
Platte River Recovery Implementation Program

2014 Interior Least Tern and Piping Plover Monitoring and Research Report for the Central Platte River, Nebraska.



Prepared for:
Governance Committee

Prepared by:
Executive Director's Office



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PLATTE RIVER
RECOVERY IMPLEMENTATION PROGRAM

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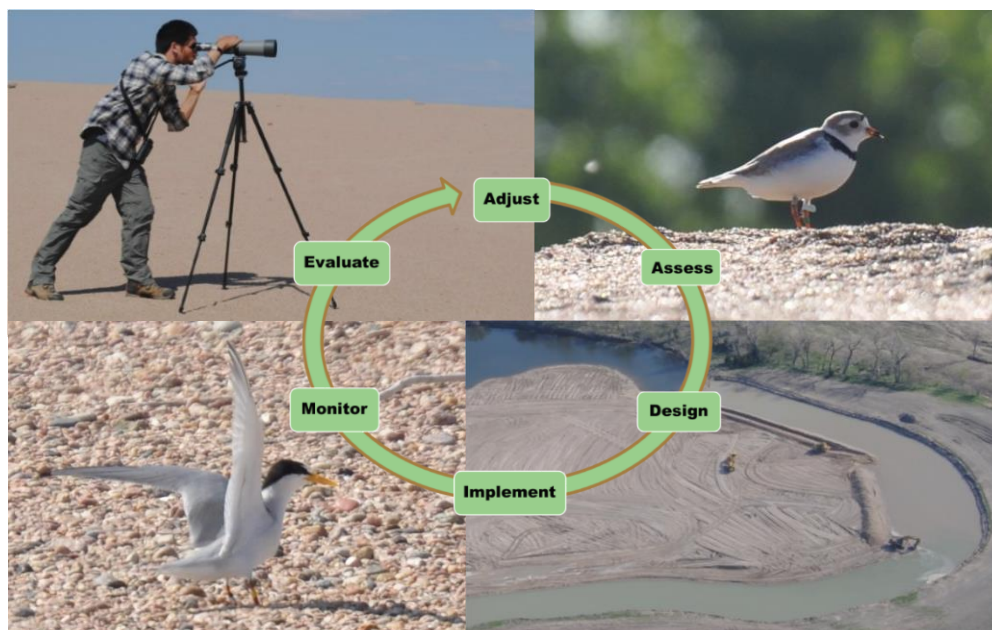
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PREFACE

This is a report of the Platte River Recovery Implementation Program's (Program) monitoring and research efforts for interior least terns (least tern) and piping plovers during 2014. The report was prepared to inform Program partners, licensing agencies, and the general public of our activities and to provide a summary of results to fulfill the requirements of the Program's state (Nebraska Master Permit #1014) and federal (TE183430-0) monitoring permits. ***Data analyses are not final and should be treated as such when citing information, data, or analyses found in this document.***

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SUMMARY OF HABITAT AVAILABILITY AND SPECIES RESPONSE, 2007-2014

On-Channel Mechanical Habitat Creation and Maintenance

Constructed on-channel habitat availability has been variable and somewhat limited during the First Increment of the Program (Table 1). Approximately 24 acres of constructed habitat were present in the AHR in 2007 as the result of efforts by other conservation organizations. That habitat was subsequently lost over the course of several years due to erosion during natural high flow events. The Program began large-scale on-channel habitat construction efforts at the Elm Creek complex in the fall of 2012 and was also able to create on-channel habitat at the Cottonwood Ranch and Plum Creek complexes as part of sediment augmentation activities. Much of that habitat was lost during a natural high flow event in the fall of 2013. On-channel island construction began at the Shoemaker Island complex following the fall 2013 event. A high flow event in June of 2014 eroded a portion of the habitat constructed in the fall of 2013 but the Program was able to construct a total of 28 acres of on-channel habitat during the fall of 2014 at the Elm Creek and Shoemaker Island complexes. It is not known how much of that habitat will remain at the start of the 2015 nesting season. On-channel habitat construction by other conservation organizations has been very limited since the first year of the First Increment.

Table 1. Constructed on- and off-channel habitat in the Associated Habitat Reach by year, 2007-2014.

Year	On-Channel Habitat			Off-Channel Habitat		
	PRRIP	Others	Total	PRRIP	Others	Total
2007	0	24	24	0	48	48
2008	0	21	21	0	48	48
2009	0	15	15	0	48	48
2010	0	5	5	32	48	80
2011	0	5	5	60	48	108
2012	0	0	0	72	48	120
2013	55	0	55	72	48	120
2014	19	0	19	80	48	128
Mean	9.3	8.8	18.0	39.5	48.0	87.5

Off-Channel Mechanical Habitat Creation and Maintenance

Approximately 48 acres of managed off-channel nesting habitat were present in the AHR at the beginning of the First Increment (Table 1). The Program began acquiring and restoring off-channel sites in 2009. Total off-channel habitat in the AHR increased to 128 acres during the period of 2009-2014 as the Program constructed and/or restored 80 acres of habitat. The Program will likely acquire one additional off-channel site prior to the end of the First Increment and one existing off-channel site (Follmer Alda) has not yet been modified to create suitable habitat. Construction at that site will be completed prior to the 2015 nesting season, increasing the total off-channel sand nesting habitat area to approximately 138 acres.

Species Response to Habitat Creation and Maintenance

The total number of breeding pairs has increased for both species during the First Increment of the Program (Table 2). In 2014, a total of 98 breeding pairs of terns and 30 breeding pairs of plovers were observed in the AHR. Most of the nesting in the AHR during the First Increment of the Program has occurred on managed off-channel habitats (Tables 3 and 4). The limited amount of on-channel nesting observed at the beginning of the First Increment declined as on-channel

habitat was lost during high flow events (Tables 1 and 3). The species have generally not responded to subsequent Program habitat construction efforts in 2013 and 2014 (Table 3). Off-channel habitat accounts for most of the nesting in the AHR and the number of breeding pairs has generally increased over the course of the First Increment as the Program has constructed additional off-channel habitats (Tables 1 and 4). Overall, the Program has observed a species response to off-channel habitat construction but not to on-channel habitat construction.

Table 2. Least tern and piping plover nesting incidence by year, 2007-2014.

Year	Least Tern					Piping Plover				
	Br. Pairs	Nests	Succ. Nests	Fledglings	Fledglings Per Pair	Br. Pairs	Nests	Succ. Nests	Fledglings	Fledglings Per Pair
2007	42	53	22	40	0.95	21	27	15	25	1.19
2008	39	64	27	44	1.13	14	21	8	10	0.71
2009	43	60	36	46	1.07	12	15	9	12	1.00
2010	51	80	44	64	1.25	22	33	22	46	2.09
2011	62	90	53	89	1.44	28	34	27	45	1.61
2012	66	88	63	84	1.27	30	46	32	59	1.97
2013	63	95	51	64	1.02	27	31	23	28	1.04
2014	98	145	54	91	0.93	30	43	25	59	1.97
Mean	58.0	84.4	43.8	65.3	1.13	23.0	31.3	20.1	35.5	1.40

Table 3. Least tern and piping plover on-channel nesting incidence and productivity by year, 2007-2014.

Year	Least Tern				Piping Plover			
	Breeding Pairs	Nests	Successful Nests	Fledglings	Breeding Pairs	Nests	Successful Nests	Fledglings
2007	11	13	2	2	1	4	2	7
2008	10	20	7	9	3	5	1	3
2009	3	8	5	4	2	2	1	1
2010	0	0	0	0	4	11	4	10
2011	0	0	0	0	0	0	0	0
2012	0	0	0	0	1	1	1	4
2013	0	0	0	0	0	0	0	0
2014	0	2	0	0	1	2	1	4
Mean	3.0	5.4	1.8	1.9	1.5	3.1	1.3	3.6

Table 4. Least tern and piping plover off-channel nesting incidence by year, 2007-2014.

Year	Least Tern					Piping Plover				
	Br. Pairs	Nests	Succ. Nests	Fledglings	Fledglings Per Pair	Br. Pairs	Nests	Succ. Nests	Fledglings	Fledglings Per Pair
2007	31	40	20	38	1.23	20	23	13	18	0.90
2008	29	44	20	35	1.21	11	16	7	7	0.64
2009	40	52	31	42	1.05	10	13	8	11	1.10
2010	51	80	44	64	1.25	18	22	18	36	2.00
2011	62	90	53	89	1.44	28	34	27	45	1.61
2012	66	88	63	84	1.27	29	45	31	55	1.90
2013	63	95	51	64	1.02	27	31	23	28	1.04
2014	98	143	54	91	0.93	29	41	24	55	1.90
Mean	55.0	79.0	42.0	63.4	1.17	21.5	28.1	18.9	31.9	1.38

INTRODUCTION

The Platte River Recovery Implementation Program (Program or PRRIP) was initiated on 1 January, 2007 as a result of a cooperative agreement negotiating process that started in 1997 between the states of Colorado, Wyoming, and Nebraska; the U.S. Department of the Interior (DOI); water users; and conservation groups. The Program is intended to address issues related to the Endangered Species Act and loss of habitat in the central Platte River between Lexington and Chapman, Nebraska by managing certain land and water resources following principles of adaptive management to provide benefits for four “target species”: the endangered whooping crane (*Grus americana*), interior least tern (*Sternula antillarum*), and pallid sturgeon (*Scaphirhynchus albus*); and the threatened piping plover (*Charadrius melodus*). The Program is led by a Governance Committee (GC) that is assisted by several standing advisory committees as well as an Executive Director (ED) and staff.

The Program has three main elements:

- Increasing stream flows in the central Platte River during relevant time periods through re-timing and water conservation or supply projects. The first increment objective is to re-time and improve flows in the central Platte River to reduce shortages to target flows by an average of 130,000 – 150,000 acre-feet per year at Grand Island.
- Enhancing, restoring, and protecting habitat lands for the target species. The first increment objective is to protect, restore, and maintain 10,000 acres of habitat.
- Accommodating certain new water-related activities.

The data summarized in this report were collected in accordance with the Program’s interior least tern and piping plover monitoring protocol. The primary objectives of protocol implementation include: 1) monitoring interior least tern (least tern) and piping plover (plover) use and productivity on midstream-river sandbars and sand and gravel mines; and 2) document habitat characteristics that are believed to influence nest site selection and nest and brood success along the central Platte River between Lexington and Chapman, Nebraska. The Program has also banded least tern and piping plover adults and chicks on the central Platte with three objectives: 1) quantify dispersal of adults between units of nesting habitat on the Central Platte River among years; 2) quantify colonization rate of newly constructed or managed nesting habitat by local versus immigrant adults; and 3) quantify frequency and location of renesting attempts by adults with failed nests. As such, banding and resighting least tern and piping plover adults and chicks has continued for six consecutive years on the central Platte River (2009–2014). We anticipate a final report documenting results of those efforts will be available on the Program’s online Public Library in 2015. Monitoring and research during 2014 was a collaborative effort between personnel of Headwaters Corporation (EDO or Program staff), Central Platte Natural Resources District (CPNRD), Nebraska Public Power District (NPPD), United States Fish and Wildlife Service (USFWS), and United States Geologic Survey-Northern Prairie Wildlife Research Center (USGS-NPWRC). Past data and analyses are reported in annual reports produced by West Incorporated (2001-2007) and Program staff (2008-2013) and are available in the Program’s online Public Library. Least tern and piping plover activity and reproductive success during 2014 are summarized in this report.

STUDY AREA

Our study area encompassed the “PRRIP Associated Habitats” region of the central Platte River between Lexington and Chapman, Nebraska (~90 river miles, Figure 2) as well as off-channel and sandpit sites within three miles of the river in this reach. In the central Platte River system, least tern and piping plover habitat was located at both on- and off-river sites. River habitat included midstream sandbars used for nesting and open river channel used for foraging. Off-river habitat included spoil piles of sparsely- or non-vegetated sand and associated sandpit lakes at sand and gravel mines. Least terns nested on managed sandpit spoil piles and foraged in sandpit lakes and open river channel. Piping plovers nested on managed sandpit spoil piles or river islands and foraged on low elevation river islands or along the waterline of sandpit ponds.

2014 RIVER CONDITIONS

The amount of low-elevation sandbars present within the PRRIP associated habitats region of the central Platte River is variable and dependent on seasonal and daily fluctuations in river flow. The size and distribution of non-vegetated, high-elevation sandbars characteristic of least tern and piping plover nesting sites within the region has been dependent upon construction and vegetation management efforts.

April to early-May daily flows were normal during 2014. Flows were below normal from mid-May through early-June. However, mid-June daily flows were considerably higher than average, which was representative of typical spring run-off flows before basin development as indicated by historical hydrographs (Figure 1). As a result, several nesting islands that were mechanically created by the Program were moated by water due to high flows during the mid-June peak. A total of approximately 17 acres of least tern and piping plover nesting habitat was made suitable by these high flows in 2014. This was the first nesting season that some of these areas conformed to the Program’s minimum suitable habitat conditions for nesting since creation in 2012 and 2013.

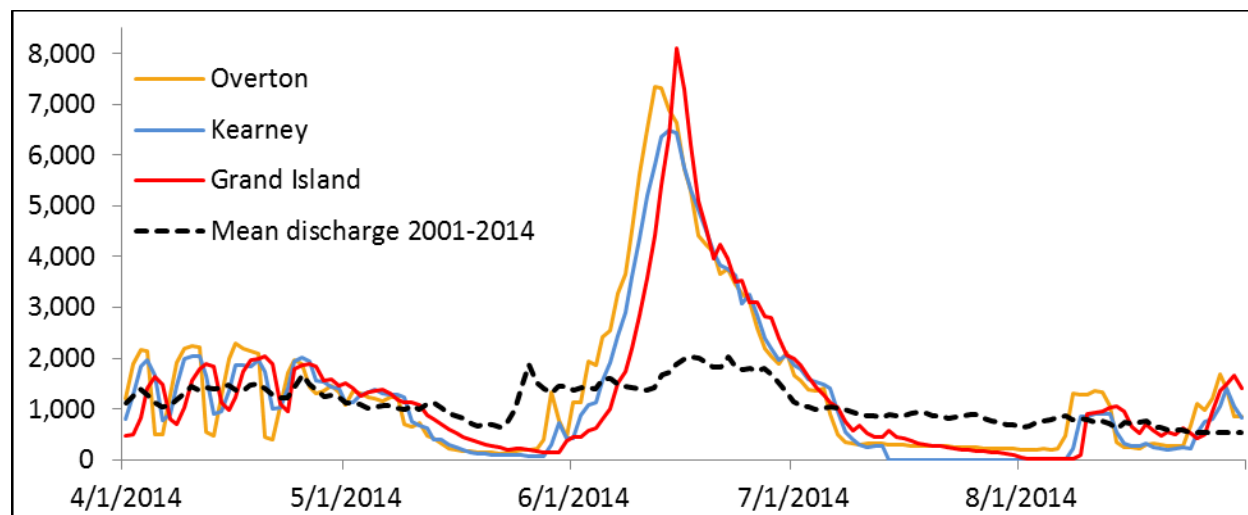


Figure 1. Mean daily discharge (ft³/second; cfs) from Overton (USGS gage 06768000), Kearney (USGS gage 06770200), and Grand Island, Nebraska (USGS gage 06770500) for 2014. Average across 2001–2014 from Kearney (USGS gage 06770200). See Figure 3 for the location of gage stations within our study area. Data available at: waterdata.usgs.gov/ne/nwis/current/?type=flowandgroup_key=NONEandsearch_site_no_station_nm=platte%20river.

