Platte River Recovery Implementation Program

2015 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

PLATTE RIVER
RECOVERY IMPLEMENTATION PROGRAM

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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 2015. 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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This section presents data collected annually and includes the number of least tern and piping plover adults, breeding pairs, nests, chicks, and fledglings observed along the central Platte River during 2015. These data are collected and summarized in a form to allow comparisons across the entire range of each species and includes annual survey results.

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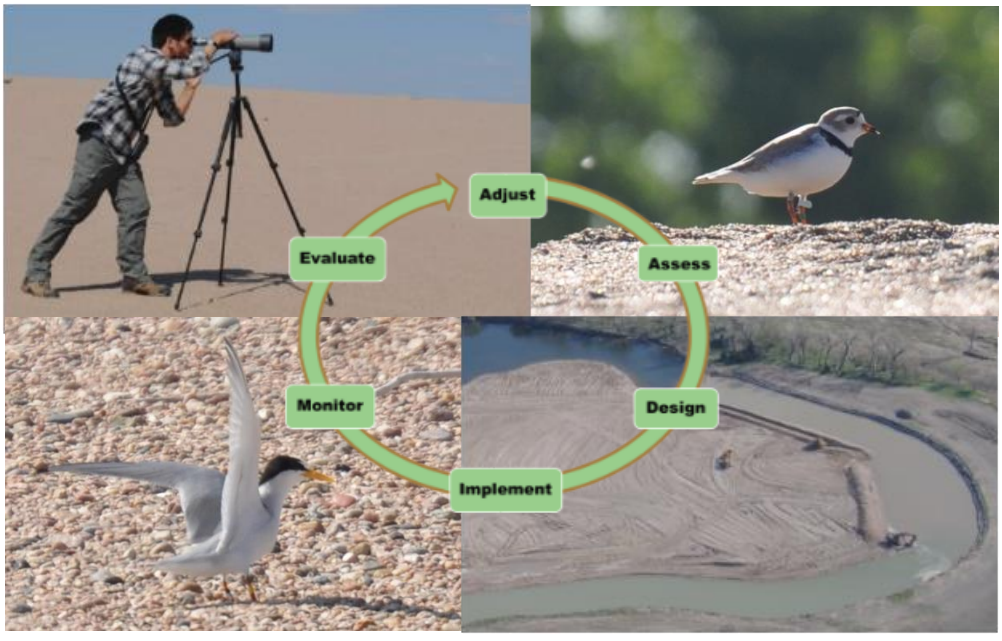


INTRODUCTION

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 seven consecutive years on the central Platte River (2009–2015). We plan to continue banding efforts for one more year with two additional years of band resighting. We anticipate a final report documenting results of those efforts will be available on the Program's online Public Library in 2019. Monitoring and research during 2015 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 (2008−2014) and are available in the Program's online Public Library. Least tern and piping plover activity and reproductive success during 2015 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 1) 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-channel sites. River or on-channel habitat included midstream sandbars used for nesting and open river channel used for foraging. Off-channel 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 or river islands 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.

2015 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.

Crew members using a canoe to access flooded sites

April to early-May daily flows were normal during 2015. Flows from mid-May to mid-July were considerably higher than normal (Figure 2). The peak flow of the 2015 season at the Overton, Kearney, and Grand Island gages was just over 16,000 cubic feet per second (cfs). This peak flow corresponds to just under a 20 year event at Overton and a 15 year event at Kearney and Grand Island. As a result, several nesting islands that were mechanically created by the Program were moated by water due to high flows during much of the 2015 season. A total of approximately 47 acres of least tern and piping plover nesting habitat was made suitable by these high flows in 2015. While the high islands were ideal for nesting this year, overall success was not observed as the high flows actually caused loss on several of these islands and much of the constructed habitat was lost due to lateral erosion.

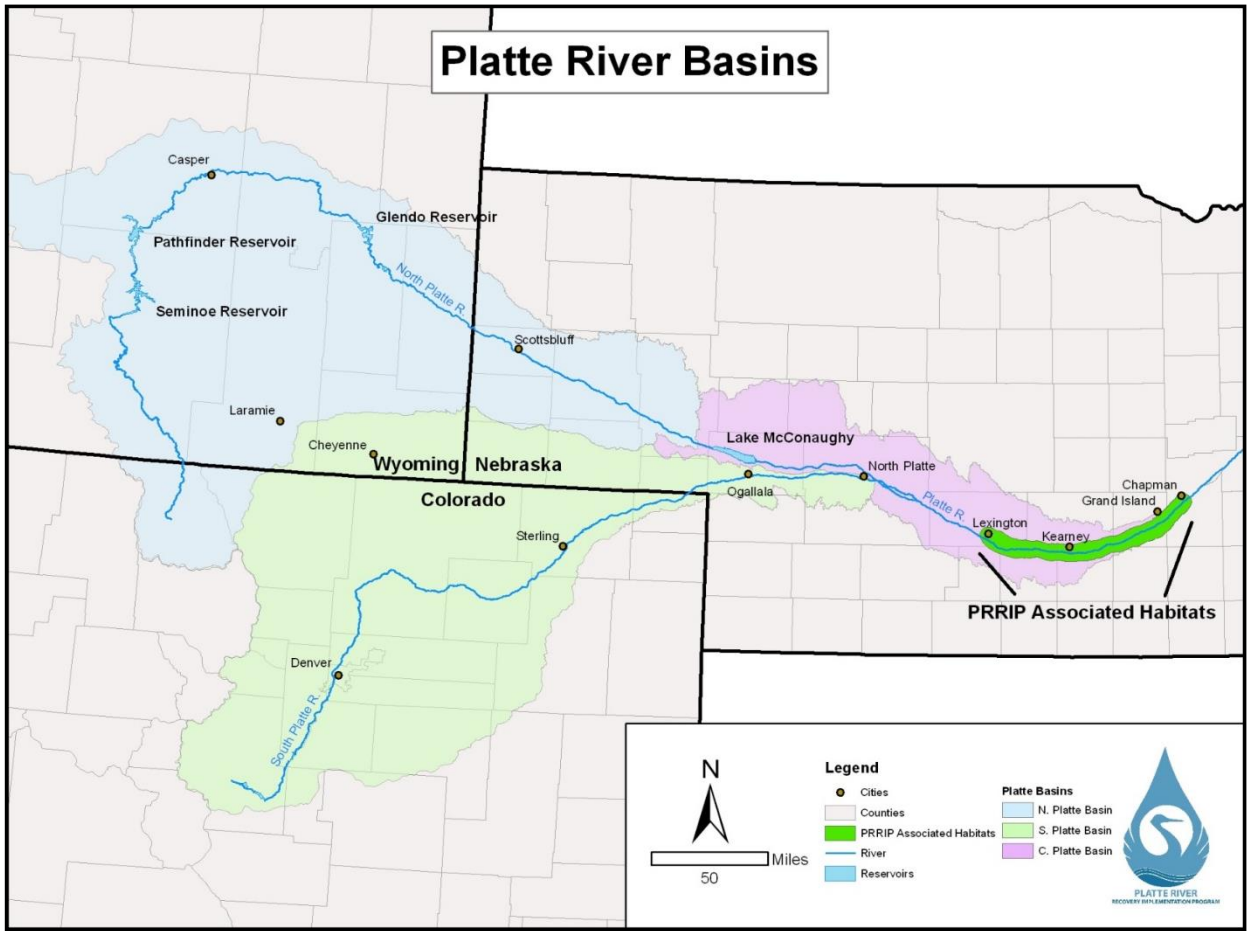


Figure 1. Platte River Basins extending from Colorado and Wyoming through Nebraska. The study area for our least tern and piping plover monitoring and research efforts was the PRRIP Associated Habitats region of the Platte River located between Lexington and Chapman, Nebraska

