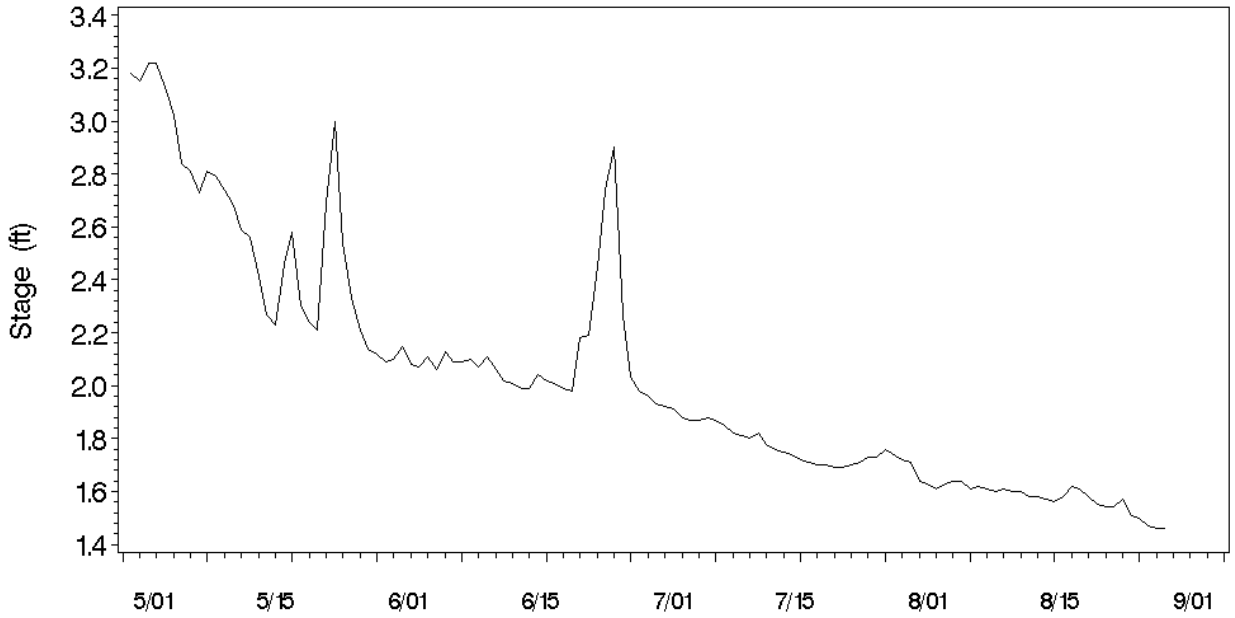


Figure 5. Discharge (cfs) at Grand Island, Nebraska (USGS Gage No. 06770500) from May 1 through August 31, 2003.

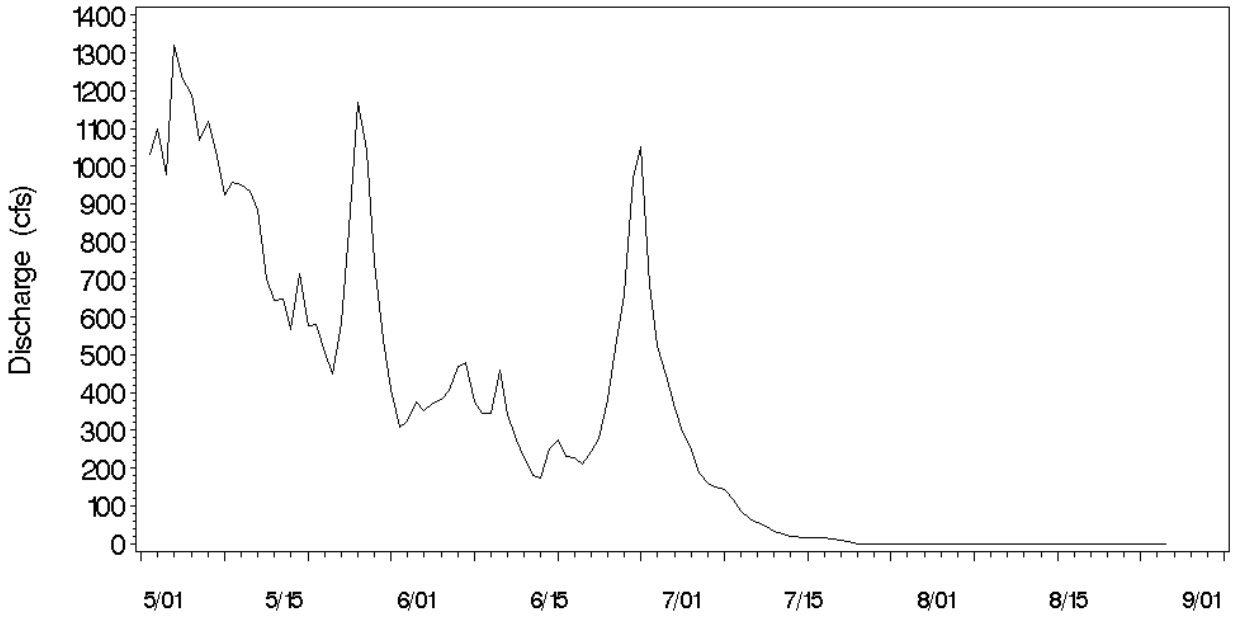


Figure 6. Stage (ft) at Grand Island, Nebraska (USGS Gage No. 06770500) from May 1 through August 31, 2003.