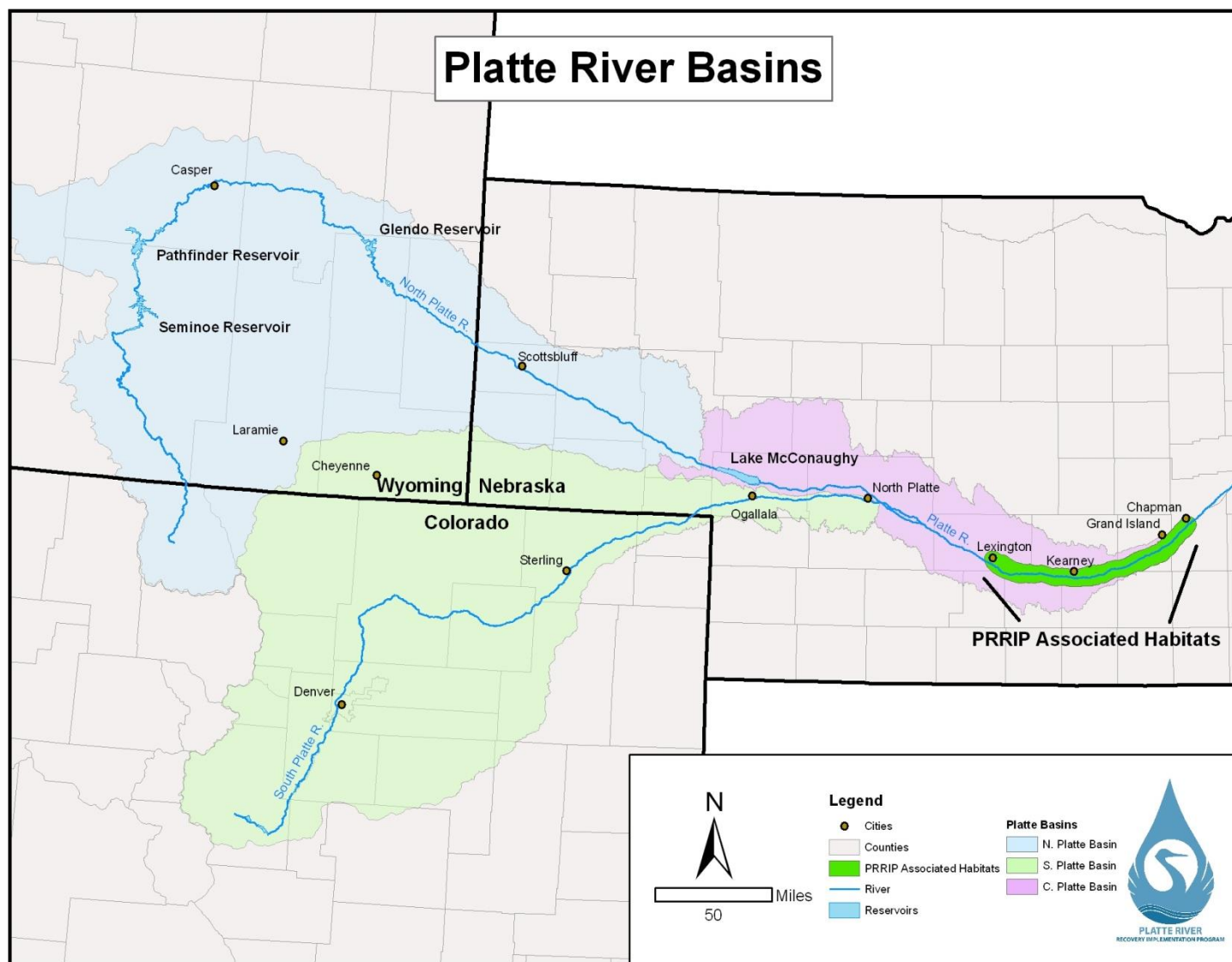


Figure 2. Platte River Basins extending from Colorado and Wyoming through Nebraska. The study area for our least tern and piping plover monitoring and research efforts was the PRRIP Associated Habitats region of the Platte River located between Lexington and Chapman, Nebraska.

MANAGEMENT

Management actions designed to increase nesting habitat (bare sand) and productivity of least terns and piping plovers within Program associated habitats were taken at on- and off-river sites during fall 2013 and spring 2014. Management activities were site specific and included: mechanical actions to create nesting habitat (dozers, scrapers, and backhoes), mechanical actions to improve nesting conditions and remove vegetative cover (disking, tree removal, and mowing); chemical application to kill or prevent emergence of vegetation (spring or fall herbicide application); and predator control (fencing and trapping).

SANDPIT SITES:

Ten of the 14 off-channel sites monitored during 2014 were actively managed to increase least tern and piping plover reproduction. Two Program-owned off-channel sites were being mined during the 2014 nesting season. Program owned and/or managed sites are denoted with a superscript “P” (^P) and Managed sites are identified by a superscript “M” (^M).

^M **Lexington Sandpit** – A pre-emergent herbicide was applied during spring 2014, the woven-wire predator fence with offset electric wires along the west side of the nesting areas was maintained, and predator trapping occurred during 2014. No sand and gravel mining occurred during 2014.

Paulsen’s Lexington Sandpit – Sand and gravel mining occurred, and no management activities were applied during 2014.

^{PM} **Dyer Sandpit** – A contact herbicide was applied to kill existing vegetation primarily along the waterline during fall 2013. A pre-emergent herbicide was applied during spring 2014, permanent 4-foot tall woven wire predator fences with offset electric wires across the south ends of each peninsula were electrified, and predator trapping occurred during 2014. No sand and gravel mining occurred during 2014.

^{PM} **Cottonwood Ranch Off-channel Sand and Water (OCSW)** – A contact herbicide was applied to kill existing vegetation primarily along the waterline during fall 2013. A pre-emergent herbicide was applied during spring 2014, and predator trapping occurred during 2014. A permanent 4-foot tall woven wire predator fence with offset electric wires was maintained in 2014. No sand and gravel mining occurred; this site was constructed with dozers and scrapers.

^M **Blue Hole Sandpit** – A pre-emergent herbicide was applied during spring 2014, the existing permanent predator fence was maintained, a temporary 4-foot tall electrified predator fence was installed along the southwest edge of the peninsula and electrified, and predator trapping occurred during 2014. Sand and gravel mining occurred northeast of the primary nesting peninsula during 2014.

^M **Johnson Sandpit** – A pre-emergent herbicide was applied during spring 2014, the woven-wire predator fence with offset electric wires along the west side of the nesting area was maintained and electrified, and predator trapping occurred during 2014. No sand and gravel mining occurred during 2014.

^{PM} **Broadfoot South Sandpit** – A contact herbicide was applied to kill existing vegetation primarily along the waterline during fall 2013. A pre-emergent herbicide was applied to the nesting area during spring 2014, a temporary 4-foot tall electrified predator fence was installed across the east end of the main peninsula, and a 4-foot tall hog-panel fence with chicken wire was placed across the land-bridge extending to one of the non-access islands located northwest of the main peninsula during 2014. Sand and gravel mining occurred northwest of the main peninsula during 2014.

PM Newark West Sandpit – A contact herbicide was applied to kill existing vegetation along the waterline during fall 2013. The nesting areas had a pre-emergent herbicide applied and predator trapping occurred during 2014. The permanent, 4-foot tall woven wire predator fences with offset electric wires was maintained in 2014. No sand and gravel mining occurred at the west sandpit.

PM Newark East Sandpit – A new nesting area was developed east of the original Newark West Sandpit. A temporary 4-foot tall electrified predator fence was installed across the east end of the main peninsula which was monitored during 2014. Sand and gravel mining occurred east of the main peninsula during 2014.

PM Leaman East OCSW –A contact herbicide was applied to kill existing vegetation along the waterline during fall 2013. A pre-emergent herbicide was applied to the nesting area during spring 2014 and predator trapping occurred during 2014. A permanent, 4-foot tall woven wire predator fence with offset electric wires was maintained in 2014. No sand and gravel mining occurred; this site was constructed with dozers and scrapers.



Aerial photo of the Broadfoot-Newark West and East sand pits. 2014 marked the first year grid searching occurred on Broadfoot-Newark East.

PM Follmer Sandpit – The Program-owned sand and gravel mining site was being mined to create least tern and piping plover nesting habitat during 2014 and was monitored, however, no suitable nesting habitat was available. No trapping occurred during 2014.

M Wild Rose Ranch East Sandpit – A contact herbicide was applied to kill existing vegetation on the nesting areas during fall 2013, nesting areas were drug with a harrow, and a pre-emergent herbicide was applied to the nesting areas during spring 2014. No sand and gravel mining occurred during 2014.

DeWeese-Alda Sandpit – Not managed. Sand and gravel mining occurred during 2014.

Hooker Brothers South East – Not managed. Sand and gravel mining occurred during 2014.

RIVERINE SITES:

Eight of the nine riverine sites monitored during 2014 were actively managed to increase least tern and piping plover reproduction. One Program-owned in-channel island (Plum Creek Complex Island) was constructed during 2013 and one island within the Shoemaker Island Complex was broken into four smaller islands in the fall of 2013.

M Lexington Island – Pre-emergent herbicide was applied to the island during spring 2014.

PM Plum Creek Complex Island – Encompasses one nesting island approximately 1.2 acres in size and was designed as to not be overtopped by flow (i.e., higher than the elevation of the adjacent bank lines). Pre-emergent herbicide was applied during spring 2014 and trapping occurred during 2014.

^{PM} **Cottonwood Ranch Complex**– Encompasses three nesting islands that were approximately 2, 4, and 4.5 acres in size and were designed as to not be overtopped by flow (i.e., higher than the elevation of the adjacent bank lines). A contact herbicide was applied to kill existing vegetation along the waterline during fall 2013. Pre-emergent herbicide was applied during spring 2014 and trapping occurred during 2014.



Aerial image of nesting islands at Cottonwood Ranch Complex.

^M **Elm Creek Complex West** – Encompasses a 1.5 mile stretch of river between the Elm Creek Bridge and the Kearney Canal Diversion that was disked during fall 2013. This river complex includes NPPD's constructed Elm Creek Island.

^{PM} **Elm Creek Complex East** – Encompasses a 2-mile stretch of river downstream of the Kearney Canal Diversion. The Program created eight least tern and piping plover nesting islands in this river complex that were eroded by fall 2013 high flows. The Program reconstructed four least tern and piping plover nesting islands prior to the 2014 nesting season. Pre-emergent herbicide was applied during spring 2014 and trapping occurred during 2014.

^{PM} **Speidell-Hostetler Island** - Encompasses one nesting island approximately 12 acres in size. A contact herbicide was applied to kill existing vegetation along the waterline and the island was disked during fall 2013. Pre-emergent herbicide was applied during spring 2014 and trapping occurred during 2014.

^{PM} **Leaman West Complex** – Encompasses 3 islands that were approximately 2, 8, and 37 acres in size. A contact herbicide was applied to kill existing vegetation along the waterline and the islands were disked during fall 2013. Predator trapping occurred during 2014.

^{PM} **Shoemaker Island Complex** – Prior to the 2014 nesting season, the Program disked 1 island that was approximately 28 acres in size. Four new islands were constructed that were approximately 2, 2, 8, and 13 acres in size. Pre-emergent herbicide was applied to the islands and trapping occurred during 2014.



Aerial image of nesting islands at Shoemaker Island Complex.

Wild Rose Ranch - No management occurred during 2014.

MONITORING

In 1997, the DOI and the States of Nebraska, Colorado, and Wyoming adopted the “Cooperative Agreement for Platte River Research and Other Efforts Relating to Endangered Species Habitats” (Cooperative Agreement). In 2001, the Cooperative Agreement coordinated a standardized protocol for monitoring reproductive success and reproductive habitat parameters of least terns and piping plovers in the central Platte River from Lexington to Chapman, Nebraska. The standardized protocol was implemented by CNPPID, CPNRD, NPPD, and USFWS-GI during 2001–2006. In 2007, the Program assumed responsibilities of the protocol; Program staff, contracted personnel, and cooperators have since implemented it. The protocol was revised prior to the 2010 nesting season.

SEMI-MONTHLY RIVER AND SANDPIT SURVEYS:

METHODS

We conducted 7 semi-monthly surveys (1 and 15 May, June, and July and 1 August) of the central Platte River between Chapman and Lexington, Nebraska (river surveys). In addition, we surveyed all sandpits within Program Associated Habitats that met the Program’s minimum habitat criteria (sandpit surveys) to document adults, breeding pairs, nests, chicks, and fledglings during 2014. We derived least tern and piping plover breeding pair estimates (BPE) by adding the number of active, or recently failed nests to the number of active, or recently failed or fledged broods observed on a given date. We obtained least tern breeding pair estimates by assuming: 1) least tern nests did not hatch within 21 days of being initiated; 2) least terns did not re-nest within 5 days of losing a nest or brood; 3) least tern chicks fledged at 21 days of age (fledging age 2010-2014); 4) least tern chicks that survived to 15 days of age (fledging age 2007-2009) also fledged; and 5) least terns did not re-nest after fledging chicks. We determined piping plover breeding pair counts by assuming: 1) piping plover nests did not hatch within 28 days of being initiated; 2) piping plovers did not re-nest within 5 days of losing a nest or brood; 3) piping plover chicks fledged at 28 days of age (fledging age 2010-2014); and 4) piping plover chicks that survived to 15 days of age (fledging age 2007-2009) also fledged. We included summaries of the total number of adults, breeding pairs, nests, chicks, and fledglings observed during river surveys, sandpit surveys, and a combination of river and sandpit surveys (semi-monthly survey totals) to provide 7 snap-shots of the numbers observed during the 2014 nesting seasons. Additional sandpit sites were observed prior to or during the 1 May survey periods each year, but were determined to be unsuitable nesting habitat for least terns and piping plovers and thus were not monitored. All counts of adults, breeding pairs, nests, chicks, and fledglings reported during semi-monthly surveys represent minimums present.

Semi-monthly River Surveys – Program staff and USGS personnel conducted semi-monthly river surveys between the J2 Return and the Chapman Bridge on 30 April–1 May; 13–15 May; 2–4 June; 16–17 June; 30 June–2 July; 14–15 July; and 30–31 July during 2014. We used an airboat to survey all channels wider than 75 yds. between Lexington and Chapman, NE that could be safely navigated, and documented all observations of least tern and piping plover adults, nests, chicks, and fledglings located within this reach of river. Due to high flows, canoes were used to survey the river during the 15 June survey. We documented all observations of least tern and piping plover adults, nests, chicks, and fledglings located between Lexington and Chapman, NE. Program staff and USGS personnel conducted semi-monthly river surveys between the J2 Return and the Chapman Bridge on 30 April–1 May; 13–15 May; 2–4 June; 16–17 June; 30 June–2 July; 14–15 July; and 30–31 July during 2014. Program staff and USGS personnel conducted semi-monthly river surveys

of Lexington Island (Lexington–Overton bridge segment) on 2 June and 2 July. Personnel from NPPD conducted semi-monthly surveys of Lexington Island (Lexington–Overton bridge segment) on 6 May; 17 May; 5 June; 24 June; and 10 July during 2014; however, this ‘island’ was attached to the bank for most of the nesting season.

Semi-monthly Sandpit Surveys – We conducted semi-monthly surveys from outside the nesting colony at 14 sandpit sites as well as from within the nesting area at 9 of these sites to count individual birds and document least tern and piping plover nests, chicks, and fledglings during 2014. Semi-monthly sandpit surveys were conducted outside the nesting area on 28 April and 1–2 and 6 May; 12 and 15–17 May; 30 May and 2–5 June; 12, 16, and 18 June; 30 June and 1–3 July; 10, 14–16, and 20 July; and 29 and 31 July and 2 August during 2014. Semi-monthly sandpit surveys were conducted inside the nesting area on 1–2 May; 13–14 May; 2–3 June; 16–18 June; 30 June and 1–2 July; 14–16 and 18 July; and 30–31 July and 1 August during 2014. Program staff, technicians and personnel from USGS, CPNRD, and NPPD conducted semi-monthly sandpit surveys during 2014.

Semi-monthly Survey Totals – To obtain estimates of minimum numbers of least tern and piping plover adults, breeding pairs, nests, chicks, and fledglings within the Program Associated Habitat Area throughout the 2014 nesting season, we summed numbers detected during semi-monthly river and sandpit surveys nearest 1 and 15 May, June, and July and 1 August.

RESULTS

Semi-monthly River Surveys – Each of the 7 semi-monthly river surveys between Lexington and Chapman, Nebraska during 2014 required 2–3 days to conduct and spanned a maximum of 3 days during 3 survey periods in 2014.