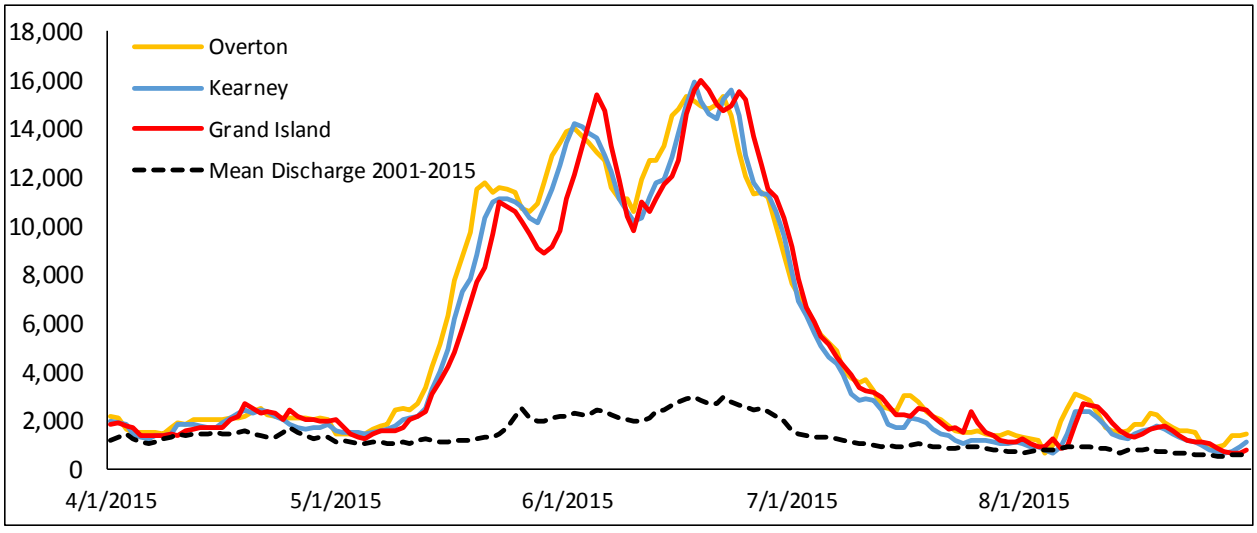


Figure 2. Mean daily discharge (ft^3/second; cfs) from Overton (USGS gage 06768000), Kearney (USGS gage 06770200), and Grand Island, Nebraska (USGS gage 06770500) for 2015. Average across 2001–2015 from Kearney (USGS gage 06770200). See Figure 3 for the location of gage stations within our study area. Data available at: waterdata.usgs.gov/ne/nwis/current/?type=flowandgroup_key=NONEandsearch_site_no_station_nm=platte%20river

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-channel sites during fall 2014 and spring 2015. 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, mowing, and nest furniture distribution); chemical application to kill or prevent emergence of vegetation (spring or fall herbicide application); and predator control (fencing and trapping). In addition, prior to nesting season occurring, several concrete blocks were added to five sites, spray-painted different colors, and GPS coordinates were obtained at each of their locations in order to provide the outside observer with spatial points of reference while observing nesting activity during the 2015 season.

SUMMARY OF HABITAT AVAILABILITY AND SPECIES RESPONSE, 2007–2015

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 Associated Habitat Reach (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. All of this habitat remained available at the start of the 2015 nesting season. However, much of it was lost due to erosion during the 2015 high flow event occurring from mid-May through mid-July. On-channel habitat construction by other conservation organizations has been very limited since 2007.

Table 1. Constructed on- and off-channel habitat in the Associated Habitat Reach by year, 2007–2015.

	On-Channel Habitat (ac)			Off-Channel Habitat (ac)		
Year	**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
2015	47	0	47	90	48	138
Mean	**13.4**	**7.8**	**21.2**	**45.1**	**48.0**	**93.1**

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 138 acres during the period of 2009−2015 as the Program constructed and/or restored 90 acres of habitat. The Program may possibly acquire one or more additional off-channel sites prior to the end of the First Increment. One existing off-channel site (Follmer Alda) was modified to create a portion of suitable habitat and was monitored during the 2015 nesting season. Mining at this site as well as the Newark East site is still under way and more habitat will become available during the 2016 nesting season. The addition of 10 acres at the Follmer Alda site increased the total off-channel sand nesting habitat area to 138 acres for 2015.

SANDPIT SITES:

Eleven of the 15 off-channel sites monitored during 2015 were actively managed to increase least tern and piping plover reproduction. Two Program-owned off-channel sites were being mined during the 2015 nesting season. High river flows caused inundation of the predator fences, rendering them inoperative from approximately early-June through early-July at all sites where predator fences were maintained. 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 2015, the woven-wire predator fence with offset electric wires along the west side of the nesting areas was maintained, and predator trapping occurred during 2015. No sand and gravel mining occurred during 2015.
- ^{PM} ***Dyer Sandpit*** – A contact herbicide was applied to kill existing vegetation primarily along the waterline during fall 2014. A pre-emergent herbicide was applied during spring 2015, permanent 4-foot tall woven wire predator fences with offset electric wires across the south ends of each peninsula were electrified, predator trapping occurred, and reference-point block distribution occurred during 2015. No sand and gravel mining occurred during 2015.
- ^{PM} ***Cottonwood Ranch Off-channel Sand and Water (OCSW)*** – A contact herbicide was applied to kill existing vegetation primarily along the waterline during fall 2014, a pre-emergent herbicide was applied, and reference-point block distribution occurred during spring 2015. Predator trapping occurred during 2015 until high flow events washed out the access road to this site, making predator trapping unmanageable. A permanent 4-foot tall woven wire predator fence with offset electric wires was maintained in 2015. 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 2015, 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 2015. It is noteworthy to address that a breach in the dike to the south of the sandpit occurred during the high flow event and subsequent erosion resulted throughout the season along the south bank of this off-channel habitat.
- ^{M} ***Johnson Sandpit*** – A pre-emergent herbicide was applied during spring 2015, 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 2015. No sand and gravel mining occurred during 2015.

[PM] ***Broadfoot South Sandpit*** – A contact herbicide was applied to kill existing vegetation primarily along the waterline during fall 2014 and a pre-emergent herbicide was applied to the nesting area during spring 2015. A temporary 4-foot tall electrified predator fence was installed across the east end of the main peninsula, 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, predator trapping, and reference-point block distribution occurred during 2015. Sand and gravel mining occurred northwest of the main peninsula during 2015.

[PM] ***Newark West Sandpit*** – A contact herbicide was applied to kill existing vegetation primarily along the waterline during fall 2014. A pre-emergent herbicide was applied during spring 2015, permanent 4-foot tall woven wire predator fences with offset electric wires across the ends of each peninsula were electrified, predator trapping, and reference-point block distribution occurred during 2015. No sand and gravel mining occurred at the west sandpit.

[PM] ***Newark East Sandpit*** – Further development continued on the nesting area 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 and predator trapping occurred during 2015. Sand and gravel mining occurred east of the main peninsula during 2015.

[PM] ***Leaman East OCSW*** –A contact herbicide was applied to kill existing vegetation along the waterline during fall 2014. A pre-emergent herbicide was applied to the nesting area during spring 2015 and predator trapping occurred during 2015. A permanent, 4-foot tall woven wire predator fence with offset electric wires was maintained in 2015. Reference-point blocks and supplementary nest furniture were also added to this site prior to the 2015 nesting season. No sand and gravel mining occurred; this site was constructed with dozers and scrapers.

Follmer-Alda sand pit. 2015 marked the first year habitat was available at the Follmer-Alda sand pit.

[PM] ***Follmer Sandpit*** – Further development on the Program-owned sand and gravel mining site was continued and 10 acres of suitable habitat was available during the 2015 season. A pre-emergent herbicide was applied to the nesting area during spring 2015. A temporary 4-foot tall electrified predator fence was installed across the west end of the main peninsula and predator trapping occurred during 2015. Sand and gravel mining occurred east of the main peninsula during 2015.

[M] ***Wild Rose Ranch East Sandpit*** – A contact herbicide was applied to kill existing vegetation on the nesting areas during fall 2014, nesting areas were drug with a harrow, and a pre-emergent herbicide was applied to the nesting areas during spring 2015. No sand and gravel mining occurred; this site was constructed with dozers and scrapers.

DeWeese-Alda Sandpit – Not managed. Sand and gravel mining occurred during 2015.

Hooker Brothers GI East – Not managed. Sand and gravel mining occurred during 2015.

Hooker Brothers South East – Not managed. Sand and gravel mining occurred during 2015.

Lilley-Wood River – Not managed. Sand and gravel mining occurred during 2015.

RIVERINE SITES:

Five of the six on-channel riverine sites monitored during 2015 were actively managed to increase least tern and piping plover reproduction. Construction was also completed on four new islands at the Program-owned on-channel Shoemaker Island Complex during spring of 2015. Program owned and/or managed sites are denoted with a superscript "P" (^{P}) and Managed sites are identified by a superscript "M" (^{M}).

Aerial image of nesting islands at Shoemaker Island Complex. 2015 was the first year nesting occurred at this island complex.

^{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). A contact herbicide was applied to kill existing vegetation along the waterline during fall 2014. Pre-emergent herbicide was applied during spring 2015 and trapping occurred during 2015.

^{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 2014. Pre-emergent herbicide was applied during spring 2015 and trapping occurred during 2015 until high flow events washed out the access road to this site, making predator trapping unmanageable.

^{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 2014. 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. A contact herbicide was applied during the fall of 2014, pre-emergent herbicide was applied during spring 2015 and trapping occurred during 2015.

Aerial image of islands at Elm Creek Complex East

^{P} ***Speidell-Hostetler Island*** − Encompasses one nesting island approximately 12 acres in size. This island did not provide adequate habitat for least tern or piping plover nesting for 2015 and no management activities occurred during this season.

^{PM} ***Shoemaker Island Complex*** – Prior to the 2015 nesting season, the Program disked 1 island that was approximately 28 acres in size. A contact herbicide was applied to the pre-existing islands. Four new islands were constructed that were approximately 1.8, 1.2, 4.9, and 7.2 acres in size. Pre-emergent herbicide was applied to the islands and trapping occurred during 2015.