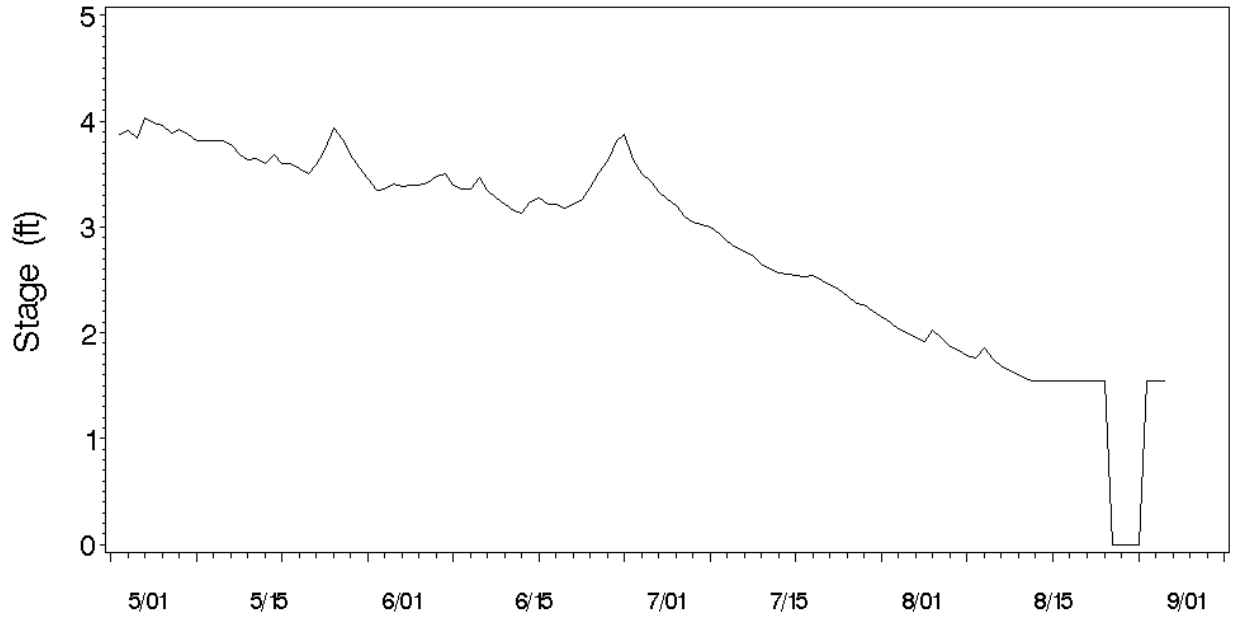
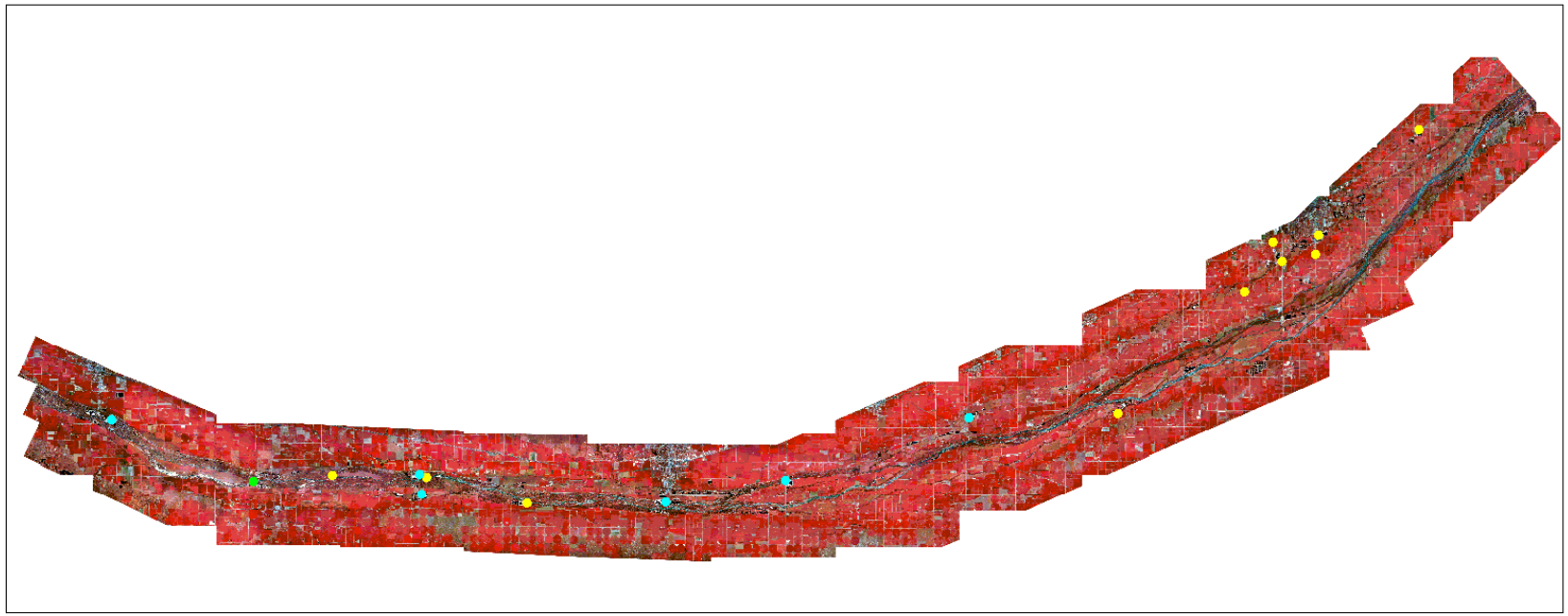