We observed the most least tern adults (39) and breeding pairs (1) on the river during the 15-June river survey and the most piping plover adults (19) during the 15-May river survey and the most piping plover breeding pairs (2) during the 15-July river survey in 2014 (Table 5). We observed the highest in-channel least tern counts since 2007 and the highest off-channel counts since 2001 (Figure 7). During the 2014, 1-June and 15-June river surveys, we observed 1 piping plover breeding pair and nest within the Cottonwood Ranch Complex on one of the islands that was constructed in 2012. Four piping plover chicks that hatched from this nest were observed during the 1-July river survey. Four fledglings from this nest were observed during the 15-July river survey and 3 fledglings from this nest were observed during the 1-August river survey. An additional piping plover breeding pair (totaling 2) and nest was observed during the 15-July river survey. This nest was located within the Cottonwood Ranch Complex on a different managed island that had been disked in the past. The nest was determined to be failed due to predation as predator tracks and scavenging evidence was found near and around the nest bowl prior to the 1-August river survey. Two least tern nests and 2 breeding pairs, determined by the Programs Breeding Pair Estimator (BPE) on 1 June, were observed on river islands within the Wild Rose Ranch complex during the 1-June river survey in 2014. Both nests failed due to flooding when snow melt caused the river flow to rise above approximately 3,000 cfs prior to the mid-June river survey. The breeding pair estimates do not match nest counts because breeding pair estimates were determined on specific dates, whereas nest counts were determined on the dates that surveys actually occurred. All other least tern and piping plover adults and fledglings observed during semi-monthly river surveys in 2014 were either known (banded) or were presumed (near areas with sandpits that fledged chicks) to be associated with nearby sandpit nesting sites.

Table 5. Number of least tern and piping plover adults, breeding pairs (pair), nests, chicks, and fledglings observed during semi-monthly airboat surveys of the Platte River between Lexington and Chapman, Nebraska, in 2014.

Survey	Interior least tern					Piping plover				
	Adults	Pair*	Nests	Chicks	Fledglings	Adults	Pair*	Nests	Chicks	Fledglings
1-May	1	0	0	0	0	8	0	0	0	0
15-May	7	0	0	0	0	19	0	0	0	0
1-Jun	30	2	2	0	0	11	1	1	0	0
15-Jun	39	1	0	0	0	3	1	1	0	0
1-Jul	36	0	0	0	0	12	1	0	4	1
15-Jul	31	0	0	0	1	13	2	1	0	13
1-Aug	35	0	0	0	23	2	0	0	0	8

* Pair represents the number of breeding pairs, as defined above, present on river islands on 1 and 15 May, June, and July and 1 August. Breeding pair counts were obtained using the Program's Breeding Pair Estimator (BPE). Quantities of Nests may be different from Breeding Pair because semi-monthly surveys occurred over several days and Breeding Pair counts were determined on the 1st or 15th of the month.

Semi-monthly Sandpit Surveys – Each of the 7 semi-monthly sandpit surveys from inside and outside the nesting area required 2–5 days to complete in 2014. Similar to past years, most least tern and piping plover breeding pairs, nests, and chicks were observed on sandpit sites where management activities occurred prior to the nesting seasons. We did, however, observe 6 least tern breeding pairs and 7 nests at the unmanaged Hooker Brothers South East sandpit and 1 piping plover breeding pair and nest at the unmanaged Paulsen's Lexington Sandpit. We observed the most adult least terns during the 1-July (130) sandpit survey and the most least tern breeding pairs (96) during the 15-July sandpit survey, in which there were 46 active nests and 34 chicks present at all sandpit sites combined (Table 6). The most active least tern nests (56) occurred during the 15-June sandpit survey. We observed the most piping plover adults (58) during the 1-June sandpit survey and the most piping plover breeding pairs (28) during the 1-July sandpit survey, when there were 12 active nests and 23 chicks present across all sandpit sites. The most piping plover active nests (21) occurred during the 1-June sandpit survey.

Table 6. Number of least tern and piping plover adults, breeding pairs (pair), nests, chicks, and fledglings documented from inside or outside the nesting area during semi-monthly sandpit surveys in 2014.

Survey	Sites	Interior least tern					Piping plover				
		Adults	Pair*	Nests	Chicks	Fledglings	Adults	Pair*	Nests	Chicks	Fledglings
1-May	14	0	0	0	0	0	36	5	7	0	0
15-May	13	10	0	0	0	0	29	16	15	0	0
1-Jun	14	102	31	45	0	0	58	25	21	12	0
15-Jun	14	111	57	56	2	0	56	24	14	27	0
1-Jul	14	130	79	50	48	0	53	28	12	23	4
15-Jul	14	129	96	46	34	13	31	22	8	29	13
1-Aug	11	83	76	14	23	20	10	10	0	25	0

* Pair represents the number of breeding pairs, as defined above, present on river islands on 1 and 15 May, June, and July and 1 August. Breeding pair counts were obtained using the Program's Breeding Pair Estimator (BPE). Quantities of Nests may be different from Breeding Pair because semi-monthly surveys occurred over several days and Breeding Pair counts were determined on the 1st or 15th of the month.

Semi-monthly Survey Totals – Semi-monthly survey totals include both sandpit and river survey totals of adults, breeding pairs, nests, chicks, and fledglings observed during the 7 semi-monthly sandpit and river surveys and represent an estimate of the overall numbers present within Program Associated Habitats during 7 time periods in the 2014 nesting season. Inside and outside sandpit surveys generally overlapped or occurred within 1–2 days of river surveys.

In 2014 we observed 56 active least tern nests during the 15-June survey when 150 adults and 58 breeding pairs were observed; however, we observed the most breeding pairs (96) during the mid-July survey (Table 7). We observed 166 least tern adults and 48 least tern chicks during the 1-July survey when there were 50 active nests and no fledglings observed.



Piping plover nest at a sandpit

In 2014, we observed 22 active piping plover nests during the 1-June surveys when 69 adults and 26 breeding pairs were observed; however, we observed the most breeding pairs (29) during the 1-July survey when 65 adults were observed (Table 7). We observed 29 piping plover chicks during the 15-July survey when there were 9 active nests and 26 fledglings observed.

Table 7. Number of least tern and piping plover adults, breeding pairs (pair), nests, chicks, and fledglings observed within Program Associated Habitats during semi-monthly surveys of sandpits and the river in 2014.

Survey	Interior least tern					Piping plover				
	Adults	Pair*	Nests	Chicks	Fledglings	Adults	Pair*	Nests	Chicks	Fledglings
1-May	1	0	0	0	0	44	5	7	0	0
15-May	17	0	0	0	0	48	16	15	0	0
1-Jun	132	31	47	0	0	69	26	22	12	0
15-Jun	150	58	56	2	0	59	25	15	27	0
1-Jul	166	79	50	48	0	65	29	12	27	5
15-Jul	160	96	46	34	14	44	24	9	29	26
1-Aug	118	76	14	23	43	12	10	0	25	8

* Pair represents the number of breeding pairs, as defined above, present on river islands on 1 and 15 May, June, and July and 1 August. Breeding pair counts were obtained using the Program's Breeding Pair Estimator (BPE). Quantities of Nests may be different from Breeding Pair because semi-monthly surveys occurred over several days and Breeding Pair counts were determined on the 1st or 15th of the month.

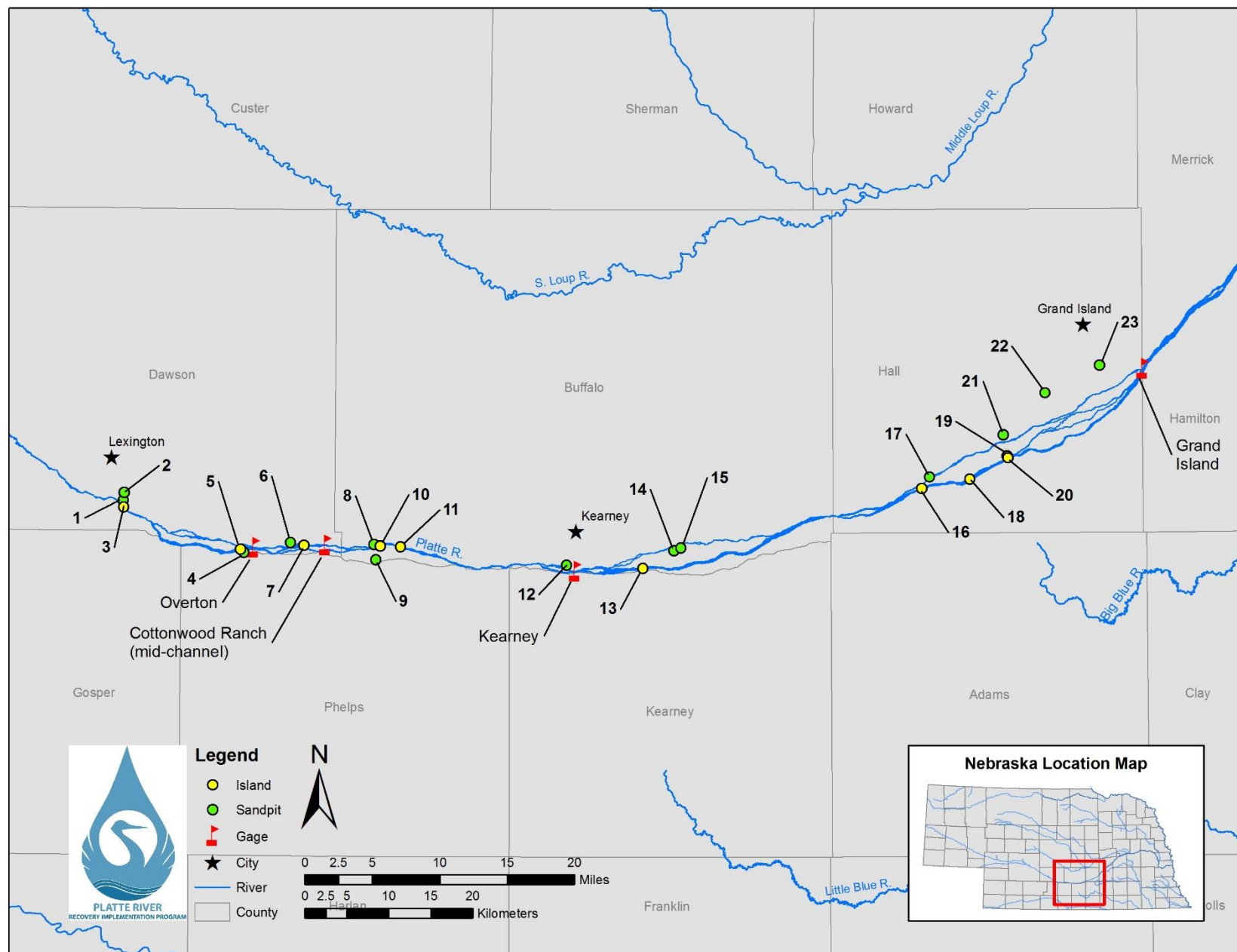


Figure 3. Study area including sandpits and constructed or managed river island sites monitored for least tern and piping plover nesting and foraging activities during 2014. Names of sites are located in Table 8.

MID-MONTH AND SEMI-MONTHLY SURVEYS

River Surveys, 2001–2014: We observed moderate use of the river by least terns and piping plovers throughout the nesting season including nesting by both species (Figure 4). Counts of least tern and piping plover adults observed during river surveys in 2014 were generally similar to, or slightly higher than numbers observed prior to Program implementation (2001–2006). The trend in numbers of adult least terns and piping plovers observed during mid-month river surveys of the central Platte River has increased slightly during the 2001–2014 timeframe. It is important to note, however, that several surveys were not completed because of low or no flow conditions in the river. The increase in numbers of least tern and piping plover adults observed during the river surveys can likely be attributed to an overall increase in numbers of adults and breeding pairs observed within the Program Associated Habitats.

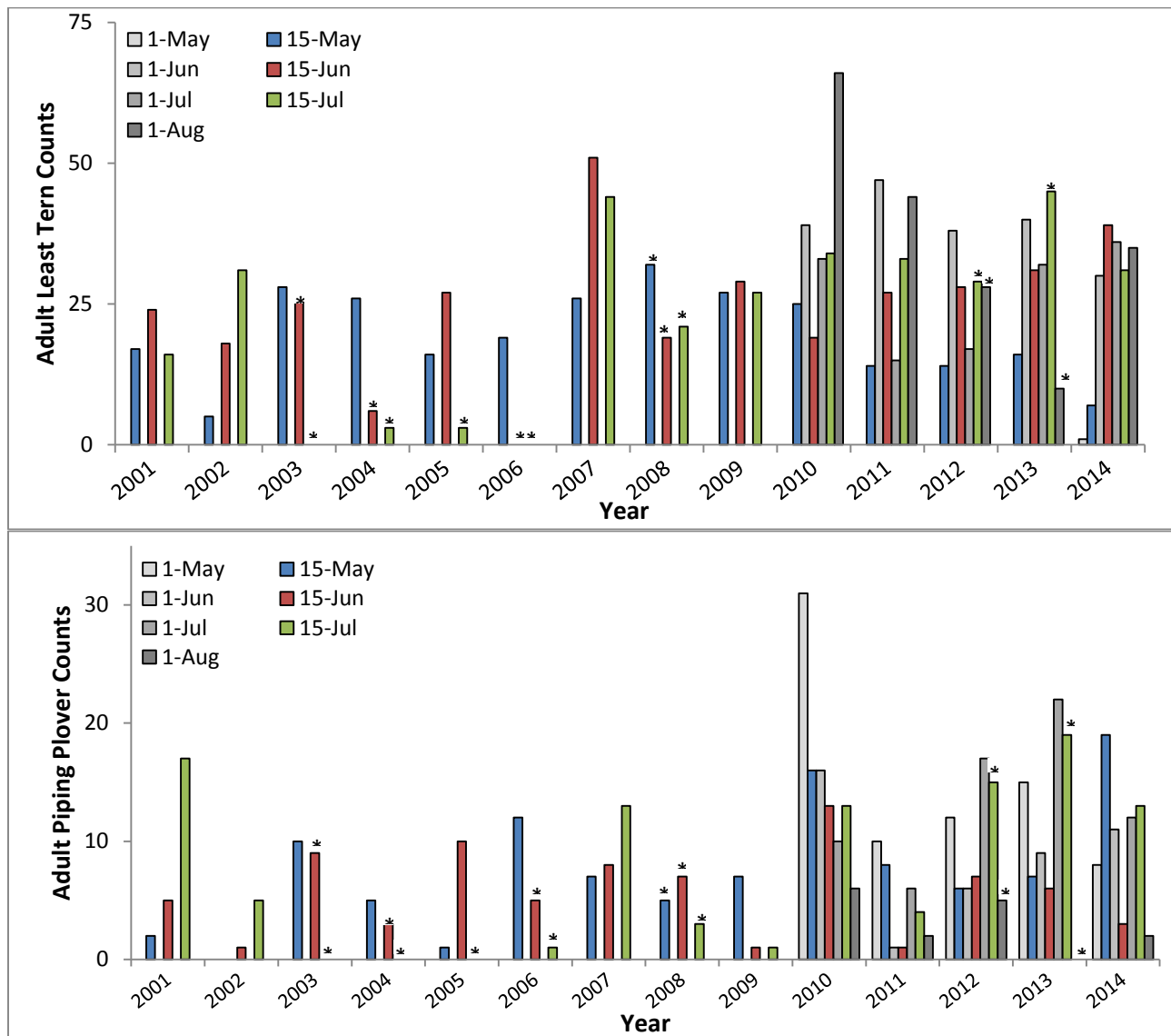


Figure 4. Numbers of least tern (top) and piping plover (bottom) adults observed during mid-month and semi-monthly surveys of the Platte River between Lexington and Chapman, Nebraska, 2001-2014. * indicates minimum numbers present as several river surveys were not completed due to a lack of flow in the channel.

Sandpit- Surveys, 2001–2014: We observed more least tern and piping plover adults on sandpits within the Program Associated Habitat Area in 2014 than we had the previous seven years of Program implementation (Figure 5). We observed the most adult least terns (130 and 129) during semi-monthly sandpit surveys that occurred during 1-July and 15-July, respectively. We observed the most adult piping plovers (58) during the 1-June semi-monthly sandpit survey.