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 2015. We derived least tern and piping plover breeding pair estimates (BPE; Baasch et al. 2015) 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 2010−2015); 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 2010−2015); 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 2015 nesting seasons. All counts of adults, breeding pairs, nests, chicks, and fledglings reported during semi-monthly surveys represent minimums present.

Semi-monthly River Surveys – Program staff, USGS personnel, and USFWS personnel conducted semi-monthly river surveys between the J2 Return and the Chapman Bridge on 29-30 April; 13-14 May; 1-2 June; 15 June; 29-30 June; 13-14, and 16 July; and 30-31 July during 2015. 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 and/or kayaks were used to perform some of the river surveys (Table 2). Program staff and USGS personnel conducted semi-monthly river surveys between the J2 Return and the Alda Bridge for all surveys.

US Fish and Wildlife conducted river surveys from the Alda Bridge to the Chapman Bridge for all surveys except the June 1st survey which was conducted by Program staff and USGS personnel.

Table 2. Boat type used and conducting personnel for semi-monthly river surveys conducted on the Central Platte River in 2015.

Survey Period	PRRIP Boat Type/ River Stretch	USFWS Boat Type/River Stretch
1-May	Airboat: J2-Alda Bridge	Airboat: Alda Bridge-Chapman Bridge
15-May	Airboat: J2-Overton & Kearney-Alda; Canoe: Overton-Kearney	Airboat: Alda Bridge-Chapman Bridge
1-Jun	Canoe: J2-Chapman Bridge	NA
15-Jun	Canoe: J2-Alda Bridge	Kayak: Alda Bridge-Chapman Bridge
1-Jul	Canoe: J2-Alda Bridge	Kayak: Alda Bridge-Chapman Bridge
15-Jul	Kayak: Dyer-Minden; Airboat: Minden-Alda	Airboat: Alda Bridge-Chapman Bridge
1-Aug	Airboat: J2-Alda Bridge	Airboat: Alda Bridge-Chapman Bridge

Semi-monthly Sandpit Surveys – We conducted semi-monthly surveys from outside the nesting colony at 15 sandpit sites as well as from within the nesting area at 8 of these sites to count individual birds and document least tern and piping plover nests, chicks, and fledglings during 2015. Semi-monthly sandpit surveys were conducted outside the nesting area on 30 April and 1, 4-5 and 8 May; 11 and 14-15 May; 29 and 31 May and 1-2 June; 11 and 15-16 June; 29-30 June and 1-2 July; 15-17 July; and 30-31 July and 3-4 August during 2015. Semi-monthly sandpit surveys were conducted inside the nesting area on 28-30 April and 1 May; 11 and 13-15 May; 28 May and 1-2 June; 17-18 June; 29-30 June and 1-2 July; 13-15 July; and 27-29 July during 2015. Program staff, technicians and personnel from Program staff, USGS, CPNRD, and NPPD conducted semi-monthly sandpit surveys during 2015.

Semi-monthly Survey Totals – To obtain an estimate of numbers of least tern and piping plover adults, nests, chicks, and fledglings within the Program Associated Habitat Area throughout the 2015 nesting season, we summed numbers detected during semi-monthly river and sandpit surveys nearest 1 and 15 May, June, and July and 1 August. 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 (Baasch et al. 2015).

RESULTS

Semi-monthly River Surveys – Each of the 7 semi-monthly river surveys between Lexington and Chapman, Nebraska during 2015 required 1–3 days to conduct and spanned a maximum of 4 days during 1 survey period in 2015.

We observed the most least tern adults (52) on the river during the 1-June river survey and the most least tern breeding pairs (6) during the 15-June river survey. The most piping plover adults (13) were observed on the river during the 1-May and 15-June river surveys and the most piping plover breeding pairs (4) were observed during the 1-June and 15-June river surveys in 2015 (Table 3). We observed 1 piping plover breeding pair and nest within the Cottonwood Ranch Complex on one of the islands that was constructed in 2012. Of the four piping plover chicks that hatched from this nest, 1 was observed fledged during the 15-July river survey. Significant alterations and construction to the Shoemaker Island complex occurred prior to the 2015 breeding season. As a result, 4 piping plover breeding pairs and 6 piping plover nests as well as 8 least tern breeding pairs and 14 least tern nests were observed in this area. However, due to high flows that peaked over 16,000 cfs, 4 nests were flooded prior to hatch (3 piping plover, 1 least tern), and while three least tern nests did hatch, the chicks failed to reach fledged age. We believe predation events along with flooding were likely responsible for the failed nest fates at the Shoemaker Island Complex. 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 2015 were either known (banded) or were presumed (near areas with sandpits that fledged chicks) to be associated with nearby sandpit nesting sites.

Piping plover nest at a sandpit

Table 3. 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 2015.

	Interior least tern					Piping plover				
Survey	**Adults**	**Pair***	**Nests**	**Chicks**	**Fledglings**	**Adults**	**Pair***	**Nests**	**Chicks**	**Fledglings**
1-May	0	0	0	0	0	13	0	0	0	0
15-May	6	0	0	0	0	7	1	0	0	0
1-Jun	52	3	3	0	0	12	4	4	0	0
15-Jun	46	6	6	0	0	13	4	1	3	0
1-Jul	42	5	5	1	0	8	3	2	3	0
15-Jul	28	4	2	0	5	4	1	1	0	3
1-Aug	39	0	0	0	34	0	0	0	0	5

** 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 4–7 days to conduct and spanned a maximum of 11 days during 1 survey period in 2015. 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 1 least tern breeding pair and nest at the unmanaged DeWeese-Alda sandpit and 4 least tern breeding pairs and 4 least tern nests at the unmanaged Hooker Brothers South East sandpit. We observed the most adult least terns during the 1-July (182) sandpit survey and the most least tern breeding pairs (129) during the 1-July sandpit survey, in which there were 88 active nests and 91 chicks present at all sandpit sites combined (Table 4). The most active least tern nests (93) occurred during the 15-June sandpit survey. We observed the most piping plover adults (62) during the 1-June sandpit survey and the most piping plover breeding pair (30) during the 15-June sandpit survey, when there were 14 active nests and 30 chicks present across all sandpit sites. The most piping plover active nests (24) occurred during the 1-June sandpit survey.

Table 4. 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 2015.

		Interior least tern					Piping plover				
Survey	**Sites**	**Adults**	**Pair***	**Nests**	**Chicks**	**Fledglings**	**Adults**	**Pair***	**Nests**	**Chicks**	**Fledglings**
1-May	15	0	0	0	0	0	32	6	5	0	0
15-May	15	19	0	0	0	0	50	24	22	0	0
1-Jun	15	80	37	35	0	0	62	26	24	18	0
15-Jun	15	170	90	93	2	0	51	30	14	30	0
1-Jul	15	182	129	88	91	0	58	27	15	25	14
15-Jul	15	158	125	38	89	54	36	17	12	25	9
1-Aug	15	97	93	5	24	62	13	10	1	15	6

** 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 counts 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 2015 nesting season. Inside and outside sandpit surveys generally overlapped or occurred within 1–8 days of river surveys.

In 2015 we observed 99 active least tern nests during the 15-June survey when 216 adults and 96 breeding pairs were observed; however, we observed the most breeding pairs (134) during the 1-July survey (Table 5) when the maximum adults (224) and maximum chicks (92) were observed. We observed 96 least tern fledglings during the 1-August survey.

In 2015, we observed 28 active piping plover nests during the 1-June survey when 74 adults and 30 breeding pairs were observed; however, we observed the most breeding pairs (34) during the 15-

June survey when 64 adults and the maximum chicks (33) were observed (Table 5). We also observed 14 fledglings during the 1-July survey.

Table 5. 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 2015.

	Interior least tern					Piping plover				
Survey	**Adults**	**Pair***	**Nests**	**Chicks**	**Fledglings**	**Adults**	**Pair***	**Nests**	**Chicks**	**Fledglings**
1-May	0	0	0	0	0	45	6	5	0	0
15-May	25	0	0	0	0	57	25	22	0	0
1-Jun	132	40	38	0	0	74	30	28	18	0
15-Jun	216	96	99	2	0	64	34	15	33	0
1-Jul	224	134	93	92	0	66	30	17	28	14
15-Jul	186	129	40	89	59	40	18	13	25	12
1-Aug	136	93	5	24	96	13	10	1	15	11