Figure 7. Sandpits and constructed islands surveyed for the 2003 season and locations of least tern sightings and nesting.



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

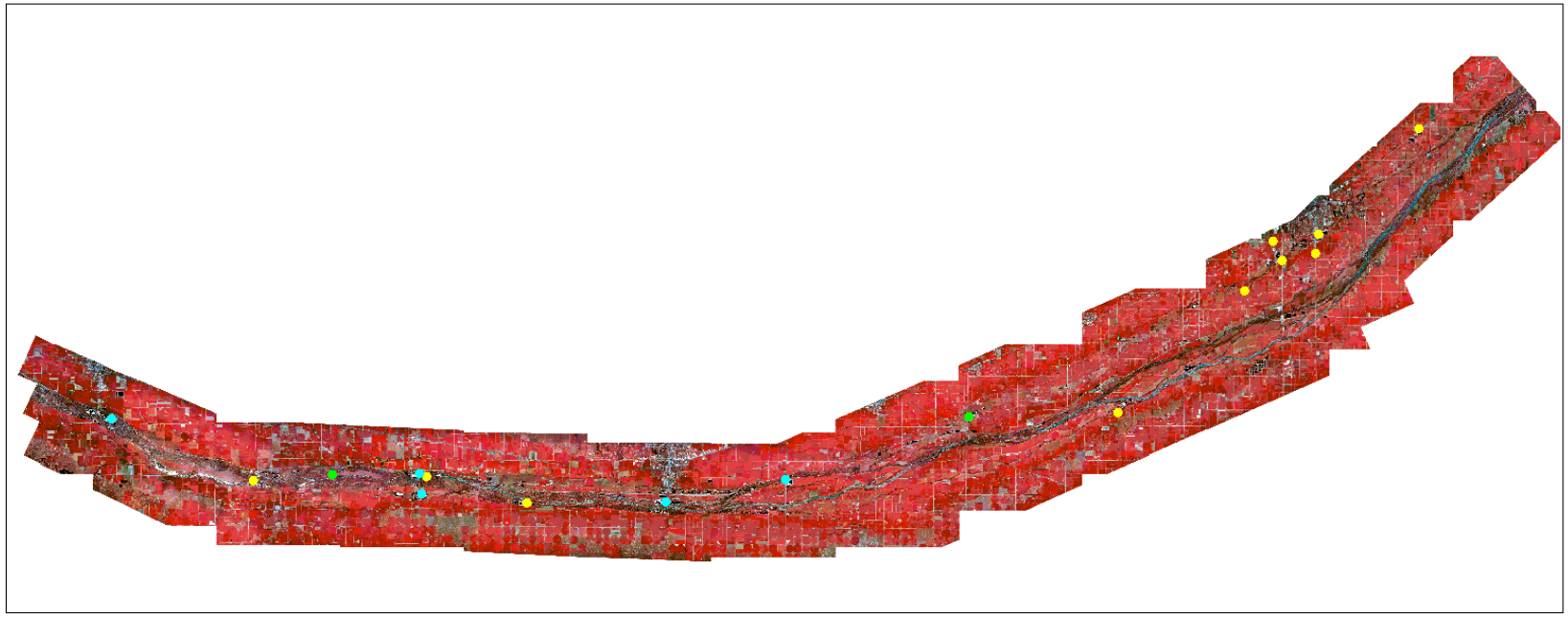
20 0 20 40 Miles

Least Tern Legend

- **Least tern nests**
- **Least tern presence**
- **No least terns observed**

N

Figure 8. Sandpits and constructed islands surveyed for the 2003 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**
- **Piping plover presence**
- **No piping plovers observed**

N