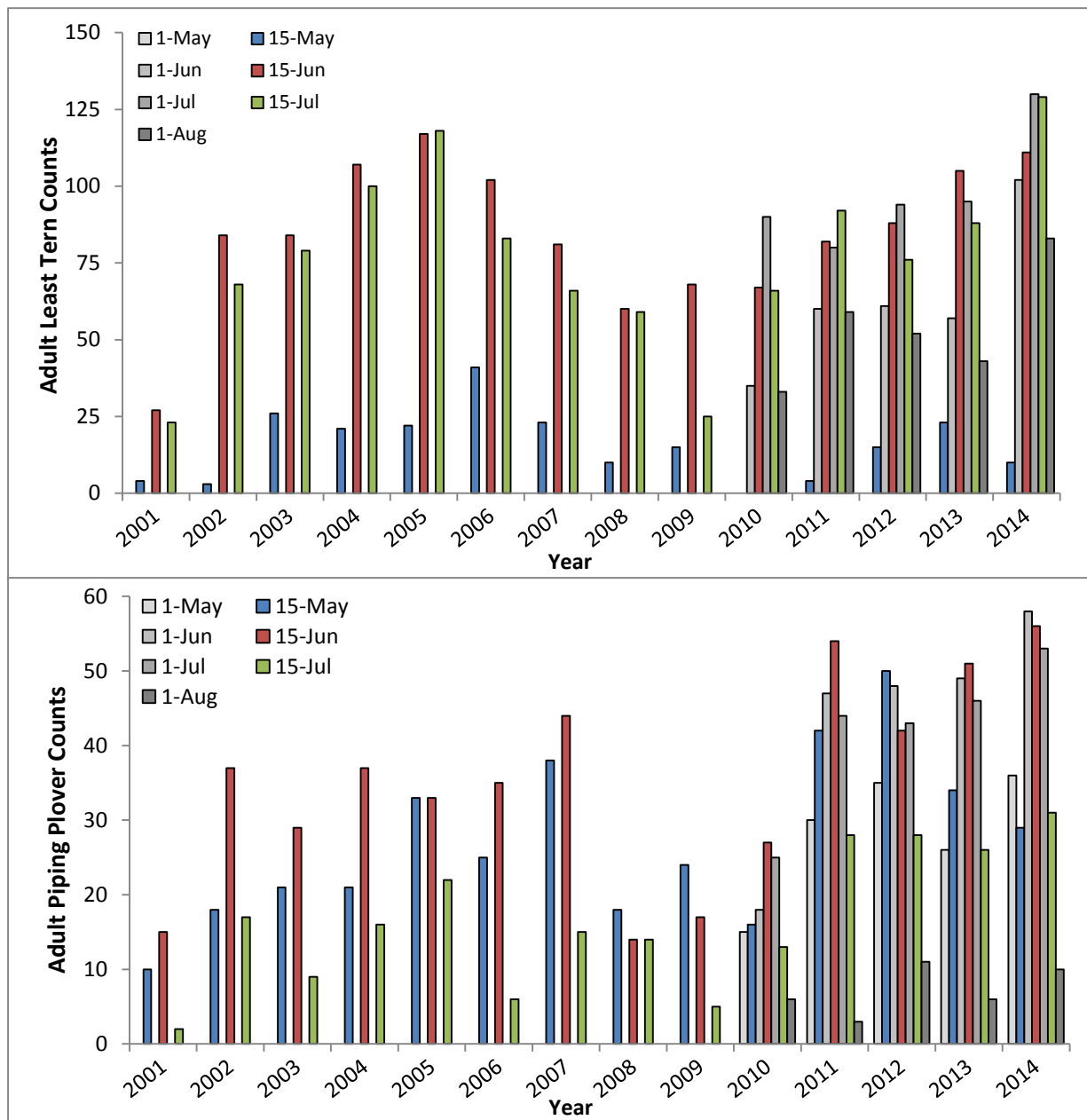


Figure 5. Numbers of least tern (top) and piping plover (bottom) adults observed during mid-month and semi-monthly surveys of sandpits along the Platte River between Lexington and Chapman, Nebraska, 2001–2014.

Sandpit-River Surveys, 2001–2014: We observed the most least terns and similar or slightly higher number of piping plover adults within the Program Associated Habitat Area in 2014 than we did the previous years (Figure 6). We observed the most adult least terns (166) and piping plovers (69) during semi-monthly sandpit and river surveys that occurred during early-July and early-June, respectively. Though the river was used fairly intensively for foraging by both species, we only observed 2 piping plover nests and 2 least tern nests on riverine habitat during 2014. High water flows inundated the 2 least tern nests, but one of the piping plover nests was successful in fledging chicks. In 2014, 76% of adult least tern and 80% of adult piping plover observations occurred at sandpits sites during semi-monthly and mid-month surveys. A total of 143 (99%) least tern nests and 41 (95%) piping plover nests were located on off-channel sandpits. It is interesting to note that least tern counts peaked slightly later in 2014 than in many other years.

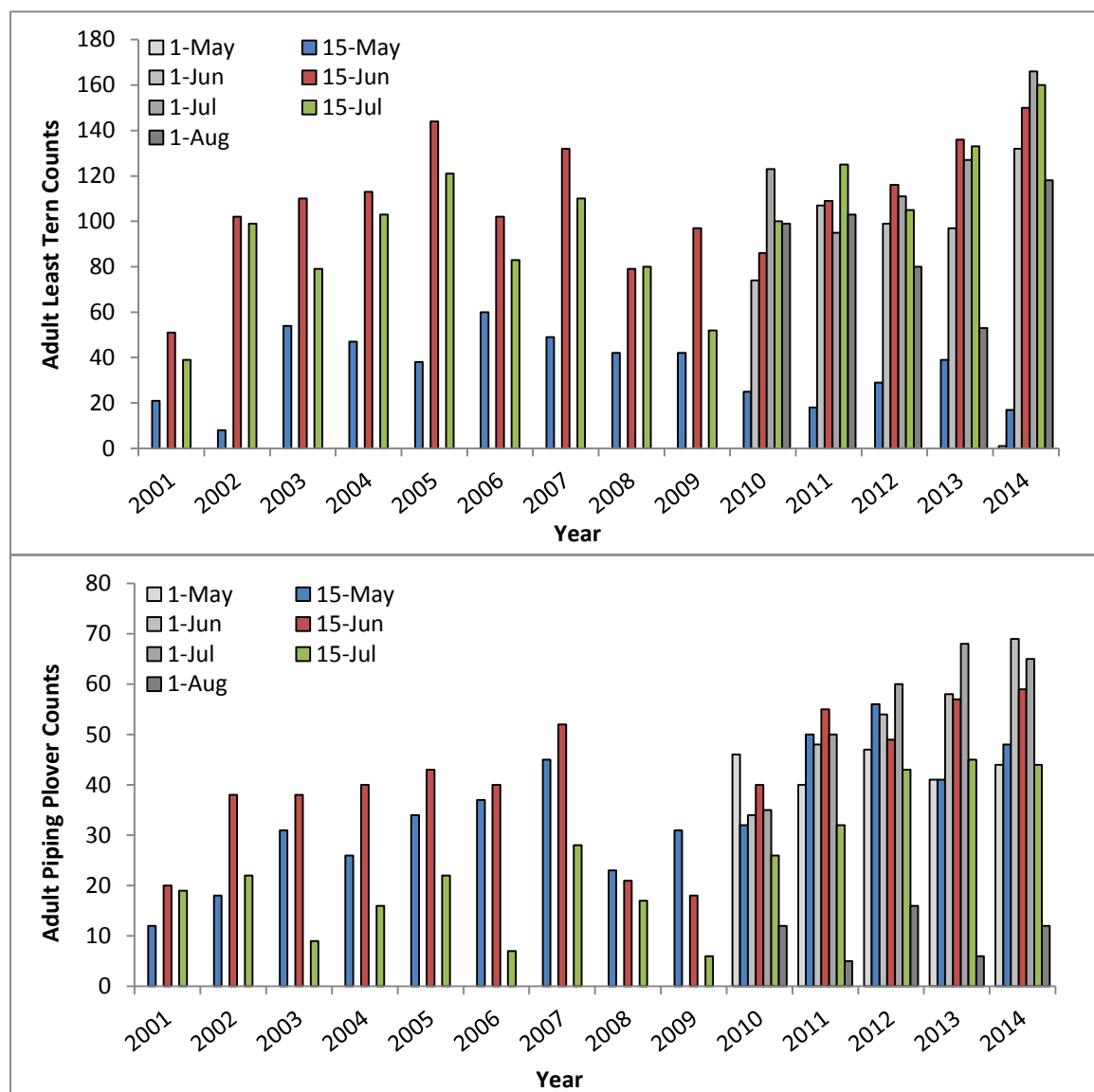


Figure 6. Numbers of adult least tern (top) and piping plover (bottom) adults observed during mid-month and semi-monthly surveys of sandpits and the central Platte River channel between Chapman and Lexington, Nebraska, 2001–2014. Counts represent minimum numbers present as several river surveys were not completed due to a lack of flow in the channel (see Figure 4).

Numbers of adult least terns and piping plovers observed during mid-month surveys of the Program Associated Habitat Area declined sharply after 2007, but have since rebounded to where counts observed during 2014 were higher than numbers observed prior to Program implementation (Figure 7). Program analyses indicate least tern and piping plover adult and breeding pair counts are positively correlated with habitat availability, however, it is a bit premature to say for certain whether the recent increases in least tern and piping plover breeding pair counts along the central Platte River are a direct result of increased management and habitat availability or natural population cycles. Analyses of future data will be used to confirm the relationship between breeding pair counts and habitat availability.



Adult Least Tern at a sandpit

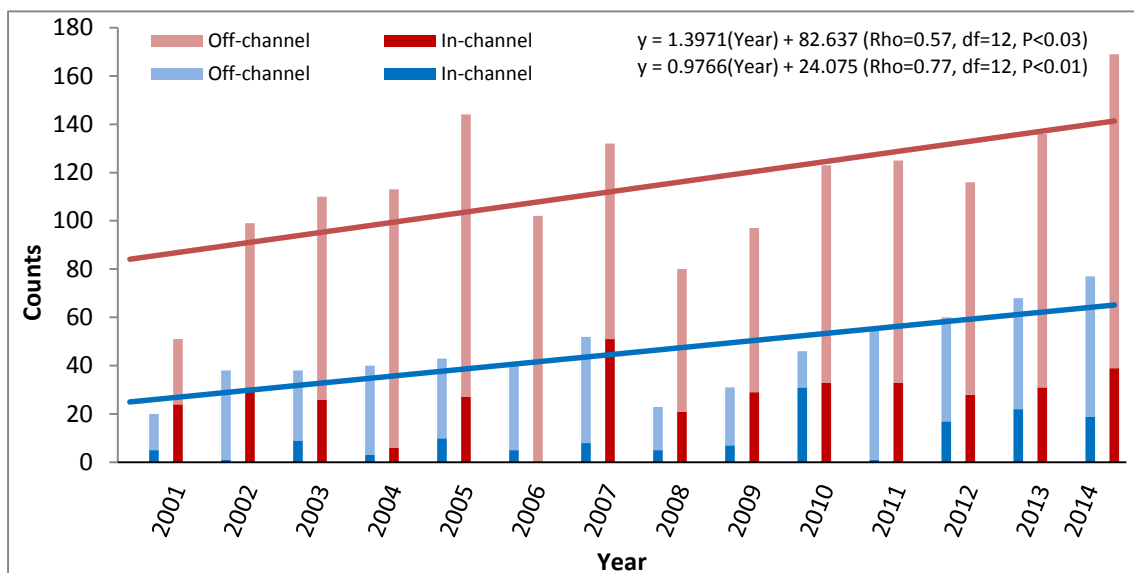


Figure 7. Trends (lines) in peak counts of least tern (red bars) and piping plover (blue bars) adults observed during mid-month and semi-monthly surveys of sandpits (light blue and light red bars) and the Platte River (dark blue and dark red bars) between Lexington and Chapman, Nebraska, 2001-2014.

NEST AND CHICK MONITORING



Piping Plover chicks hatching

METHODS:

In addition to semi-monthly surveys, we monitored all sites with active nests or broods on a semi-weekly basis throughout the nesting season. We attempted to observe nests and chicks twice per week until the nest or brood failed or the chicks fledged. We conducted surveys of adults, nests, chicks, and fledglings from both outside and within the nesting area, and attempted to conduct these surveys during the same day. Program staff and technicians, USGS field crews, and

Program partners monitored nesting sites from outside the nesting colonies and Program staff and USGS field crews conducted nest and brood searches from within the nesting colonies during

2014. Observations of adults, nests, chicks, and fledglings collected from outside and inside the nesting area were documented on separate data sheets; final counts contained herein represent maximum numbers counted by either method of observation during each site visit.

We recorded date, temperature, observation start and stop times, and the number of least tern and piping plover adults, nests, broods, chicks, and fledglings present during each semi-weekly site visit. During the initial observation of each nest, we counted the number of eggs present, estimated nest-initiation date, took a photograph of the nest, and collected habitat measures believed to influence nest placement and productivity (vegetation height, canopy cover, and distance to vegetation ≥ 6 inches tall within a 1-yd² area centered on the nest; classified bare-sand area of nesting sites; documented presence/absence of nest furniture; determined distances to predator perch and nearest waterline; and used a GIS to determine elevation of each nest above the waterline). We recorded maximum vegetation height and percent canopy cover within a 1-yd² area centered on each nest and classified percent bare-sand area at the nesting site during subsequent observations of each nest. When chicks or fledglings were observed, we estimated the date of hatching or fledging based on current and previous chick observations. We determined the amount of nesting habitat available at each site using a GIS. We delineated exposed bare-sand areas present within CIR imagery captured 13 June, 2014 when flows at Overton, Kearney, and Grand Island ranged from 5,410 cfs to 7,330 cfs. Summaries of habitat metrics are not included in this report, but can be found in the habitat selection study that will be produced in 2015.



Outside monitoring

Outside Monitoring – Outside surveys were performed from the ground or boats using binoculars and/or spotting scopes, at a distance great enough to not cause disturbance to nesting birds (usually >165 ft., but closer or farther as terrain dictated), and for at least 1/2 hour. Observations were conducted from multiple locations to provide as complete of coverage of the site as possible. From outside the nesting colony, nests and chicks were often located by observing adult birds.

Inside Monitoring – A systematic grid-search pattern was used to conduct inside surveys (Figure 8). To initiate this search method, investigators formed a straight line on the edge of and parallel to the side of the sandpit pond (pictured to the right). Investigators were evenly spaced and the spacing was adjusted to ensure all nests and chicks were detected; the distance between individuals did not exceed 10 yards unless chicks were detected at which point the spacing was widened to allow the chicks to pass between observers to prevent driving chicks out of their natal territory. When visibility was low due to vegetation or because the substrate was similar in size and shape to the eggs, then the distance between technicians was decreased.



Crew grid searching

We calculated daily and incubation-period nest survival rates using Program MARK (Version 5.1). We included nests located at sandpit and riverine sites that were monitored during 2014 by Program staff, USGS field crews, and personnel from CPNRD and NPPD to determine survival

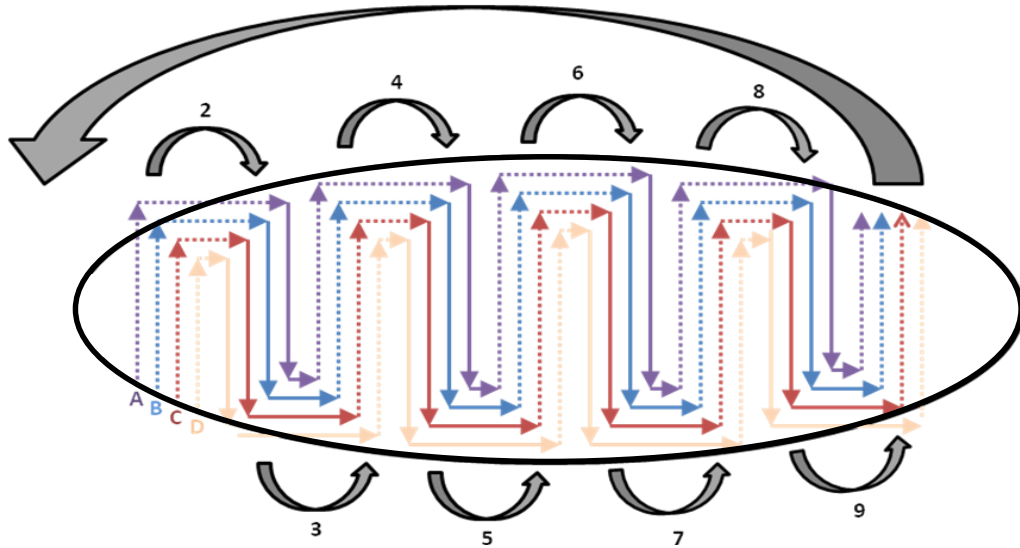


Figure 8. Systematic grid-search pattern used to locate nests and broods while conducting inside surveys of sandpit sites.

rates. Nest success was defined as any nest that hatched ≥ 1 chick. We considered the incubation period for least terns and piping plovers to be 21 and 28 days, respectively, from when nests were determined to have been initiated. When the fate of a nest was unknown, we assigned a “failed” status to the nest if the date of determination (date first observed inactive) was < 21 days (least tern) or < 28 days (piping plover) after the date the nest was initiated and we failed to observe chicks of appropriate age near the nest bowl. For example, if a piping plover nest, observed to be active and intact 12 days after it was initiated was found to be empty (no eggs) 16 days after it was initiated with no sign of chicks of appropriate age in the area, we censored the nest at 14 days (midpoint of the 2 observation periods) and assigned a “failed” status to the nest as it likely did not hatch within 16 days of initiation. If, however, a piping plover nest with an unknown fate was last observed to be active 25 days after it was initiated, but 29 days after it was initiated we observed an empty nest bowl and no sign of chicks of appropriate age in the area, we assigned the fate of the nest to be 27 days (midpoint of the 2 observation periods) and assigned a “successful” status to the nest. Our assumption was that, on average, we discarded survived and failed intervals in the same proportion they existed in the data.