** 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.*

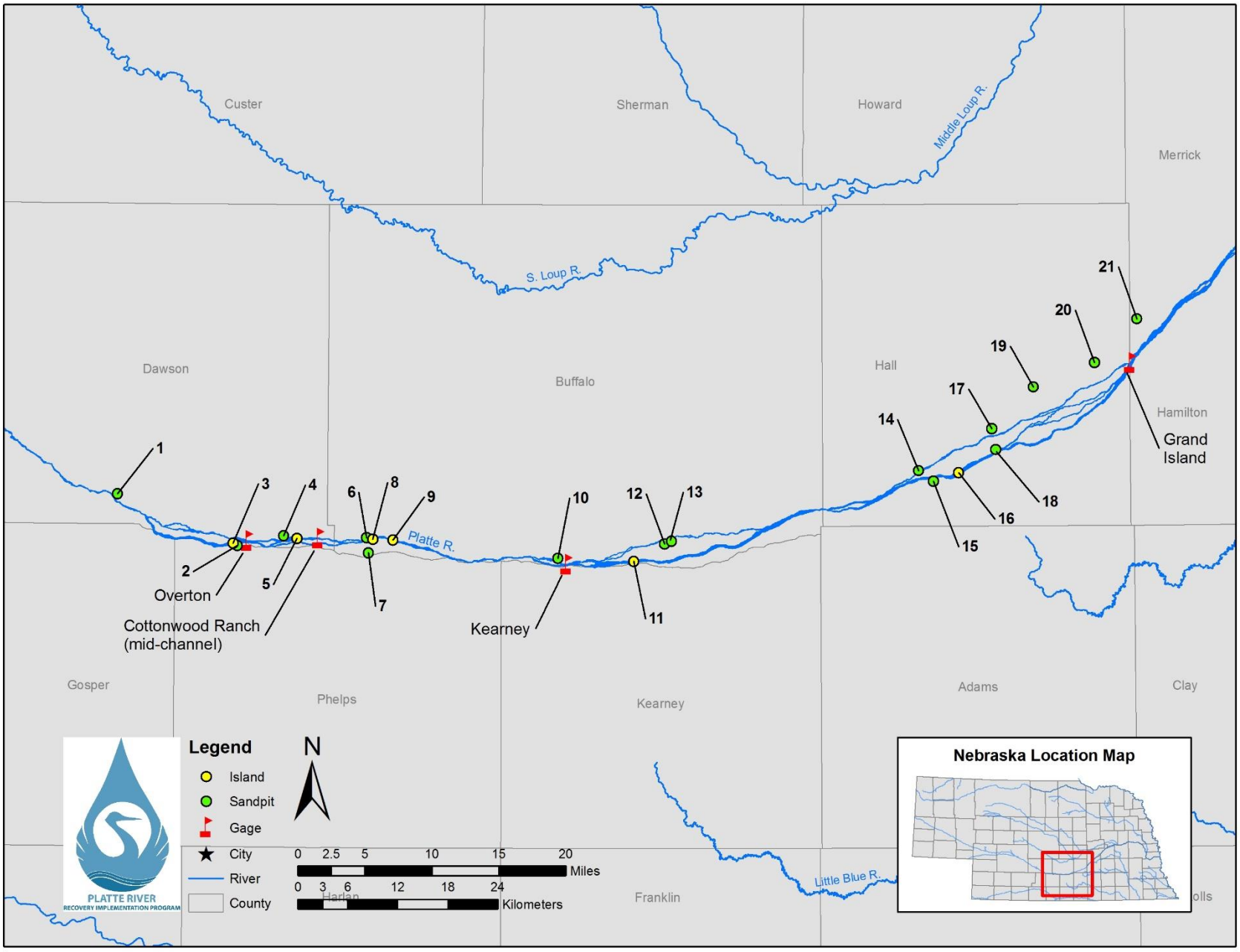


Figure 3. Study area including sandpits and constructed or managed river island sites monitored for least tern and piping plover nesting and foraging activities during 2015. Names of sites are located in Table 8.

MID-MONTH AND SEMI-MONTHLY SURVEYS

River Surveys, 2001–2015: 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 2015 were generally similar to, or slightly higher than numbers observed prior to Program implementation (2001–2006). We observed the most least tern nests in 7 years and the most piping plover nests in 5 years on the river in 2015. 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 2001–2015 timeframe. It is important to note, however, that several surveys were not completed because of low or no flow conditions in the river during previous years. 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.

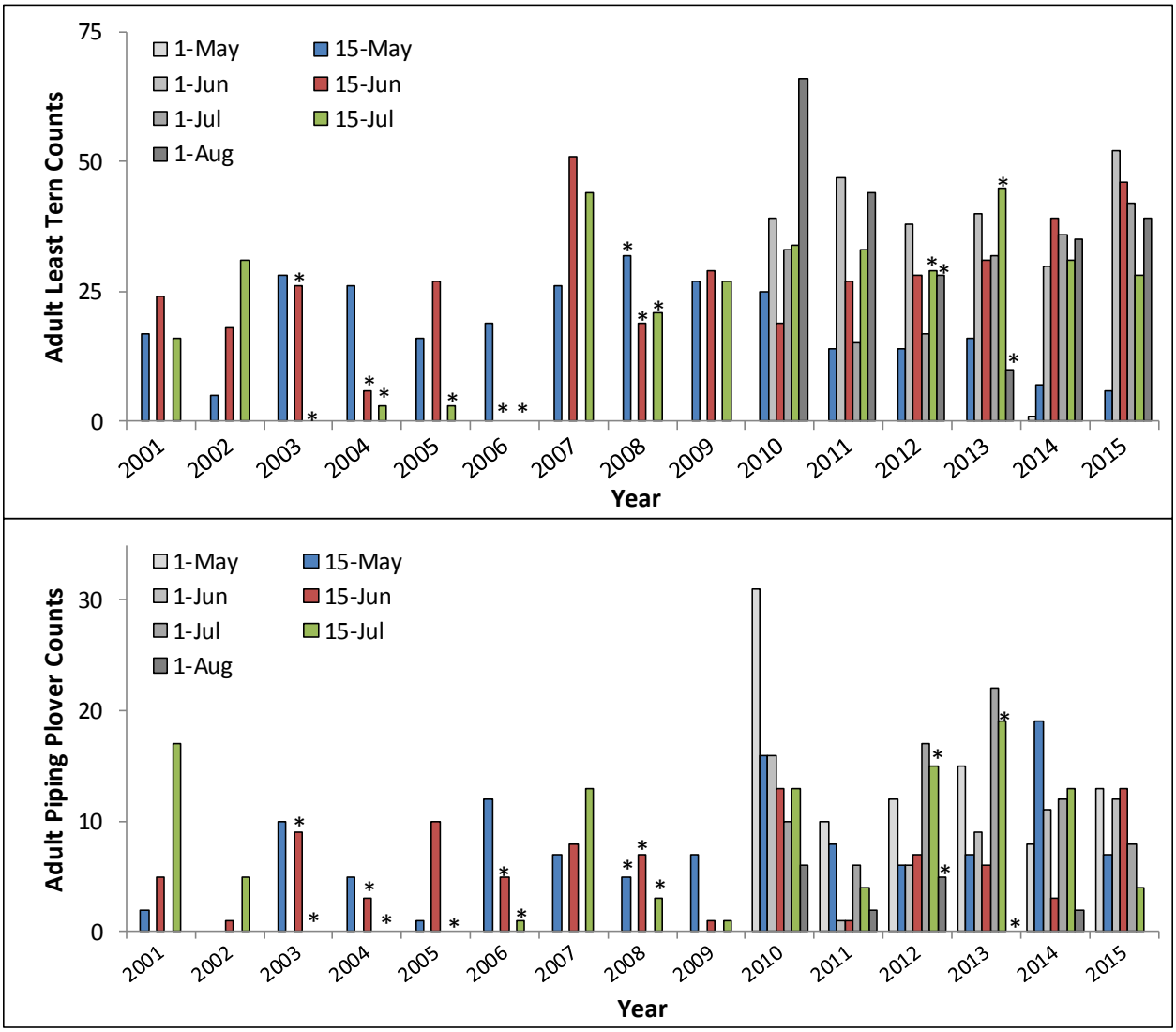


Figure 4. Numbers of least tern (top) and piping plover (bottom) adults observed during mid-month and semi-monthly surveys of the Platte River between Lexington and Chapman, Nebraska, 2001-2015. * indicates minimum numbers present as several river surveys were not completed due to a lack of flow in the channel.

Sandpit Surveys, 2001–2015: We observed similar to or more least tern and piping plover adults on sandpits within the Program Associated Habitat Area in 2015 than we had in the previous eight years of Program implementation (Figure 5). We observed the most adult least terns (170 and 182) during semi-monthly sandpit surveys that occurred during the 15-June and 1-July survey, respectively. We observed the most adult piping plovers (62) during the 1-June semi-monthly sandpit survey.