We also used Program MARK to determine daily and brooding-period survival rates for broods of chicks. As the exact date of hatching was occasionally unknown, we considered the brooding period for least tern and piping plover chicks to be 21 and 28 days from the date we first observed nestlings, respectively. A successful brood was defined as any brood with ≥ 1 chick that was observed fledged or that survived 21 days (least terns) or 28 days (piping plovers). Similar to nest survival methods, when the fate of a brood was unknown, we assigned the fate of the broods to be the midpoint of when a brood was last observed active and first documented as an “unknown” status and assigned a failed status to a brood if the date of fate determination was < 21 or < 28 days after we first observed least tern or piping plover chicks, respectively, and a successful status to the brood otherwise.

We also calculated Mayfield estimates of daily and incubation-period or brooding-period survival rates for all least tern and piping plover nests and broods because, only Mayfield estimates were reported in the past (2001–2007). We calculated Mayfield estimates of daily nest survival (S) using: $S = 1 - N_f / E_s$, where N_f is the number of nests that failed and E_s is exposure days or number of days that elapsed between when the nest was first observed and when it was observed to have hatched or failed; losses occurring between visits were assumed to have occurred at the midpoint between visits. We calculated incubation-period survival rates for nests by raising the daily survival rate to the 21st or 28th power for least tern and piping plover nests, respectively. For example, if the daily survival rate for least tern nests was 0.97, the incubation-period survival rate would be approximately 0.53 (0.97^{21}). The same process was used to obtain estimates of daily and brooding-period survival rates for least tern and piping plover broods and chicks. We calculated standard errors (SE_s) and 95% confidence intervals (CI_{95}) for survival estimates using: $SE_s = ([S - S^2] / E_s)^{1/2}$ where E_s was the total number of exposure days used to calculate S and $CI_{95} = S \pm 1.96(SE_s)$. The 95% confidence intervals for the corresponding Mayfield incubation-period and brood-rearing period estimates were calculated by raising the confidence limits for S to the power of 21 or 28 for least terns and piping plovers, respectively.

RESULTS:

Mortality: We did not observe any research-related mortality during 2014. Weather was attributed as the cause of 1 piping plover nest (14%) and 21 least tern nest (33%) failures during 2014. Predation was documented as the cause of loss for 7 least tern nests (11%) and 3 piping plover nests (43%) and was suspected in the loss of several additional least tern and piping plover nests and chicks during 2014. Nineteen least tern (30%) and 2 piping plover (29%) nest failures were attributed to unknown causes and the fate of 2 piping plover nest were unknown as the nest bowls were empty on or near the expected hatch date, but no chicks were observed and associated with the nests. Sixteen least tern (25%) and 1 piping plover nest (14%) were abandoned. Eleven piping plover chicks and five least tern chicks were found dead. Of the sixteen observed deaths, seven were attributed to weather (44%), one to electrocution (6%), and eight were unknown causes (50%).



Dead piping plover chick

Least Terns: Least tern nests were observed and monitored at 8 of the 14 sandpits and one of the riverine sites monitored during 2014 (Table 8, Figure 9). All counts of adults, nests, chicks, and fledglings reported in Table 8 represent maximum numbers observed from inside and outside the nesting colony during all surveys. The first observation of least tern nests occurred on 23 May, 2014 and the last nest initiated was first observed on 24 July, 2014. The first observation of a least tern chick occurred on 16 June and the last nest known to hatch did so on 6 August, 2014. At least 1 egg from 55% (80/145) of least tern nests hatched which resulted in 180 chicks and an overall nest-success rate of 1.24 chicks/nest or 1.84 chicks/breeding pair (180 chicks/98 breeding pairs) during 2014 (Table 9). Average daily survival rate of least tern nests during 2014 was 0.9694 (range = 0.8683–0.9959; Appendices 1 & 9) with at least one significant difference observed between sites [$\chi^2(8, N = 145) = 18.937$; $p = 0.0152$]; average survival rate over the 21-day incubation period was 0.5204 (range = 0.0515–0.9167). We observed the first least tern fledgling on 7 July, 2014 and the last known least tern chick to fledge did so on 22 August, 2014. Apparent

fledge success at all sites monitored was 0.63 fledglings/nest (91 fledglings/145 nests) or 0.93 fledglings/breeding pair (91 fledglings/98 breeding pairs) with all but 2 nests occurring on sandpit sites during 2014. Average daily survival rates for least tern broods across all sites during 2014 was 0.9824 (range = 0.6687–1.0000; Appendices 2 & 10) with at least one significant difference observed between sites [$\chi^2(5, N = 79) = 16.476$; $p = 0.0056$]; average brooding-period survival rate across all sites was 0.6882 (range = 0.0002–1.0000).

We tested for an effect of ownership (i.e., Program or other) on nest and brood survival rates during 2014. Least tern incubation period survival was higher at Program owned and managed sites than at other nesting areas, 0.6178, 0.4074 respectively, with at least one difference observed between sites [$\chi^2(1, N = 145) = 6.167$; $p = 0.0130$]; (Appendices 5 & 13). Brooding period survival rates were generally lower at Program owned and managed nesting areas than other nesting areas for least terns, 0.5009, 0.5972 respectively, but the difference was not significant at $\alpha=0.05$ level (Appendices 6 & 14).

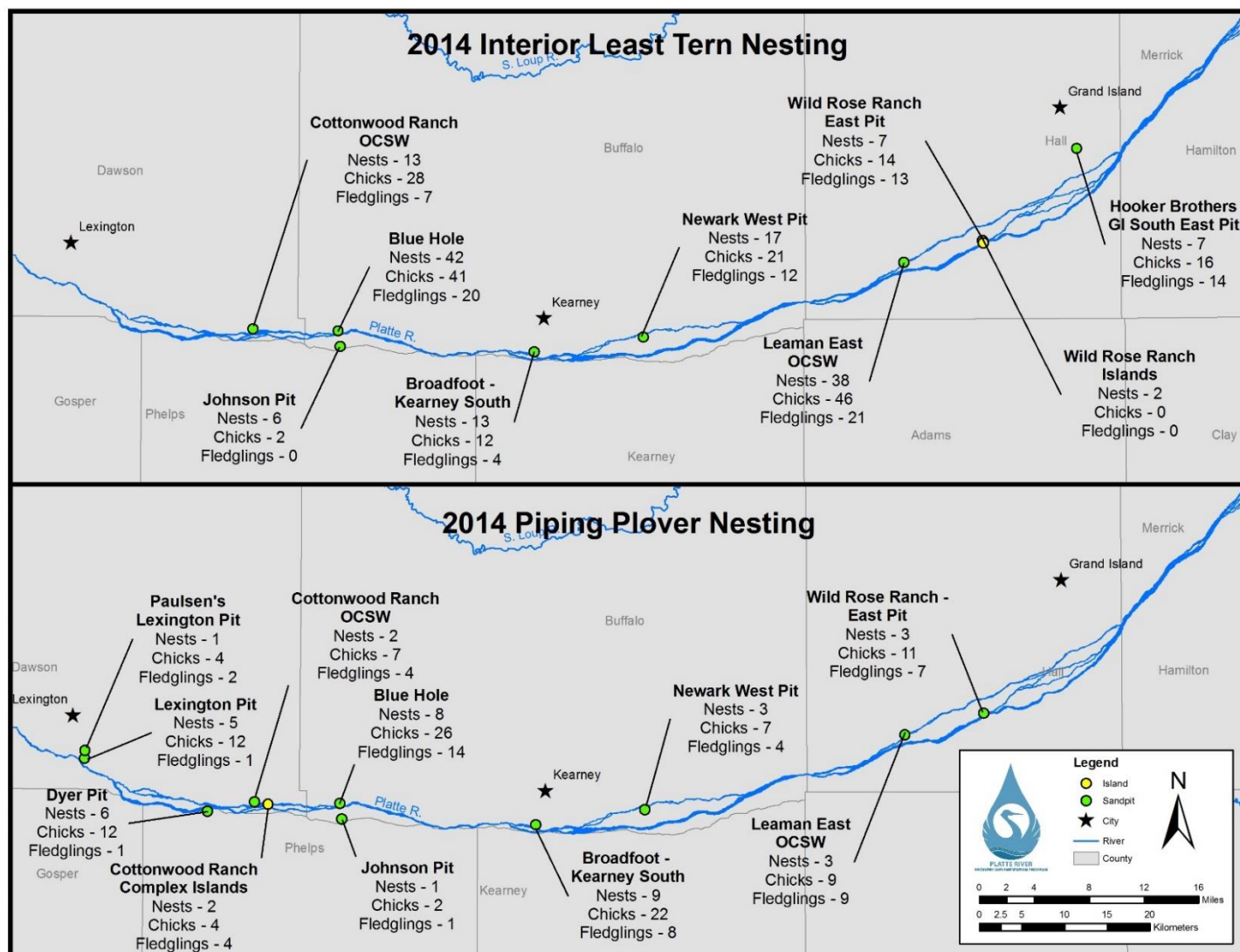


Figure 9. Distribution and numbers of least tern and piping plover nests, chicks, and fledglings observed within Program associated habitats during 2014 surveys of sandpits and managed, constructed, or naturally occurring river islands. Least tern

Table 8. Site-specific numbers of adults, nests, chicks, and fledglings observed while monitoring sandpits and constructed or managed river islands for least tern and piping plover reproduction during 2014. Chick and fledgling counts represent numbers documented as being produced from each site. See the Management Section of this report for a detailed description of management actions taken at each site. Site numbers correspond with Figure 3.

Site #/Name	Habitat Type ^A	Management ^A	Surveys	Survey Time (hr.)	Least tern								Piping plover							
					Breeding Pairs ^B	Bre. Pair (Max) ^B	Adults (Max) ^B	Nests	Nests Hatched	Chicks 0-14 Days	Chicks 15-21 D.	Fledglings	Breeding Pairs ^B	Bre. Pair (Max) ^B	Adults (Max) ^B	Nests	Nests Hatched	Chicks 0-14 Days	Chicks 15-28 D.	Fledglings
1 Lexington Pit	SP	PFT	48	62	0	0	2	0	0	0	0	0	1	4	10	5 ^D	3	12	1	1
2 Paulsen’s Lexington Pit	SP	N	17	7	0	0	1	0	0	0	0	0	1	1	4	1	1	4	2	2
3 Lexington Island ^C	RI	P	6	3	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
4 Dyer Pit	SP	HPFT	66	94	0	0	8	0	0	0	0	0	4	5	9	6	4	12	5	1
5 Plum Creek Complex Island ^C	RI	PT	10	3	0	0	1	0	0	0	0	0	0	0	3	0	0	0	0	0
6 Cottonwood Ranch OCSW	OC	HPFT	80	117	11	12	18	13	12	28	13	7	2	2	8	2	2	7	5	4
7 Cottonwood Ranch Complex ^C	RI	HPT	38	24	0	0	7	0	0	0	0	0	1	2	6	2	1	4	4	4
8 Blue Hole Pit	SP	PFT	110	224	26	26	30	42 ^E	18	41	20	20	7	7	16	8	7	26	15	14
9 Johnson Pit	SP	PFT	57	45	1	5	12	6	1	2	0	0	1	1	4	1	1	2	1	1
10 Elm Creek Complex West ^C	RI	D	4	4	0	0	7	0	0	0	0	0	0	0	3	0	0	0	0	0
11 Elm Creek Complex East ^C	RI	PTC	13	10	0	0	12	0	0	0	0	0	0	0	1	0	0	0	0	0
12 Broadfoot South Pit	SP	HPFT	104	171	11	12	40	13 ^F	6	12	4	4	5	5	12	9	7	22	11	8
13 Speidell-Hostetler Island ^C	RI	DHPT	7	2	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
14 Newark West Pit	SP	HPFT	84	119	11	11	25	17	10	21	13	12	2	2	5	3	2	7	5	4
15 Newark East Pit	SP	FTC	27	7	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
16 Leaman West Complex ^C	RI	DHT	9	4	0	0	3	0	0	0	0	0	0	0	1	0	0	0	0	0
17 Leaman East OCSW	OC	HPFT	70	100	27	28	34	38	22	46	27	21	3	3	6	3	3	9	9	9
18 Shoemaker Island Complex ^C	RI	DPTC	15	11	0	0	3	0	0	0	0	0	0	0	2	0	0	0	0	0
19 Wild Rose Ranch East Pit	SP	GHP	37	26	5	7	20	7	5	14	13	13	3	3	8	3	3	11	9	7
20 Wild Rose Ranch Islands ^C	RI	N	12	9	0	2	20	2	0	0	0	0	0	0	7	0	0	0	0	0
21 Follmer Pit	SP	C	7	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 Deweese – Alda Pit	SP	N	7	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 Hooker Brothers – GI South East Pit	SP	N	16	8	6	6	14	7	6	16	14	14	0	0	0	0	0	0	0	0

^A Habitat types include sandpits (SP), off-channel sand and water (OC), or river islands (RI). Management actions applied to each site following the 2013 nesting season and prior to the 2014 nesting season could include: mowed (M), burned (B), disked (D), graded (G), tree/vegetation removal (R), or herbicide (H) during fall 2013; pre-emergent herbicide (P), predator fencing (F), or predator trapping (T) during spring 2014; no management (N); unknown (U); or construction (C) which include monitored sites that were considered non-habitat prior to June 15 due to construction activities.

^B Breeding pair counts determined on 17 July for least terns and 28 June for piping plovers when numbers observed within the Program Associated Habitat area first peaked. Breeding pair counts, however, do not necessarily represent maximum numbers of least tern or piping plover breeding pairs observed at any site throughout the year as some adults are known to have re-nested at different sites after losing their first nest or brood. Bre. Pairs (Max) represents the maximum number of pairs at a site, regardless of Breeding Pair peak dates. Adults (Max) represent the maximum number adults observed during any single survey at the site.

^C Lexington Island encompasses an NPPD managed area that was attached to the bank.

Plum Creek Complex Island encompasses a Program managed 1.5-mile stretch of river between Lexington Bridge and Overton Bridge.

Cottonwood Ranch Complex encompasses a Program managed 3-mile stretch of river between Overton Bridge and Elm Creek Bridge.

^D Includes 2 piping plover nests that were outside the managed nesting areas and thus were not surrounded by electrified fence and water. Both nests were determined to be failed.

^E Includes 1 least tern nest that was located outside the managed nesting area and thus was not surrounded by electrified fence and water. This nest hatched 3 chicks and fledged 2.

^F Includes 2 least tern nest that were located on the non-access islands. Both least tern nests had failed-unknown fates.

Table 9. Summary of least tern reproductive success at sandpit and river-island sites on the central Platte River in Nebraska, 2007–2014. Site-specific details on numbers of adults, nest, chicks, and fledglings observed during 2014 are provided in Table 8. Habitat- and site-specific details of daily, incubation- and brooding-period survival rates for 2014 are provided in Appendices 1–2 and 5–6 (Program Mark estimates) and Appendices 9–10 and 13–14 (Mayfield estimates).

Reproductive Parameter	Least Tern							
	2007	2008	2009	2010	2011	2012	2013	2014
Maximum Adults Observed	132	80	97	123	125	116	136	166
Breeding Pairs	39	37	42	53	60	64	58	98
Total Nests Observed	53	64	60	76	90	88	95	145
Successful Nests (≥ 1 egg hatched)	22	27	37	43	52	63	51	80
Apparent Nest Success	0.42	0.42	0.62	0.57	0.58	0.72	0.54	0.55
Daily Nest Survival Rate (All sites)	0.97	0.98	0.99	0.98	0.97	0.99	0.97	0.97
Incubation-period Survival Rate (All sites)	0.55	0.61	0.73	0.64	0.58	0.76	0.56	0.52
Chicks Observed	50	54	71	105	124	144	118	180
Hatch Ratio (Chicks/Nest)	0.94	0.84	1.18	1.38	1.38	1.64	1.24	1.24
Hatch Ratio (Chicks/Breeding Pair)	1.28	1.46	1.69	1.98	2.07	2.25	2.03	1.84
Chicks (15D)	40	44	48	67	98	95	70	104
Fledglings (21D)	----- ^A	-----	----	64	89	84	64	91
Historic Fledge Ratio (15D Chicks/Nest)	0.75	0.69	0.80	0.88	1.09	1.08	0.74	0.72
Fledge ratio (21D Chicks/Nest)	-----	-----	----	0.84	0.99	0.95	0.67	0.63
Historic Fledge Ratio (15D Chicks/Breeding Pair)	1.03	1.19	1.14	1.26	1.63	1.48	1.21	1.06
Fledge Ratio (21D Chicks/Breeding Pair)	-----	-----	----	1.21	1.48	1.31	1.10	0.93
Daily Brood Survival Rate (All sites)	-----	0.98	0.98	0.98	0.99	0.99	0.97	0.98
Brooding-period Survival Rate (All sites) ^B	-----	0.75	0.79	0.72	0.89	0.81	0.59	0.69

^A “-----” indicates these data were not reported.

^B Brood survival rates reported in the table are not comparable because estimates are reported as survival for a 15 day interval for least tern chicks during 2007–2009 and in 2010 the Program began to use 21 days as the fledge age for least tern chicks.

Piping Plovers: Piping plover nests were observed at 10 of 14 sandpits and one river site monitored during 2014 (Table 8; Figure 9). The first observation of a piping plover nest was made on 28 April, 2014 and the last nest initiated was first observed on 2 July, 2014. The first observation of a piping plover chick occurred on 28 May, 2014 and the last successful nest observed hatched on 28 July, 2014. At least one egg from 79% (34/43) of piping plover nests hatched, which resulted in 116 chicks and an overall nest-success rate of 2.70 chicks/nest or 3.87 chicks/breeding pair (116 chicks/30 breeding pairs) during 2014 (Table 10). One of these nests was located on a river island that hatched and fledged four chicks. The riverine island was created in 2012 within the Cottonwood Ranch Complex and was moated by spring runoff flows during June 2014. Piping plover daily nest survival rate across all sites during 2014 was 0.9906 (range = 0.9661–1.0000; Appendices 3 & 11) with no difference observed between sites [$\chi^2(5, N = 43) = 7.239$; $p = 0.204$]; average incubation-period survival rate



Adult piping plover with chicks

was 0.7685 (range = 0.3806–1.0000). We first observed a piping plover fledgling on 19 June, 2014 and the last known piping plover chick to fledge did so on 19 August, 2014. We observed an apparent nest-based fledging rate of 1.28 (55 fledglings/43 nests) and a pair-based fledging rate of 1.83 (55 fledglings/30 breeding pairs) at all sites monitored during 2014 (Table 10). Average daily survival rates for piping plover broods across all sites during 2014 was 0.9869 (range = 0.9486–1.0000; Appendices 4 & 12) with at least one significant difference observed between sites [$\chi^2(4, N = 34) = 13.4690$; $p = 0.0092$]; average brooding-period survival rate across all sites was 0.6916 (range = 0.2283–1.0000). We tested for an effect of ownership (i.e., Program or other) on nest and brood survival rates during 2014. Piping plover incubation period survival rates were generally lower at Program owned and managed nesting areas than other nesting areas, 0.5289, 0.5500 respectively, but the difference was not significant at the $\alpha=0.05$ level (Appendices 7 & 15). Piping plover brooding period survival rates were also generally lower at Program owned and managed nesting areas than other nesting areas, 0.4419, 0.7129 respectively, but the difference was not significant at the $\alpha=0.05$ level (Appendices 8 & 16).

Table 10. Summary of piping plover reproductive success at sandpit and river-island sites along the central Platte River in Nebraska, 2007–2014. Site-specific details on numbers of adults, nest, chicks, and fledglings observed during 2014 are provided in Table 9. Site-specific details of daily, incubation- and brooding-period survival rates for 2014 are provided in Appendices 3–4 and 11–12 (Program Mark estimates) and Appendices 7–8 and 15–16 (Mayfield estimates).

Reproductive Parameter	Piping Plover							
	2007	2008	2009	2010	2011	2012	2013	2014
Adults Observed	52	23	31	46	55	60	68	69
Breeding Pairs	19	13	12	20	27	30	27	30
Total Nests Observed	27	21	15	33	34	46	31	43
Successful Nests (≥ 1 egg hatched)	15	8	9	21	27	32	23	34
Apparent Nest Success	0.56	0.38	0.60	0.64	0.79	0.70	0.74	0.79
Daily Nest Survival Rate (All sites)	0.99	0.98	0.99	0.98	0.99	0.99	0.99	0.99
Incubation-period Survival Rate (All sites)	0.71	0.58	0.67	0.54	0.77	0.69	0.73	0.77
Chicks Observed	44	26	27	76	87	99	80	116
Hatch Ratio (Chicks/Nest)	1.63	1.24	1.80	2.30	2.56	2.15	2.58	2.70
Hatch Ratio (Chicks/Breeding Pair)	2.32	1.24	2.25	3.80	3.22	3.30	2.96	3.87
Chicks (15D)	27	10	18	53	61	68	43	67
Fledglings (28D)	----- ^A	-----	-----	42	45	59	28	55
Historic Fledge Ratio (15D Chicks/Nest)	1.00	0.48	1.20	1.61	1.79	1.48	1.39	1.56
Fledge ratio (28D Chicks/Nest)	-----	-----	-----	1.27	1.32	1.28	0.90	1.28
Historic Fledge Ratio (15D Chicks/Breeding Pair)	1.42	0.77	1.50	2.65	2.26	2.27	1.59	2.23
Fledge Ratio (28D Chicks/Breeding Pair)	-----	-----	-----	2.01	1.67	1.97	1.04	1.83
Daily Brood Survival Rate (All sites)	-----	0.94	0.98	0.99	0.99	0.99	0.98	0.99
Brooding-period Survival Rate (All sites) ^B	-----	0.42	0.79	0.70	0.73	0.78	0.62	0.69

^A “-----” indicates these data were not reported.

^B Brood survival rates reported in the table are not comparable because estimates are reported as survival for a 15 day interval for piping plover chicks during 2007–2009 and in 2010 the Program began to use 28 days as the fledge age for piping plover chicks.

Breeding Pair Counts: We estimated numbers of least tern and piping plover breeding pairs by adding the number of active and recently (within five days) failed nests to the number of active and recently failed least tern and piping plover broods and recently fledged least terns and fledged piping plovers observed on each day of the nesting season as described above. Least tern breeding pair counts peaked at 98 pairs on 17 July, 2014. Piping plover breeding pair counts peaked at 30 pair on 28 June, 2014; these dates were later than what we observed in 2012 and 2013. Similar to nest and adult counts, least tern breeding pair counts have increased steadily since 2001 (Figure 10). Piping plover breeding pair counts increased slightly from 2001-2007, declined during 2008 and 2009, and have since increased (Figure 11). Though nesting has occurred on riverine sandbars a few years since 2001, off-channel sandpits have provided the most consistent nesting habitat for both species to date.

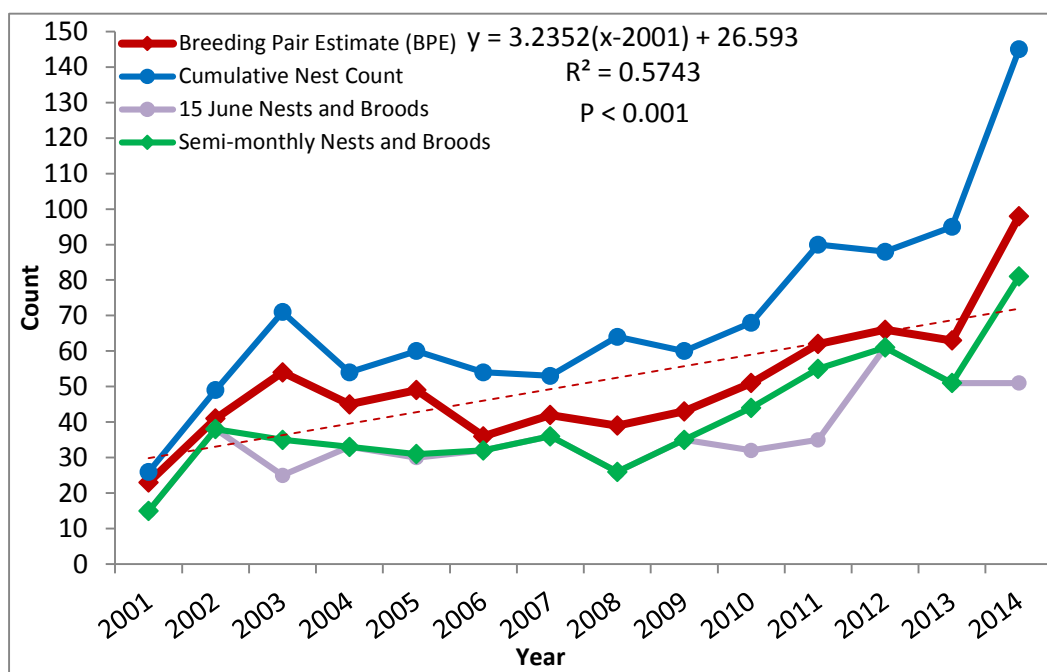


Figure 10. Comparison of numbers of least tern river nests, sandpit nests, total nests, ‘pairs’ (maximum adult count/2), and Program defined breeding pairs observed within the Program Associated Habitat Area, 2001-2014.

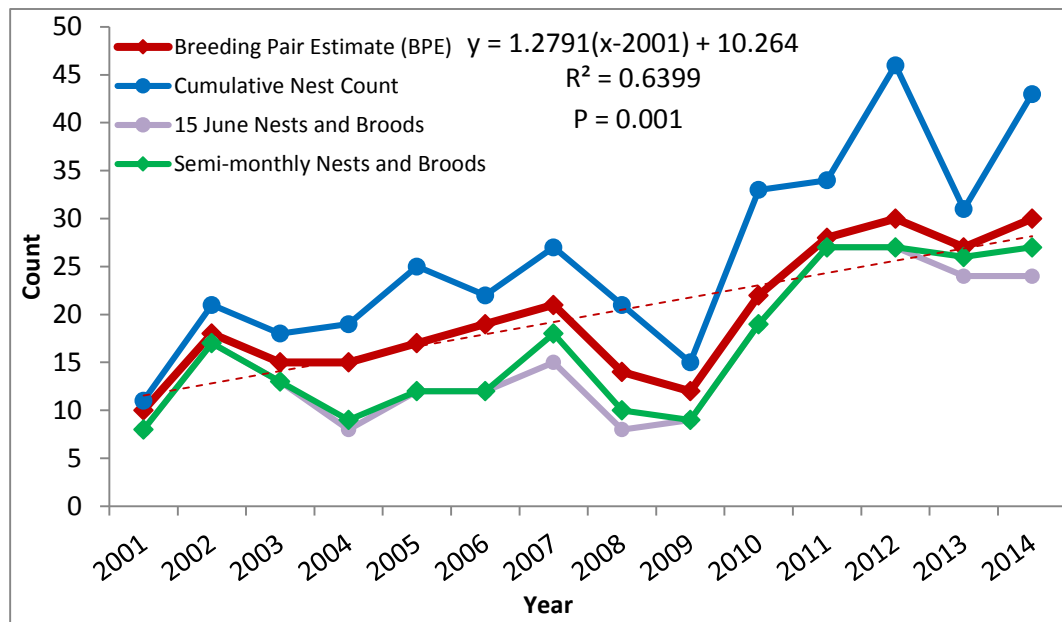


Figure 11. Comparison of numbers of piping plover river nests, sandpit nests, total nests, ‘pairs’ (maximum adult count/2), and Program defined breeding pairs observed within the Program Associated Habitat Area, 2001-2014.

RESEARCH

In addition to implementation of the Program’s surveillance monitoring protocol, conservation monitoring and directed research will be conducted during the course of the Program’s First Increment to provide data to evaluate the Program’s management objectives and priority hypotheses. Over the next several years, activities will include research on least tern and piping plover nest-site selection, habitat colonization, dispersal rates, re-nesting events, and comparisons of use and reproductive success on riverine versus off-channel sand and water habitat. Design and implementation of this research will be guided by the ED Office, the TAC, and Program partners and will be reviewed by the Program’s Independent Scientific Advisory Committee (ISAC).

FORAGING HABITS STUDY

The first directed research project related to least terns and piping plovers on the central Platte River began in 2009 with the implementation of the Foraging Habits Study. A contract to conduct this study over two field seasons (2009–2010) was awarded to the USGS-NPWRC. The research was jointly funded by the Program and the USGS-NPWRC. Final results of the Foraging Habits Study can be found in the Program Library at the following link:

<https://www.platteriverprogram.org/PubsAndData/ProgramLibrary/Forms/DispForm.aspx?ID=158>

HABITAT COLONIZATION STUDY

In 2011, the Program and the USGS entered into an agreement for the USGS to conduct a study to evaluate Habitat Colonization and Productivity of Least Terns and Piping Plovers Nesting on Central Platte River sandpits and sandbars. This study will address three specific objectives that will contribute to the understanding of habitat use by least terns and piping plovers in the CPRV:

- 1. Dispersal**

Quantify dispersal of adults between units of nesting habitat on the Central Platte River among years.

- 2. Colonization**

Quantify colonization rate of newly constructed or managed nesting habitat by local vs. immigrant adults.

- 3. Renesting**

Quantify frequency and location of renesting attempts by adults with failed nests.

The research is jointly funded by the Program and the USGS-NPWRC. Details about findings of this research can be found in the Draft Research Project Report to be generated by the USGS-NPWRC in early 2015 and in the Final Research Project Report that will be produced after the 2015 nesting season.



Banded piping plover chick

Adult and Chick Band Observations – As part of Program-funded research implemented by the USGS field crews, 96 adult and 523 juvenile least terns and 64 adult and 413 juvenile piping plovers have been banded along the central Platte River to date (Table 11).

Table 11. Summary of numbers of interior least tern and piping plover adults and chicks banded along the central Platte River, 2009–2014.

Year	Least Tern Adults	Least Tern Chicks	Piping Plover Adults	Piping Plover Chicks
2009	16	35	11	25
2010	7	74	13	64
2011	4	98	2	68
2012	9	103	15	86
2013	32	99	12	64
2014	28	114	11	106
Total	96	523	64	413

After six years of banding on the central Platte River, we have compiled valuable information regarding site and habitat (sandpit or riverine) fidelity and philopatry, wintering ground locations for central Platte River piping plovers, survival and recruitment, re-nesting events, and disturbance. We have observed several adult least terns and piping plovers return to nest at the site where they were banded (and at other sites); however, all banded chicks observed to date that returned to nest have nested at non-natal sites. On multiple occasions, we have observed least tern and piping plover fledglings at non-natal sites late in the nesting season, which may be an indication that fledglings begin selecting nesting habitat for the subsequent year prior to departing for the winter grounds. A detailed summary of what has been observed and learned from banding efforts implemented to date will be available in 2015.



Multiple banded piping plover fledges observed during a river survey

Table 12. Central Platte River sites where first nesting attempts of piping plovers were documented following hatch-year dispersal, 2011-2014.

Site	2011	2012	2013	2014	Total
Blue Hole	0	2	1	0	3
Broadfoot - Kearney South	0	1	1	1	3
Cottonwood Ranch PRRIP Island	0	0	0	1	1
Cottonwood Ranch Sandpit	0	0	2	0	2
Dyer Sandpit	1	3	2	0	6
Lexington Sandpit	0	0	1	1	2
Paulsen's Lexington Pit	0	0	0	1	1
Total	1	6	7	4	18

SURVEY METHODOLOGY STUDY

Inside-Outside Monitoring – Inside and outside counts were obtained at seven sandpit sites and four river island sites during 2014. Similar to past observations, outside monitoring generally resulted in fewer nests and chicks, as well as fledglings. The biggest difference in inside and outside counts and observations during 2014 appears to be in numbers of nests and chicks that were observed as well as incorrect associations of chicks and fledglings with nests from outside the colony.