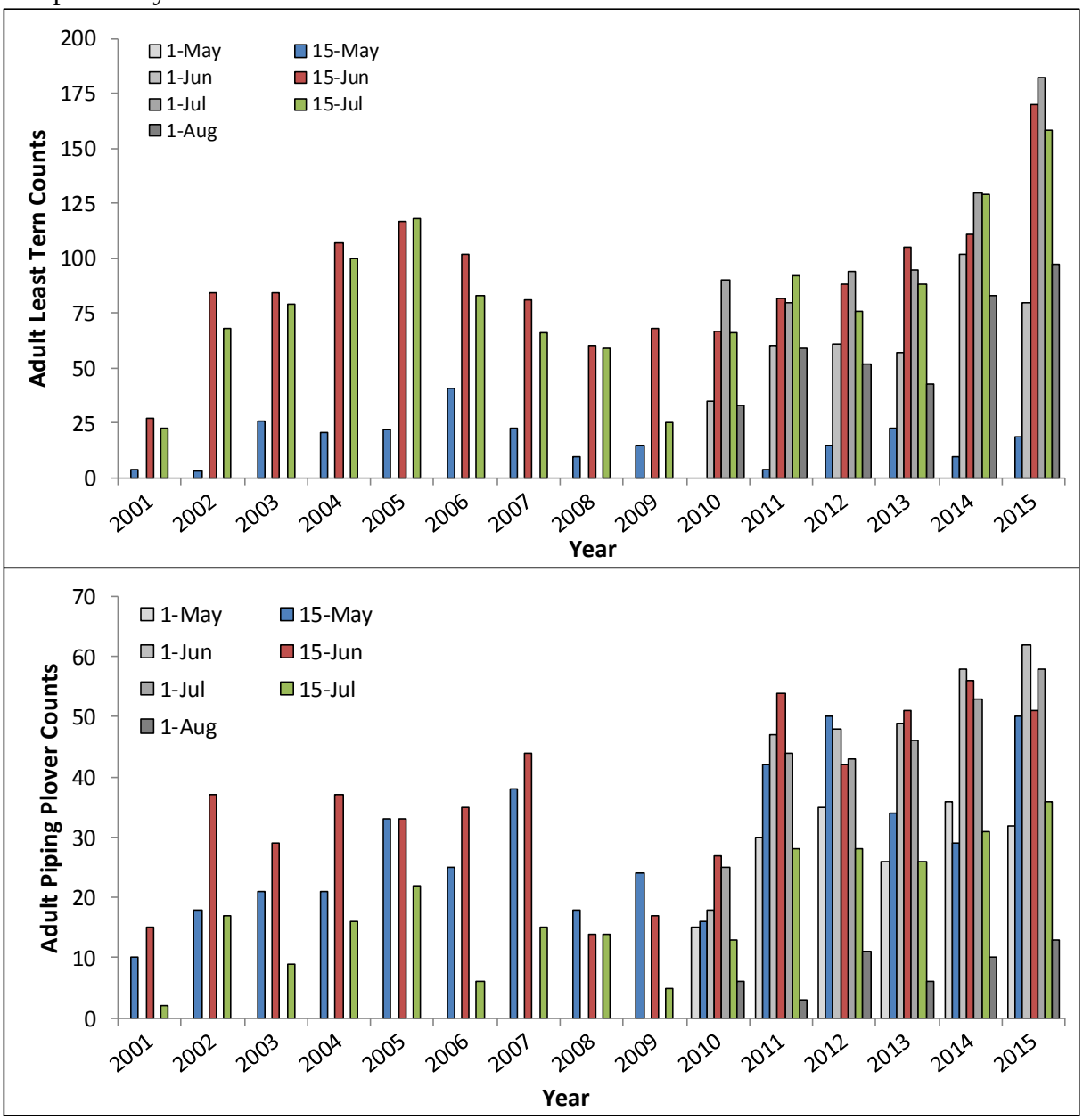


Figure 5. Numbers of least tern (top) and piping plover (bottom) adults observed during mid-month and semi-monthly surveys of sandpits along the Platte River between Lexington and Chapman, Nebraska, 2001–2015.

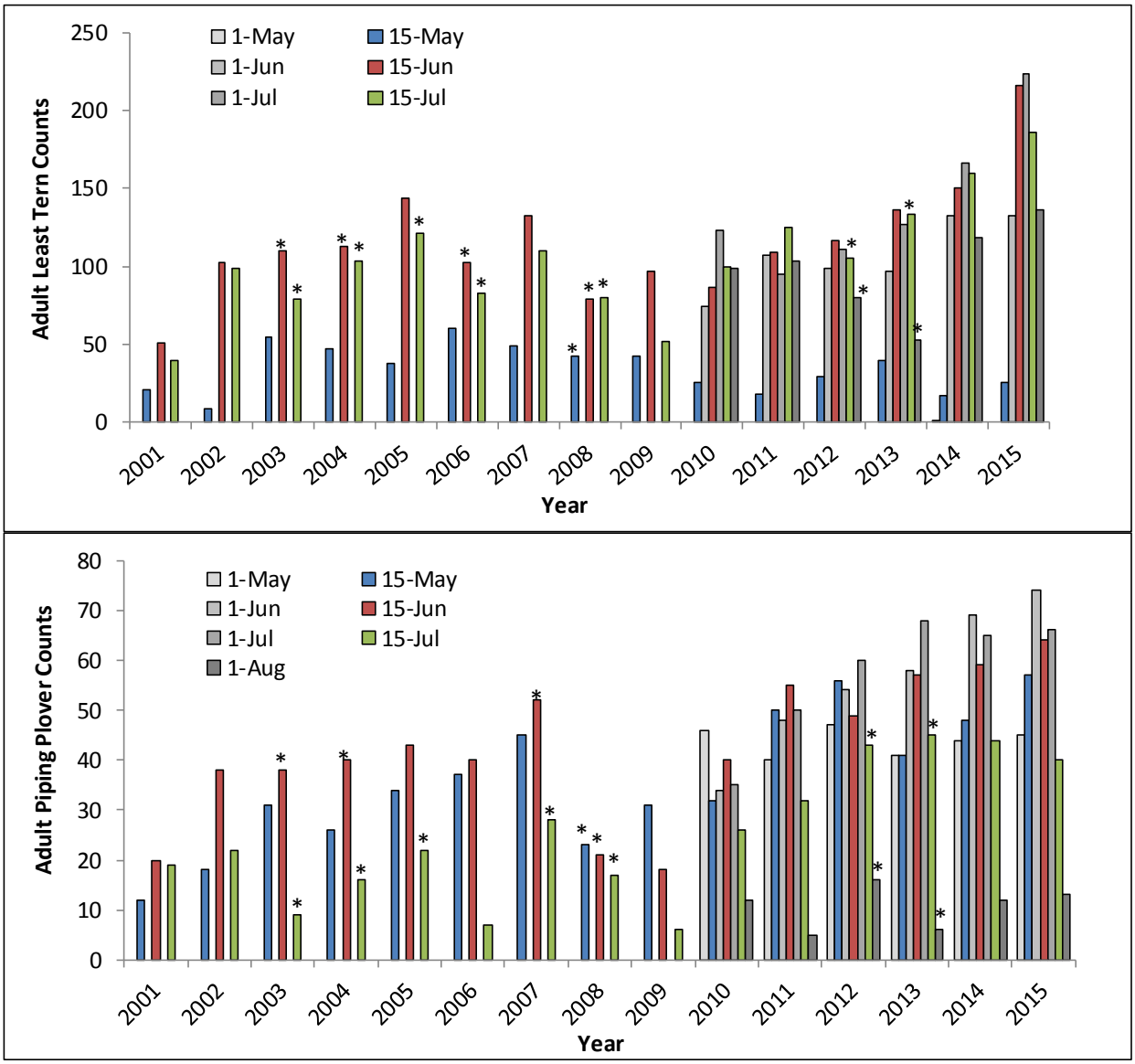


Figure 6. Numbers of adult least tern (top) and piping plover (bottom) adults observed during mid-month and semi-monthly surveys of sandpits and the central Platte River channel between Chapman and Lexington, Nebraska, 2001–2015. Counts represent minimum numbers present as several river surveys were not completed due to a lack of flow in the channel (see Figure 4).

Sandpit-River Surveys, 2001–2015: During 2015, we observed the most least terns amongst the river and sandpits combined than we had since 2001. We observed similar or slightly higher numbers of piping plover adults within the Program Associated Habitat Area in 2015 than we did the previous years (Figure 6). We observed the most adult least terns (224) and piping plovers (74) during semi-monthly sandpit and river surveys that occurred during early-July and early-June, respectively. We observed an increase in nesting on the riverine habitat in 2015 (7 piping plover nests and 14 least tern nests); whereas in the past years the river was used most intensively for foraging by both species only. High water flows inundated 4 nests, but one of the piping plover nests was successful and fledged chicks. In 2015, 77% of adult least tern and 84% of adult piping plover observations occurred at sandpits sites during semi-monthly and mid-month surveys. A total of 174 (93%) least tern nests and 47 (87%) piping plover nests were located on off-channel sandpits.

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 2015 were higher than numbers observed prior to Program implementation (Figure 7). We observed the highest on-channel least tern counts since 2007 and the highest off-channel least tern and piping plover counts since 2001 (Figure 7). Program analyses indicate least tern and piping plover adult and breeding pair counts are positively correlated with habitat availability, however, analyses of future data will be used to confirm the relationship between breeding pair counts and habitat availability.