Inside and outside counts of nests, chicks, and fledglings were obtained at sandpit sites and river island sites from 2011–2014. Outside monitoring at Program-owned sites was insufficient during 2011–2012, therefore comparisons for those years are not available. To compare the counts produced by these two methods, we present the counts for each year by site (Table 13). To visualize the relationship between the two methods, we plotted counts of nests, chicks, and fledglings obtained from outside counts against inside counts. To quantitatively assess the relationship between the two methods, we used linear regression with a fixed intercept of zero (Figure 12). This regression equation, presented in Figure 12, can be interpreted as the expected outside count given the inside count. A slope of zero, therefore, suggests that counts obtained from the outside will, on average, be the same as inside counts (i.e., there is no systematic difference in the two methods). A slope >1 suggests that, on average, inside counts will be greater than outside counts; a slope of <1 suggests the antipodal.

Our results show annual totals of inside counts of nests, chicks, and fledglings were always greater than annual totals of outside counts (Table 13). The regression analysis shows that nest and brood counts from the inside surveys are expected to be over 30% and 40% greater, respectively, than outside counts (Fig. 12). For counts of fledglings, inside and outside counts are expected to result in similar numbers.

HABITAT AVAILABILITY ASSESSMENTS

The Program has entered into a contract with Rainwater Basin Joint Venture to assess aerial imagery and LiDAR data and identify in-channel and off-channel habitat areas that conform to the Program's current minimum habitat criteria. Assessment results for 2007–2014 will be available in 2015.

HABITAT SELECTION STUDY

The EDO plans to use nest location and habitat assessment data collected through 2014 to evaluate least tern and piping plover nest site selection on the Central Platte River. Results of these evaluations will be available in 2015.

Table 13. Cumulative number of nests, chicks, and fledglings counted from outside (Outside Counts) and within (Inside Counts) sites monitored at 10 sites in 2013 and 2014.

Year	Site	Inside Nests	Outside Nests	Inside Chicks	Outside Chicks	Inside Fledges	Outside Fledges
2013	Cottonwood Ranch OCSW	10	10	6	4	0	0
2013	Cottonwood Island	0	0	0	0	0	0
2013	Dyer	17	17	35	20	8	5
2013	Paulsen Lex Pit	NA	NA	NA	NA	NA	NA
2013	Lexington Pit	6	5	12	4	0	0
2013	Blue Hole	25	22	43	31	27	20
2013	Johnson	NA	NA	NA	NA	NA	NA
2013	Newark	3	3	10	9	4	4
2013	Broadfoot South	37	26	41	23	11	15
2013	Leaman OCSW	7	6	9	11	4	4
2013	Totals	105	89	156	102	54	48
2014	Cottonwood Ranch OCSW	15	14	35	26	8	9
2014	Cottonwood Island	2	2	4	0	4	0
2014	Dyer	6	6	12	9	1	0
2014	Paulson Lex Pit	1	1	4	3	2	0
2014	Lexington Pit	5	5	12	8	1	0
2014	Blue Hole	50	32	65	50	23	34
2014	Johnson	7	7	4	2	0	1
2014	Newark	18	18	26	18	10	10
2014	Broadfoot South	21	16	33	16	10	2
2014	Leaman OCSW	41	30	46	35	21	17
2014	Totals	166	131	241	167	80	73

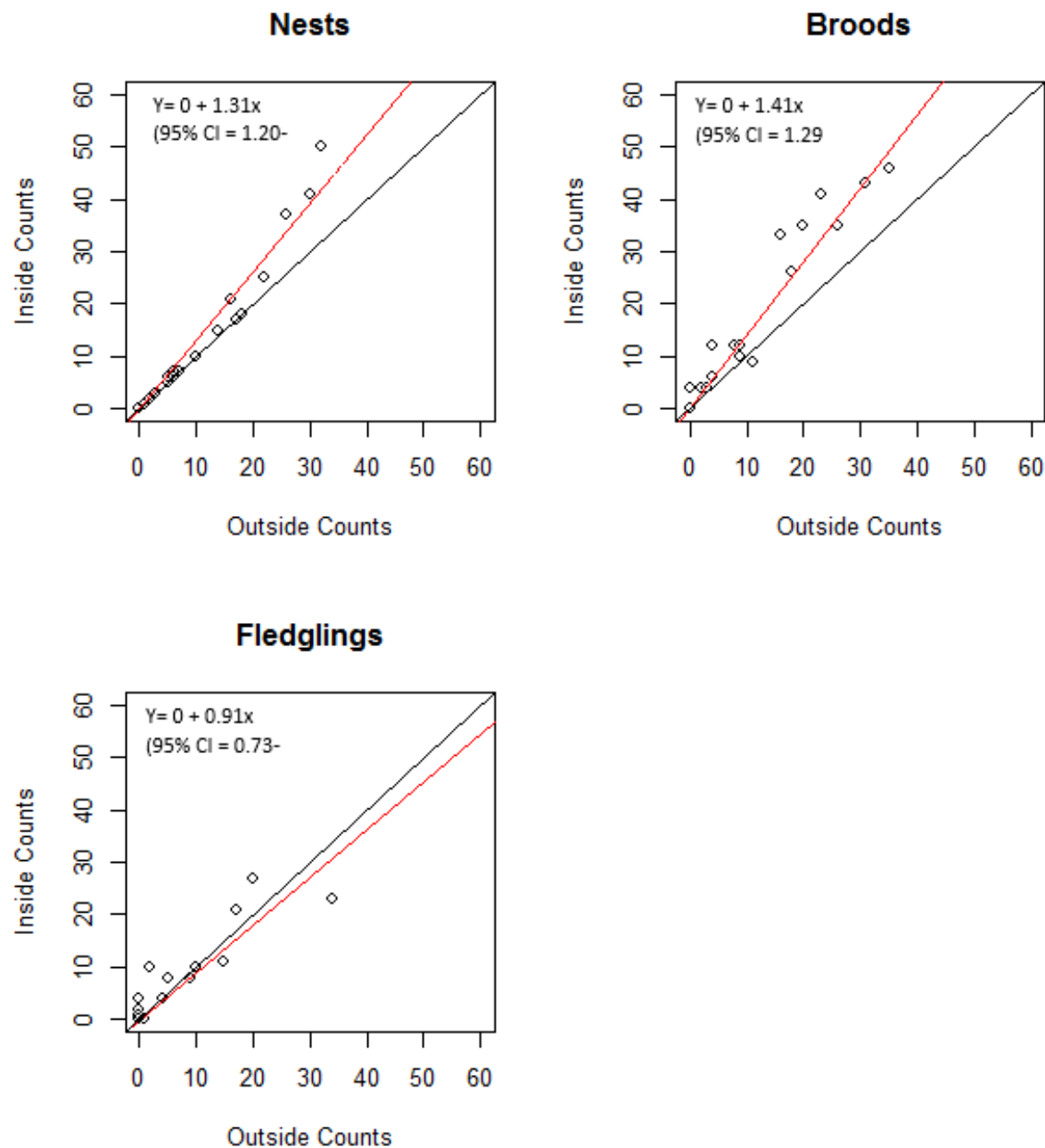


Figure 12. Cumulative numbers of nests, broods, and fledglings counted from outside (Outside Counts) and within (Inside Counts) the nesting colony at 10 sites (Cottonwood, Cottonwood Island, Dyer, Lexington Pit, Blue Hole, Newark, Broadfoot South, Leaman, Paulson's Lex Pit, and Johnson). Black lines show a one-to-one relationship and red line shows the line of best fit to the counts. When the red line is above the black line it shows Outside Counts were, on average, less than Inside Counts; the reverse is true if the red line is below the black line.

ACKNOWLEDGEMENTS

Support for monitoring and research activities outlined in this report were provided by the Central Platte Natural Resources District, Nebraska Public Power District, Platte River Recovery Implementation Program, and the U.S. Geological Survey–Northern Plains Wildlife Research Center. We extend a special thanks to non-governmental agencies and private landowners that allowed access to their properties and the many people who assisted in collecting data and provided technical guidance during the past eight years.



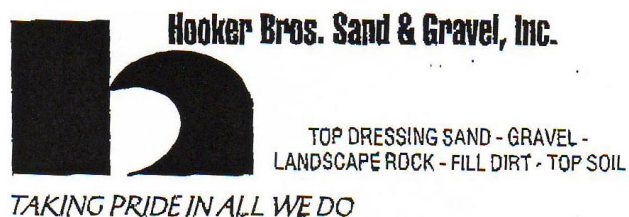
The
**CENTRAL NEBRASKA PUBLIC POWER
and IRRIGATION DISTRICT**



**PLATTE RIVER
RECOVERY IMPLEMENTATION PROGRAM**



We would also like to acknowledge the privately-owned sand and gravel mining companies who allowed us access to their property to monitor and collect data on interior least tern and piping plover activities. These companies included Broadfoot Sand and Gravel Corporation, DeWeese Sand and Gravel Inc., and Hooker Brothers Sand and Gravel.



Appendices

Program Mark Survival Estimates

Appendix 1. Daily and incubation-period survival rates for least tern nests monitored on sandpits and a river island site during 2014. Incubation-period nest survival rate = (daily nest survival rate)²¹.

Site	# Nests	# Nests Lost	Exposure Days	Daily Nest Survival Rate	Daily Nest Survival SE	Daily Nest Survival Rate 95% CI		Incubation Period Survival Rate	Incubation Period Nest Survival Rate 95% CI	
						Lower	Upper		Lower	Upper
Cottonwood ¹	13	1	255	0.9959	0.0041	0.9713	0.9994	0.9167	0.5871	0.9884
Blue Hole	42	24	598	0.9577	0.0085	0.9376	0.9715	0.4034	0.2688	0.5543
Johnson	6	5	69	0.9223	0.0351	0.8260	0.9675	0.1832	0.0347	0.5832
Broadfoot ²	13	7	307	0.9652	0.1398	0.9246	0.9843	0.4750	0.2252	0.7380
Newark	17	7	285	0.9742	0.0096	0.9469	0.9877	0.5776	0.3430	0.7817
Leaman ¹	38	16	631	0.9733	0.0066	0.9569	0.9836	0.5670	0.4079	0.7134
Wild Rose ¹	7	2	110	0.9807	0.0135	0.9260	0.9952	0.6638	0.2671	0.9145
Trust Island ³	2	2	17	0.8683	0.0878	0.5943	0.9674	0.0515	0.0007	0.8135
Hooker BSE ¹	7	2	92	0.9766	0.0164	0.9112	0.9941	0.6082	0.2109	0.9002
All Sites	145	66	2,631	0.9694	0.0037	0.9611	0.9759	0.5204	0.4379	0.6018

¹ ‘Cottonwood’ represents Cottonwood Ranch Off Channel Sand and Water (OCSW); ‘Leaman’ represents Leaman OCSW; ‘Wild Rose’ represents Wild Rose Ranch East Sandpit; ‘Hooker BSE’ represents Hooker Brothers Southeast Sandpit.

² ‘Broadfoot’ represents the main peninsula as well as the islands that we could not access at Broadfoot South.

³ ‘Trust Island’ represents islands within a stretch of river east of the Alda bridge that were disked during 2013 and overtopped by a high-flow event during fall 2013.

Appendix 2. Daily and brooding-period survival rates for least tern broods (1 or more chicks) monitored on sandpits during 2014. Brooding-period brood survival rate = (daily brood survival rate)²¹.

Site	# Broods	# Broods Lost	Exposure Days	Daily Brood Survival Rate	Daily Brood Survival SE	Daily Brood Survival Rate 95% CI		Brooding Period Survival Rate	Brooding Period Survival Rate 95% CI	
						Lower	Upper		Lower	Upper
Cottonwood ¹	12	6	220	0.9715	0.0115	0.9381	0.9872	0.5454	0.2920	0.7772
Blue Hole	18	5	336	0.9844	0.0069	0.9630	0.9935	0.7184	0.4767	0.8772
Johnson	1	1	4	0.6687	0.2991	0.1253	0.9661	0.0002	0.0000	1.0000
Broadfoot ²	6	4	83	0.9493	0.0247	0.8726	0.9809	0.3355	0.0916	0.7167
Newark	10	2	196	0.9893	0.0075	0.9583	0.9973	0.7978	0.4562	0.9489
Leaman ¹	22	7	440	0.9832	0.0063	0.9652	0.9920	0.7011	0.4931	0.8498
Wild Rose ¹	5	0	105	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Hooker BSE ¹	5	0	105	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
All Sites	79	25	1,489	0.9824	0.0035	0.9740	0.9881	0.6882	0.5798	0.7793

¹ ‘Cottonwood’ represents Cottonwood Ranch Off Channel Sand and Water (OCSW); ‘Leaman’ represents Leaman OCSW; ‘Wild Rose’ represents Wild Rose Ranch East Sandpit; ‘Hooker BSE’ represents Hooker Brothers Southeast Sandpit.

² ‘Broadfoot’ represents the main peninsula as well as the islands that we could not access at Broadfoot South.

Appendix 3. Daily and incubation-period survival rates for piping plover nests monitored on sandpits and a river island site during 2014. Incubation-period nest survival rate = (daily nest survival rate)²⁸.

Site	# Nests	# Nests Lost	Exposure Days	Daily Nest Survival Rate	Daily Nest Survival SE	Daily Nest Survival Rate 95% CI		Incubation Period Survival Rate	Incubation Period Nest Survival Rate 95% CI	
						Lower	Upper		Lower	Upper
Lexington	5	2	117	0.9822	0.0125	0.9317	0.9955	0.6051	0.2081	0.8993
Paulsen ¹	1	0	14	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Dyer	6	2	143	0.9855	0.0102	0.9439	0.9964	0.6644	0.2678	0.9146
Cottonwood ¹	2	0	58	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
CWR Island ¹	2	1	31	0.9661	0.0333	0.7950	0.9952	0.3806	0.0281	0.9289
Blue Hole	8	1	203	0.9949	0.0051	0.9646	0.9993	0.8662	0.4413	0.9815
Johnson	1	0	19	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Broadfoot ²	9	2	209	0.9900	0.0070	0.9611	0.9975	0.7558	0.3871	0.9381
Newark	3	1	60	0.9825	0.0174	0.8857	0.9975	0.6091	0.1148	0.9493
Leaman ¹	3	0	81	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Wild Rose ¹	3	0	66	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
All Sites	43	9	1,000	0.9906	0.0031	0.9821	0.9951	0.7685	0.6122	0.8747

¹ ‘Paulsen’ represents Paulsen’s Lexington Sandpit; ‘Cottonwood’ represents Cottonwood Ranch Off Channel Sand and Water (OCSW); ‘CWR Island’ represents Cottonwood Ranch Complex Constructed Islands; ‘Leaman’ represents Leaman OCSW; ‘Wild Rose’ represents Wild Rose Ranch East Sandpit

² ‘Broadfoot’ represents the main peninsula as well as the islands that we could not access at Broadfoot South.

Appendix 4. Daily and brooding-period survival rates for piping plover broods (one or more chicks) monitored on sandpits and a river island site during 2014. Brooding-period survival rate = (daily brood survival rate)²⁸.

Site	# Broods	# Broods Lost	Exposure Days	Daily Brood Survival Rate	Daily Brood Survival SE	Daily Brood Survival Rate 95% CI		Brooding Period Survival Rate	Brooding Period Survival Rate 95% CI	
						Lower	Upper		Lower	Upper
Lexington	3	2	41	0.9486	0.0354	0.8163	0.9871	0.2283	0.0204	0.8081
Paulsen ¹	1	0	28	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Dyer	4	3	94	0.9670	0.1873	0.9027	0.9893	0.3910	0.1008	0.7862
Cottonwood ¹	2	0	57	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
CWR Island ¹	1	0	28	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Blue Hole	7	1	173	0.9940	0.0060	0.9586	0.9992	0.8448	0.3927	0.9786
Johnson	1	0	28	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Broadfoot ²	7	3	128	0.9755	0.0140	0.9277	0.9921	0.4992	0.1718	0.8274
Newark	2	0	56	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Leaman ¹	3	0	85	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Wild Rose ¹	3	1	76	0.9864	0.0135	0.9097	0.9981	0.6814	0.1680	0.9577
All Sites	34	10	794	0.9869	0.0041	0.9759	0.9929	0.6916	0.5166	0.8247

¹ 'Paulsen' represents Paulsen's Lexington Sandpit; 'Cottonwood' represents Cottonwood Ranch Off Channel Sand and Water (OCSW); 'CWR Island' represents Cottonwood Ranch Complex Constructed Islands; 'Leaman' represents Leaman OCSW; 'Wild Rose' represents Wild Rose Ranch East Sandpit

² 'Broadfoot' represents the main peninsula as well as the islands that we could not access at Broadfoot South.