Adult Least Tern at a sandpit

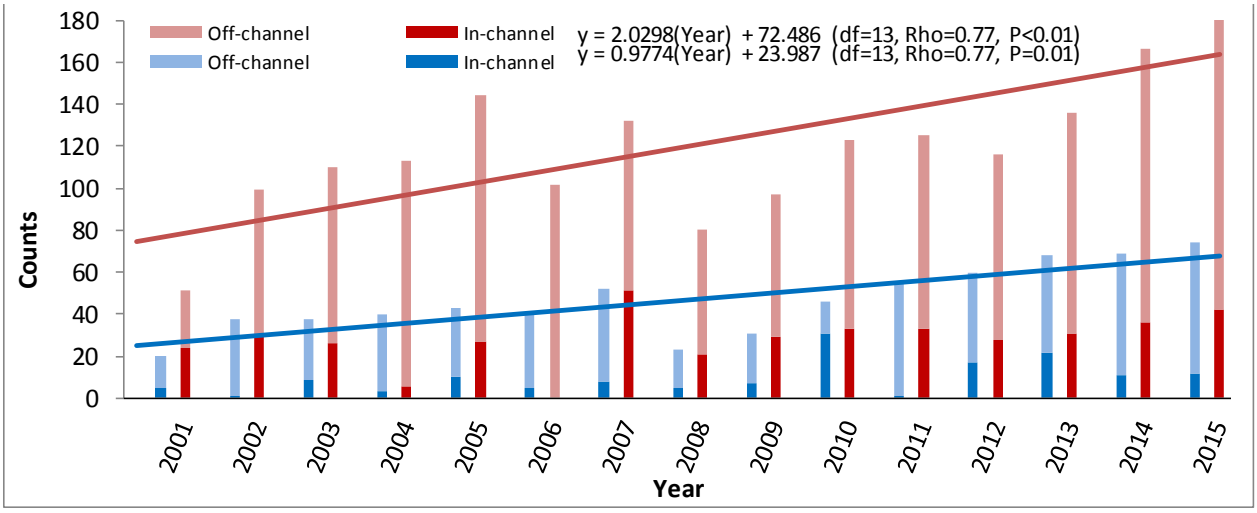
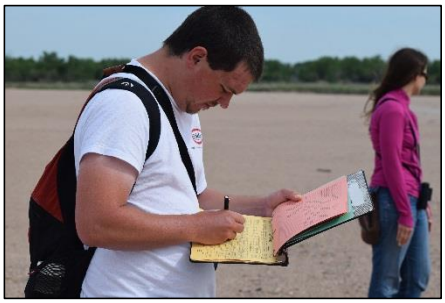


Figure 7. Trends (lines) in peak counts of least tern (red bars) and piping plover (blue bars) adults observed during mid-month and semi-monthly surveys of sandpits (light blue and light red bars) and the Platte River (dark blue and dark red bars) between Lexington and Chapman, Nebraska, 2001-2015.

NEST AND CHICK MONITORING

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 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 2015. 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.



Crew member recording data

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-yd^2 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-yd^2 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 31 July–1 August, 2015 when flows at Overton, Kearney, and Grand Island ranged from 611 cfs to 1,790 cfs. Summaries of the habitat metrics for Off-Channel and On-Channel least tern and piping plover nests from 2007–2015 can be found in Tables 14-19 under the Research portion of this paper. This data can also be found in the habitat selection study that is currently underway and will be finalized in 2016.

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. 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 member inspecting eggs

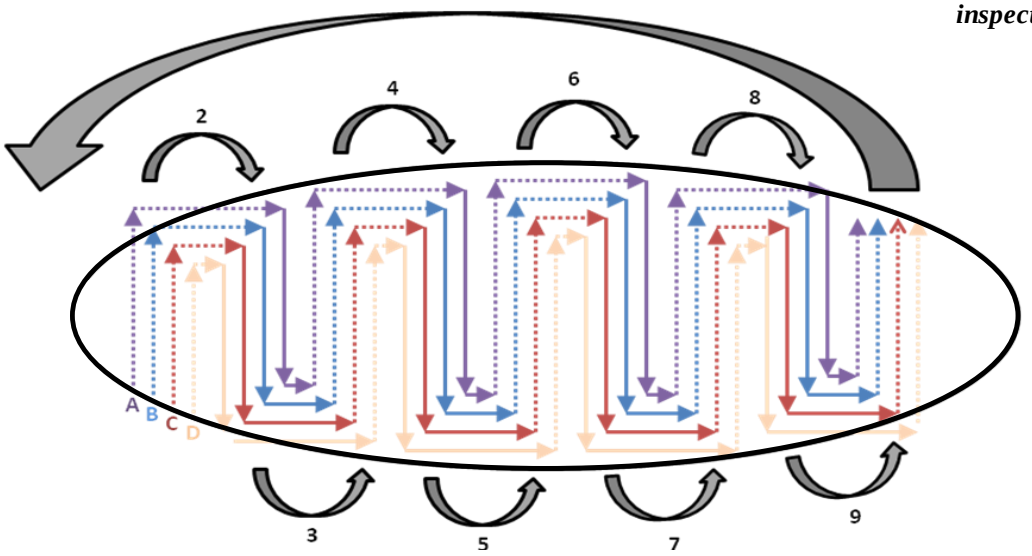


Figure 8. Systematic grid-search pattern used to locate nests and broods while conducting inside surveys of sandpit sites.

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 2015 by Program staff, USGS field crews, and personnel from CPNRD and NPPD to determine survival 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 had one incident of research-related mortality during 2015. One least tern egg was accidentally cracked during an adult banding trap set up. This incident was reported to USFWS and led to a change in egg containers used for holding the eggs during trapping events. Weather was attributed as the cause of 3 piping plover nest (16%) and 10 least tern nest (15%) failures during 2015. Predation was documented as the cause of loss for 5 piping plover nests (26%) and was suspected in the loss of several additional least tern and piping plover nests and chicks during 2015. Twenty-three least tern (34%) and 7 piping plover (37%) nest failures were attributed to unknown causes and the fate of 2 piping plover nests 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. Twenty-nine least tern (43%) and 1 piping plover nest (5%) were abandoned. High river flows lead to the

Fledged least tern wing

destruction by flooding of 5 least tern (7%) and 3 piping plover (16%) nests during 2015. We found 3 dead piping plovers (2 chicks, 1 adult) and 31 dead least terns (28 chicks, 3 adults) in 2015. Many of these deaths could have been attributed to weather and/or predation related events, but most of the evidence was either inconclusive or no evidence was present.

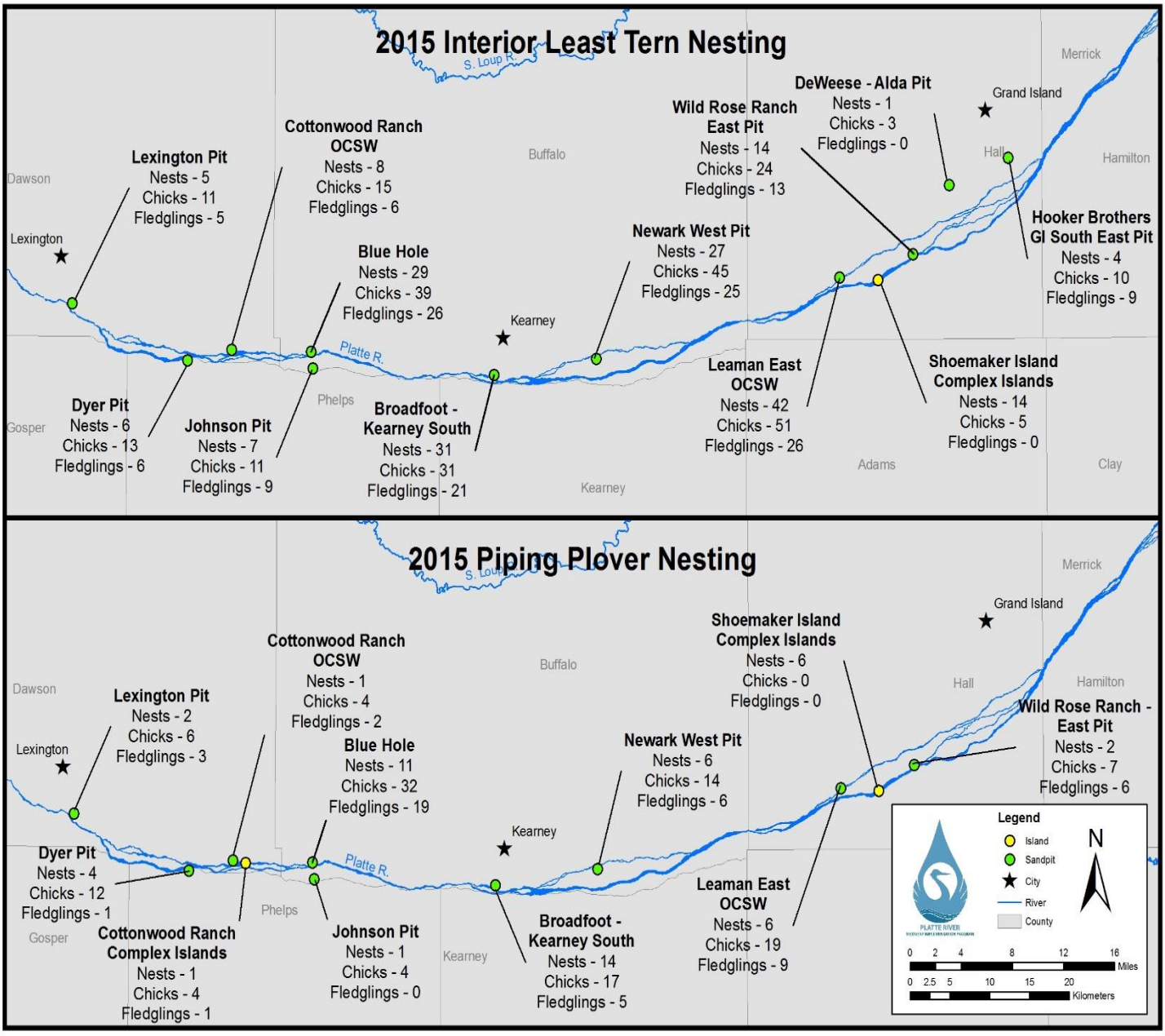


Figure 9. Distribution and numbers of least tern and piping plover nests, chicks, and fledglings observed within Program associated habitats during 2015 surveys of sandpits and managed, constructed, or naturally occurring river islands. Least tern nests were observed and monitored at 11 of the 15 sandpits and 1 of the riverine sites monitored during 2015. Piping plover nests were observed and monitored at 9 of the 15 sandpits and 2 of the riverine sites monitored during 2015.

Least Terns: Least tern nests were observed and monitored at 11 of the 15 sandpits and 1 of the 6 riverine sites monitored during 2015 (Table 8, Figure 9). All counts of adults, nests, chicks, and fledglings reported in Table 8 represent maximum numbers observed from inside or outside the nesting colony during all surveys. The first observation of a least tern nest occurred on 25 May, 2015 and the last nest was first observed on 3 August, 2015. The first observation of a least tern chick occurred on 16 June, 2015 and the last nest known to hatch did so on 12 August, 2015. At least 1 egg from 62% (116/188) of least tern nests hatched which resulted in 258 chicks and an overall nest-success rate of 1.37 chicks/nest or 1.83 chicks/breeding pair (258 chicks/141 breeding pairs) during 2015 (Table 6). Average daily survival rate of least tern nests during 2015 was 0.9780 (range = 0.9264–1.0000; Appendices 1 & 9) with at least one significant difference observed between sites [$\chi^2(7, N = 188) = 36.986$; $p < 0.0001$]; average survival rate over the 21-day incubation period was 0.6262 (range = 0.2007–1.0000). We observed the first least tern fledgling on 8 July, 2015 and the last known least tern chick to fledge did so on 28 August, 2015. Apparent fledge success at all sites monitored was 0.78 fledglings/nest (146 fledglings/188 nests) or 1.04 fledglings/breeding pair (146 fledglings/141 breeding pairs) with all but 14 nests occurring on sandpit sites during 2015. Average daily survival rates for least tern broods across all sites during 2015 was 0.9815 (range = 0.0000–1.0000; Appendices 2 & 10) with at least one significant difference observed between sites [$\chi^2(8, N = 116) = 27.815$; $p = 0.0050$]; average brooding-period survival rate across all sites was 0.6761 (range = 0.0000–1.0000).

We tested for an effect of ownership (i.e., Program or other) on nest and brood survival rates during 2015. Least tern incubation period survival was slightly lower at Program owned and managed sites than at other nesting areas, 0.6374, 0.7047 respectively, but the difference was not significant at $\alpha=0.05$ level (Appendices 5 & 13). Brooding period survival rates were generally slightly lower at Program owned and managed nesting areas than other nesting areas for least terns, 0.6882, 0.7128 respectively, but the difference was not significant at $\alpha=0.05$ level (Appendices 6 & 14).

Banded least tern adult

Table 6. Summary of least tern reproductive success at sandpit and river-island sites on the central Platte River in Nebraska, 2007–2015. Site-specific details on numbers of adults, nest, chicks, and fledglings observed during 2015 are provided in Table 8. Habitat- and site-specific details of daily, incubation- and brooding-period survival rates for 2015 are provided in Appendices 1-2 and 5-6 (Program Mark estimates) and Appendices 9-10 and 13-14 (Mayfield estimates).

	Least Tern								
Reproductive Parameter	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Maximum Adults Observed	132	80	97	123	125	116	136	166	224
Breeding Pairs	39	37	42	53	60	64	58	98	141
Total Nests Observed	53	64	60	76	90	88	95	145	188
Successful Nests (≥1 egg hatched)	22	27	37	43	52	63	51	80	116
Apparent Nest Success	0.42	0.42	0.62	0.57	0.58	0.72	0.54	0.55	0.62
Daily Nest Survival Rate (All sites)	0.97	0.98	0.99	0.98	0.97	0.99	0.97	0.97	0.98
Incubation-period Survival Rate (All sites)	0.55	0.61	0.73	0.64	0.58	0.76	0.56	0.52	0.63
Chicks Observed (<15D)	50	54	71	105	124	144	118	180	258
Hatch Ratio (Chicks/Nest)	0.94	0.84	1.18	1.38	1.38	1.64	1.24	1.24	1.37
Hatch Ratio (Chicks/Breeding Pair)	1.28	1.46	1.69	1.98	2.07	2.25	2.03	1.84	1.83
Chicks (≥15D)	40	44	48	67	98	95	70	104	158
Fledglings (21D)	-----[A]	-----	----	64	89	84	64	91	146
Historic Fledge Ratio (15D Chicks/Nest)	0.75	0.69	0.80	0.88	1.09	1.08	0.74	0.72	0.84
Fledge ratio (21D Chicks/Nest)	-----	-----	----	0.84	0.99	0.95	0.67	0.63	0.78
Historic Fledge Ratio (15D Chicks/Breeding Pair)	1.03	1.19	1.14	1.26	1.63	1.48	1.21	1.06	1.12
Fledge Ratio (21D Chicks/Breeding Pair)	-----	-----	----	1.21	1.48	1.31	1.10	0.93	1.04
Daily Brood Survival Rate (All sites)	-----	0.98	0.98	0.98	0.99	0.99	0.97	0.98	0.98
Brooding-period Survival Rate (All sites) [B]	-----	0.75	0.79	0.72	0.89	0.81	0.59	0.69	0.68

[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 9 of 15 sandpits and two river sites monitored during 2015 (Table 8; Figure 9). The first observation of a piping plover nest was made on 29 April, 2015 and the last nest was first observed on 13 July, 2015. The first observation of a piping plover chick occurred on 26 May, 2015 and the last successful nest observed hatched on 6 August, 2015. At least one egg from 63% (34/54) of piping plover nests hatched, which resulted in 119 chicks and an overall nest-success rate of 2.20 chicks/nest or 3.05 chicks/breeding pair (119 chicks/39 breeding pairs) during 2015 (Table 7). Seven of these nests were located on river islands in 2015. Six of these seven nests were located within the Shoemaker island complex and all were lost due to flooding, abandonment, or unknown causes. One of the island nests was located within the Cottonwood Ranch Complex and hatched four chicks and fledged one. Piping plover daily nest survival rate across all sites during 2015 was 0.9840 (range = 0.9229–1.0000; Appendices 3 & 11) with at least one difference observed between sites [$\chi^2(5, N = 54) = 20.967$; $p = 0.0008$]; average incubation-period survival rate was 0.6375 (range = 0.1057–1.0000). We first observed a piping plover fledgling on 22 June, 2015 and the last known piping plover chick to fledge did so on 1 September, 2015. We observed an apparent nest-based fledging rate of 0.96 (52 fledglings/54 nests) and a pair-based fledging rate of 1.33 (52 fledglings/39 breeding pairs) at all sites monitored during 2015 (Table 7). Average daily survival rates for piping plover broods across all sites during 2015 was 0.9861 (range = 0.0000–1.0000; Appendices 4 & 12) with at least one significant difference observed between sites [$\chi^2(3, N = 34) = 25.436$; $p < 0.0001$]; average brooding-period survival rate across all sites was 0.6757 (range = 0.0000–1.0000).

Adult piping plover

We tested for an effect of ownership (i.e., Program or other) on nest and brood survival rates during 2015. Piping plover incubation period survival rates were generally lower at Program owned and managed nesting areas than other nesting areas, 0.6287, 0.8742 respectively, but the difference was not significant at the α=0.05 level (Appendices 7 & 15). Piping plover brooding period survival rates were also generally lower at Program owned and managed nesting areas that other nesting areas, 0.4859, 0.9203 respectively, with at least one significant difference observed [$\chi^2(1, N = 33) = 7.079$; $p = 0.0078$]; (Appendices 8 & 16).

Table 7. Summary of piping plover reproductive success at sandpit and river-island sites along the central Platte River in Nebraska, 2007–2015. Site-specific details on numbers of adults, nest, chicks, and fledglings observed during 2015 are provided in Table 8. Site-specific details of daily, incubation- and brooding-period survival rates for 2015 are provided in Appendices 3-4 and 11-12 (Program Mark estimates) and Appendices 7-8 and 15-16 (Mayfield estimates).