Appendix 5. Daily and incubation-period survival rates for least tern nests monitored on Program and non-Program sites during 2014. Incubation-period nest survival rate = (daily nest survival rate)²¹.

Site	# Nests	# Nests Lost	Exposure Days	Daily Nest Survival Rate	Daily Nest Survival SE	Daily Nest Survival Rate 95% CI		Incubation Period Survival Rate	Incubation Period Nest Survival Rate 95% CI	
						Lower	Upper		Lower	Upper
Non-Program	64	35	884	0.9581	0.0069	0.9422	0.9698	0.4074	0.2938	0.5319
Program	81	31	1,477	0.9773	0.0042	0.9676	0.9842	0.6178	0.5054	0.7189
All Sites	145	66	2,631	0.9697	0.0037	0.9615	0.9763	0.5246	0.4417	0.6061

Appendix 6. Daily and brooding-period survival rates for least tern broods (1 or more chicks) monitored on Program and non-Program sites during 2014. Brooding-period brood survival rate = (daily brood survival rate)²¹.

Site	# Broods	# Broods Lost	Exposure Days	Daily Brood Survival Rate	Daily Brood Survival SE	Daily Brood Survival Rate 95% CI		Brooding Period Survival Rate	Brooding Period Survival Rate 95% CI	
						Lower	Upper		Lower	Upper
Non-Program	29	6	550	0.9885	0.0047	0.9747	0.9948	0.7850	0.5972	0.8999
Program	50	19	939	0.9788	0.0048	0.9669	0.9864	0.6370	0.5009	0.7542
All Sites	79	25	1489	0.9824	0.0035	0.9740	0.9881	0.6882	0.5798	0.7793

Program owned and managed sites include: Dyer, Cottonwood Ranch Off Channel Sand and Water (OCSW), Cottonwood Ranch Complex Constructed Islands, Broadfoot Newark West, & Leaman OCSW

Non-Program owned and managed sites include: Lexington, Paulsen's Lexington Sandpit, Blue Hole, Johnson, Broadfoot South, Wild Rose Ranch East Sandpit, Trust Island, & Hooker Brothers Southeast Sandpit

Appendix 7. Daily and incubation-period survival rates for piping plover nests monitored on Program and non-Program sites during 2014. Incubation-period nest survival rate = (daily nest survival rate)²⁸.

Site	# Nests	# Nests Lost	Exposure Days	Daily Nest Survival Rate	Daily Nest Survival SE	Daily Nest Survival Rate 95% CI		Incubation Period Survival Rate	Incubation Period Nest Survival Rate 95% CI	
						Lower	Upper		Lower	Upper
Non-Program	18	3	418	0.9925	0.0043	0.9771	0.9976	0.8108	0.5500	0.9376
Program	25	6	582	0.9893	0.0044	0.9763	0.9952	0.7394	0.5289	0.8776
All Sites	43	9	1,000	0.9906	0.0031	0.9821	0.9951	0.7685	0.6122	0.8747

Appendix 8. Daily and brooding-period survival rates for piping plover broods (one or more chicks) monitored on Program and non-Program sites during 2014. Brooding-period brood survival rate = (daily brood survival rate)²⁸.

Site	# Broods	# Broods Lost	Exposure Days	Daily Brood Survival Rate	Daily Brood Survival SE	Daily Brood Survival Rate 95% CI		Brooding Period Survival Rate	Brooding Period Survival Rate 95% CI	
						Lower	Upper		Lower	Upper
Non-Program	15	4	346	0.9880	0.0060	0.9684	0.9955	0.7129	0.4389	0.8874
Program	19	6	448	0.9861	0.0056	0.9694	0.9937	0.6756	0.4419	0.8457
All Sites	34	10	794	0.9869	0.0041	0.9759	0.9929	0.6916	0.5166	0.8247

Program owned and managed sites include: Dyer, Cottonwood Ranch Off Channel Sand and Water (OCSW), Cottonwood Ranch Complex Constructed Islands, Broadfoot Newark West, & Leaman OCSW

Non-Program owned and managed sites include: Lexington, Paulsen's Lexington Sandpit, Blue Hole, Johnson, Broadfoot South, Wild Rose Ranch East Sandpit, Trust Island, & Hooker Brothers Southeast Sandpit

Mayfield Survival Estimates

Appendix 9. Daily and incubation-period survival rates for least tern nests monitored on sandpits and a river island site during 2014. Incubation-period nest survival rate = (daily nest survival rate)²¹.

Site	# Nests	# Nests Lost	Exposure Days	Daily Nest Survival Rate	Daily Nest Survival SE	Daily Nest Survival Rate 95% CI		Incubation Period Survival Rate	Incubation Period Nest Survival Rate 95% CI	
						Lower	Upper		Lower	Upper
Cottonwood ¹	13	1	255	0.9961	0.0039	0.9884	1.0037	0.9208	0.7828	1.0818
Blue Hole	42	24	598	0.9599	0.0080	0.9441	0.9756	0.4231	0.2990	0.5952
Johnson	6	5	69	0.9275	0.0312	0.8664	0.9887	0.2060	0.0492	0.7878
Broadfoot ²	13	7	307	0.9772	0.0085	0.9605	0.9939	0.6161	0.4290	0.8794
Newark	17	7	285	0.9754	0.0092	0.9575	0.9934	0.5932	0.4014	0.8703
Leaman ¹	38	16	631	0.9746	0.0063	0.9624	0.9869	0.5831	0.4469	0.7583
Wild Rose ¹	7	2	110	0.9818	0.0127	0.9568	1.0068	0.6802	0.3960	1.1526
Trust Island ³	2	2	17	0.8824	0.0781	0.7292	1.0355	0.0722	0.0013	2.0809
Hooker BSE ¹	7	2	92	0.9783	0.0152	0.9485	1.0081	0.6303	0.3292	1.1836
All Sites	145	66	2,631	0.9749	0.0030	0.9689	0.9809	0.5865	0.5155	0.6669

¹ ‘Cottonwood’ represents Cottonwood Ranch Off Channel Sand and Water (OCSW); ‘Leaman’ represents Leaman OCSW; ‘Wild Rose’ represents Wild Rose Ranch East Sandpit; ‘Hooker BSE’ represents Hooker Brothers Southeast Sandpit.

² ‘Broadfoot’ represents the main peninsula as well as the islands that we could not access at Broadfoot South.

³ ‘Trust Island’ represents islands within a stretch of river east of the Alda bridge that were disked during 2013 and overtopped by a high-flow event during fall 2013.

Appendix 10. Daily and brooding-period survival rates for least tern broods (1 or more chicks) monitored on sandpits during 2014. Brooding-period brood survival rate = (daily brood survival rate)²¹.

Site	# Broods	# Broods Lost	Exposure Days	Daily Brood Survival Rate	Daily Brood Survival SE	Daily Brood Survival Rate 95% CI		Brooding Period Survival Rate	Brooding Period Survival Rate 95% CI	
						Lower	Upper		Lower	Upper
Cottonwood ¹	12	6	220	0.9727	0.0110	0.9512	0.9943	0.5595	0.3497	0.8860
Blue Hole	18	5	336	0.9851	0.0066	0.9722	0.9981	0.7299	0.5529	0.9601
Johnson	1	1	4	0.7500	0.2165	0.3256	1.1744	0.0024	0.0000	29.2259
Broadfoot ²	6	4	83	0.9518	0.0235	0.9057	0.9979	0.3544	0.1250	0.9565
Newark	10	2	196	0.9898	0.0072	0.9757	1.0039	0.8062	0.5969	1.0844
Leaman ¹	22	7	440	0.9841	0.0060	0.9724	0.9958	0.7141	0.5556	0.9151
Wild Rose ¹	5	0	105	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Hooker BSE ¹	5	0	105	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
All Sites	79	25	1,489	0.9832	0.0033	0.9767	0.9897	0.7008	0.6093	0.8052

¹ ‘Cottonwood’ represents Cottonwood Ranch Off Channel Sand and Water (OCSW); ‘Leaman’ represents Leaman OCSW; ‘Wild Rose’ represents Wild Rose Ranch East Sandpit; ‘Hooker BSE’ represents Hooker Brothers Southeast Sandpit.

² ‘Broadfoot’ represents the main peninsula as well as the islands that we could not access at Broadfoot South.

Appendix 11. Daily and incubation-period survival rates for piping plover nests monitored on sandpits and a river island site during 2014. Incubation-period nest survival rate = (daily nest survival rate)²⁸.

Site	# Nests	# Nests Lost	Exposure Days	Daily Nest Survival Rate	Daily Nest Survival SE	Daily Nest Survival Rate 95% CI		Incubation Period Survival Rate	Incubation Period Nest Survival Rate 95% CI	
						Lower	Upper		Lower	Upper
Lexington	5	2	117	0.9829	0.0120	0.9594	1.0064	0.6962	0.4190	1.1432
Paulsen ¹	1	0	14	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Dyer	6	2	143	0.9860	0.0098	0.9668	1.0053	0.7440	0.4918	1.1165
Cottonwood ¹	2	0	58	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
CWR Island ¹	2	1	31	0.9677	0.0317	0.9055	1.0299	0.5023	0.1245	1.8580
Blue Hole	8	1	203	0.9951	0.0049	0.9854	1.0047	0.9015	0.7349	1.1036
Johnson	1	0	19	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Broadfoot ²	9	2	209	0.9904	0.0067	0.9772	1.0036	0.8172	0.6165	1.0791
Newark	3	1	60	0.9833	0.0165	0.9509	1.0157	0.7026	0.3477	1.3878
Leaman ¹	3	0	81	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Wild Rose ¹	3	0	66	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
All Sites	43	9	1,000	0.9910	0.0030	0.9851	0.9969	0.8271	0.7303	0.9360

¹ 'Paulsen' represents Paulsen's Lexington Sandpit; 'Cottonwood' represents Cottonwood Ranch Off Channel Sand and Water (OCSW); 'CWR Island' represents Cottonwood Ranch Complex Constructed Islands; 'Leaman' represents Leaman OCSW; 'Wild Rose' represents Wild Rose Ranch East Sandpit

² 'Broadfoot' represents the main peninsula as well as the islands that we could not access at Broadfoot South.

Appendix 12. Daily and brooding-period survival rates for piping plover broods (1 or more chicks) monitored on sandpits and a river island site during 2014. Brooding-period survival rate = (daily brood survival rate)²⁸.

Site	# Broods	# Broods Lost	Exposure Days	Daily Brood Survival Rate	Daily Brood Survival SE	Daily Brood Survival Rate 95% CI		Brooding Period Survival Rate	Brooding Period Survival Rate 95% CI	
						Lower	Upper		Lower	Upper
Lexington	3	2	41	0.9512	0.0336	0.8853	1.0172	0.3499	0.0774	1.4294
Paulsen ¹	1	0	28	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Dyer	4	3	94	0.9681	0.0181	0.9326	1.0036	0.5060	0.2307	1.0788
Cottonwood ¹	2	0	57	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
CWR Island ¹	1	0	28	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Blue Hole	7	1	173	0.9942	0.0058	0.9829	1.0055	0.8854	0.6965	1.1225
Johnson	1	0	28	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Broadfoot ²	7	3	128	0.9766	0.0134	0.9504	1.0028	0.6077	0.3432	1.0599
Newark	2	0	56	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Leaman ¹	3	0	85	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Wild Rose ¹	3	1	76	0.9868	0.0131	0.9612	1.0125	0.7572	0.4358	1.2970
All Sites	34	10	794	0.9874	0.0040	0.9796	0.9952	0.7663	0.6493	0.9032

¹ 'Paulsen' represents Paulsen's Lexington Sandpit; 'Cottonwood' represents Cottonwood Ranch Off Channel Sand and Water (OCSW); 'CWR Island' represents Cottonwood Ranch Complex Constructed Islands; 'Leaman' represents Leaman OCSW; 'Wild Rose' represents Wild Rose Ranch East Sandpit

² 'Broadfoot' represents the main peninsula as well as the islands that we could not access at Broadfoot South.

Appendix 13. Daily and incubation-period survival rates for least tern nests monitored on Program and non-Program sites during 2014. Incubation-period nest survival rate = (daily nest survival rate)²¹.

Site	# Nests	# Nests Lost	Exposure Days	Daily Nest Survival Rate	Daily Nest Survival SE	Daily Nest Survival Rate 95% CI		Incubation Period Survival Rate	Incubation Period Nest Survival Rate 95% CI	
						Lower	Upper		Lower	Upper
Non-Program	64	35	884	0.9604	0.0066	0.9476	0.9733	0.4281	0.3226	0.5660
Program	81	31	1,477	0.9790	0.0037	0.9717	0.9863	0.6405	0.5472	0.7488
All Sites	145	66	2,631	0.9749	0.0030	0.9689	0.9809	0.5865	0.5155	0.6669

Appendix 14. Daily and brooding-period survival rates for least tern broods (1 or more chicks) monitored on Program and non-Program sites during 2014. Brooding-period brood survival rate = (daily brood survival rate)²¹.

Site	# Broods	# Broods Lost	Exposure Days	Daily Brood Survival Rate	Daily Brood Survival SE	Daily Brood Survival Rate 95% CI		Brooding Period Survival Rate	Brooding Period Survival Rate 95% CI	
						Lower	Upper		Lower	Upper
Non-Program	29	6	550	0.9891	0.0044	0.9804	0.9978	0.7943	0.6600	0.9542
Program	50	19	939	0.9798	0.0046	0.9708	0.9888	0.6510	0.5362	0.7889
All Sites	79	25	1489	0.9832	0.0033	0.9767	0.9897	0.7008	0.6093	0.8052

Program owned and managed sites include: Dyer, Cottonwood Ranch Off Channel Sand and Water (OCSW), Cottonwood Ranch Complex Constructed Islands, Broadfoot Newark West, & Leaman OCSW

Non-Program owned and managed sites include: Lexington, Paulsen's Lexington Sandpit, Blue Hole, Johnson, Broadfoot South, Wild Rose Ranch East Sandpit, Trust Island, & Hooker Brothers Southeast Sandpit

Appendix 15. Daily and incubation-period survival rates for piping plover nests monitored on Program and non-Program sites during 2014. Incubation-period nest survival rate = (daily nest survival rate)²⁸.

Site	# Nests	# Nests Lost	Exposure Days	Daily Nest Survival Rate	Daily Nest Survival SE	Daily Nest Survival Rate 95% CI		Incubation Period Survival Rate	Incubation Period Nest Survival Rate 95% CI	
						Lower	Upper		Lower	Upper
Non-Program	18	3	418	0.9928	0.0041	0.9847	1.0009	0.8596	0.7239	1.0194
Program	25	6	582	0.9897	0.0042	0.9815	0.9979	0.8044	0.6754	0.9568
All Sites	43	9	1,000	0.9910	0.0030	0.9851	0.9969	0.8271	0.7303	0.9360

Appendix 16. Daily and brooding-period survival rates for piping plover broods (1 or more chicks) monitored on Program and non-Program sites during 2014. Brooding-period brood survival rate = (daily brood survival rate)²⁸.

Site	# Broods	# Broods Lost	Exposure Days	Daily Brood Survival Rate	Daily Brood Survival SE	Daily Brood Survival Rate 95% CI		Brooding Period Survival Rate	Brooding Period Survival Rate 95% CI	
						Lower	Upper		Lower	Upper
Non-Program	15	4	346	0.9884	0.0057	0.9772	0.9997	0.7833	0.6158	0.9938
Program	19	6	448	0.9866	0.0054	0.9760	0.9973	0.7534	0.5999	0.9438
All Sites	34	10	794	0.9874	0.0040	0.9796	0.9952	0.7663	0.6493	0.9032

Program owned and managed sites include: Dyer, Cottonwood Ranch Off Channel Sand and Water (OCSW), Cottonwood Ranch Complex Constructed Islands, Broadfoot Newark West, & Leaman OCSW

Non-Program owned and managed sites include: Lexington, Paulsen's Lexington Sandpit, Blue Hole, Johnson, Broadfoot South, Wild Rose Ranch East Sandpit, Trust Island, & Hooker Brothers Southeast Sandpit