	Piping Plover								
Reproductive Parameter	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Adults Observed	52	23	31	46	55	60	68	69	74
Breeding Pairs	19	13	12	20	27	30	27	30	39
Total Nests Observed	27	21	15	33	34	46	31	43	54
Successful Nests (≥1 egg hatched)	15	8	9	21	27	32	23	34	34
Apparent Nest Success	0.56	0.38	0.60	0.64	0.79	0.70	0.74	0.79	0.63
Daily Nest Survival Rate (All sites)	0.99	0.98	0.99	0.98	0.99	0.99	0.99	0.99	0.98
Incubation-period Survival Rate (All sites)	0.71	0.58	0.67	0.54	0.77	0.69	0.73	0.77	0.64
Chicks Observed (<15D)	44	26	27	76	87	99	80	116	119
Hatch Ratio (Chicks/Nest)	1.63	1.24	1.80	2.30	2.56	2.15	2.58	2.70	2.2
Hatch Ratio (Chicks/Breeding Pair)	2.32	1.24	2.25	3.80	3.22	3.30	2.96	3.87	3.05
Chicks (≥15D)	27	10	18	53	61	68	43	67	73
Fledglings (28D)	-----[A]	-----	-----	42	45	59	28	55	52
Historic Fledge Ratio (15D Chicks/Nest)	1.00	0.48	1.20	1.61	1.79	1.48	1.39	1.56	1.35
Fledge ratio (28D Chicks/Nest)	-----	-----	-----	1.27	1.32	1.28	0.90	1.28	0.96
Historic Fledge Ratio (15D Chicks/Breeding Pair)	1.42	0.77	1.50	2.65	2.26	2.27	1.59	2.23	1.87
Fledge Ratio (28D Chicks/Breeding Pair)	-----	-----	-----	2.01	1.67	1.97	1.04	1.83	1.33
Daily Brood Survival Rate (All sites)	-----	0.94	0.98	0.99	0.99	0.99	0.98	0.99	0.99
Brooding-period Survival Rate (All sites) [B]	-----	0.42	0.79	0.70	0.73	0.78	0.62	0.69	0.68

[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.

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 2015. 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.

					Least tern								Piping plover							
Site #/Name	Habitat Type[A]	Management[A]	Surveys	Survey Time (hr.)	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	76	92	5	5	12	5	4	11	5	5	1	2	8	2	2	6	5	3
2 Dyer Pit	SP	HPFTE	74	102	6	6	14	6	6	13	9	6	3	3	8	4	3	12	3	1
3 Plum Creek Complex Island	RI	PT	8	3	0	0	3	0	0	0	0	0	0	0	2	0	0	0	0	0
4 Cottonwood Ranch OCSW[C]	OC	HPFTE	48	66	8	8	19	8	8	15	8	6	1	1	6	1	1	4	3	2
5 Cottonwood Ranch Complex[C]	RI	HPT	11	9	0	0	4	0	0	0	0	0	1	1	3	1	1	4	3	1
6 Blue Hole Pit[D]	SP	PFT	96	187	17	23	34	29[E]	16[E]	39[E]	26[E]	26[E]	9	9	20	11	9	32	23	19
7 Johnson Pit	SP	PFT	38	31	7	7	14	7	6	11	9	9	1	1	2	1	1	4	0	0
8 Elm Creek Complex West	RI	D	8	2	0	0	7	0	0	0	0	0	0	0	1	0	0	0	0	0
9 Elm Creek Complex East	RI	PT	7	4	0	0	4	0	0	0	0	0	0	0	1	0	0	0	0	0
10 Broadfoot South Pit	SP	HPFTE	88	151	21	25	37	31[F]	15[F]	31[F]	22[F]	21[F]	8	8	14	14[G]	6[G]	17[G]	6	5
11 Speidell-Hostetler Island	RI	N	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 Newark West Pit	SP	HPFTE	81	117	21	23	30	27	18	45	25	25	4	4	9	6	4	14	10	6
13 Newark East Pit	SP	FTC	8	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
14 Leaman East OCSW	OC	HPFTES	7	101	31	33	33	42	24	51	31	26	5	5	10	6	5	19	14	9
15 Lilley-Woodriver	SP	N	7	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16 Shoemaker Island Complex	RI	DHPTC	16	24	8	8	17	14	3	5	0	0	4	5	7	6	0	0	0	0
17 Follmer Pit	SP	PFTC	7	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 Wild Rose Ranch East Pit	OC	GHP	28	20	13	13	24	14	11	24	14	13	2	2	5	2	2	7	6	6
19 Deweese – Alda Pit	SP	N	13	5	0	1	2	1	1	3	0	0	0	0	0	0	0	0	0	0
20 Hooker Brothers – GI South East Pit	SP	N	21	9	4	4	8	4	4	10	9	9	0	0	2	0	0	0	0	0
21 Hooker Brothers-GI East	SP	N	7	3	0	0	0	0	0	0	0	0	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 2014 nesting season and prior to the 2015 nesting season could include: mowed (M), burned (B), disked (D), graded (G), tree/vegetation removal (R), or herbicide (H) during fall 2014; pre-emergent herbicide (P), predator fencing (F), predator trapping (T), Reference-Point Block Distribution (E), or Nest Furniture Distribution (S) during spring 2015; 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 7 July for least terns and 25 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] Cottonwood OSCW and Cottonwood Island Complex were predator trapped until rising river flow prevented access to trapping either site around June 1 through the rest of the 2015 season.

[D] The dike to the south of Blue Hole sandpit broke during the summer, resulting in erosion along the south shoreline throughout the remainder of the 2015 season as well as the removal of the temporary predator fence.

[E] Includes 2 least tern nests that were outside the managed nesting areas and thus were not surrounded by electrified fence and water. One nest was determined to be failed and one nest hatched and fledged 2 chicks.

[F] Includes 17 least tern nests that were located on the non-access islands. Nine nests failed, eight nests were successful, with 17 chicks hatching and 10 chicks fledging from these nests.

[G] Includes 1 piping plover nest that was located on the non-access islands. This nest was successful, with 1 chick hatching but no chick fledged from this nest.

SURVEY METHODOLOGY STUDY

Outside monitoring

Inside-Outside Monitoring – Monitoring efforts were made by inside and outside crews to determine least tern and piping plover counts at eight sandpit and two river island sites during 2015. However, due to the difficulty of reaching certain sites because of high river flows, Shoemaker Island Complex, Cottonwood Ranch Complex, and Cottonwood Ranch OCSW, were monitored jointly rather than comparatively by both the inside and outside monitoring crews. Similarly, Johnson Sandpit was not monitored independently by the inside crew, but was primarily visited for banding operations. Data collected on these banding visits was supplemented into the outside monitoring data collection. Quantities listed for Broadfoot Kearney South only include the main peninsula that was monitored by both the inside and outside monitoring crews. The non-access islands were monitored solely by the outside monitoring crew and are included in the quantities listed in Table 8. Similar to past observations, outside monitoring generally resulted in fewer young chick and nest observations. However, the outside observers were able to observe a greater quantity of fledglings during 2015.

Banded piping plover chick observed from inside the colony

Inside and outside counts of nests, chicks, and fledglings were obtained at sandpit sites and river island sites from 2011–2015. 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 9). Our results show annual totals of inside counts of nests, and chicks were always greater than annual totals of outside counts. The annual total of outside counts of fledglings for 2015 were greater than annual totals of inside counts.

Table 9. Cumulative number of nests, chicks, and fledglings counted from outside (Outside Counts) and within (Inside Counts) sites monitored at 10 sites in 2013−2015.

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**
2015	Cottonwood Ranch OCSW[1]	9	9	19	11	7	6
2015	Cottonwood Island[1]	NA	NA	NA	NA	NA	NA
2015	Dyer	10	10	25	23	6	6
2015	Paulson Lex Pit	NA	NA	NA	NA	NA	NA
2015	Lexington Pit	7	7	17	15	6	8
2015	Blue Hole	40	33	71	54	35	45
2015	Johnson[2]	8	8	14	13	2	6
2015	Newark	33	31	59	38	15	31
2015	Broadfoot South[3]	26	23	30	17	16	6
2015	Leaman OCSW	48	43	70	58	31	33
2015	**Totals**	**181**	**164**	**305**	**229**	**118**	**141**

[1] Cottonwood Ranch OCSW and Cottonwood Island were monitored jointly by the inside and outside crews due to high river flows which limited the access to these sites.
[2] Johnson Sandpit was not monitored as frequently or intensively by the inside crew as other sites were; data collected during these visits was used to supplement outside monitoring data collection.
[3] Broadfoot South is a comparison of only the main peninsula and does not include data observed by the outside monitoring crew taken from the non-access islands.

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 (Baasch et al. 2015). Least tern breeding pair counts peaked at 141 pairs on 7 July, 2015. Piping plover breeding pair counts peaked at 39 pair on 25 June, 2015; these dates were earlier than what we observed in 2014. 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, with an increase during 2015, off-channel sandpits have provided the most consistent nesting habitat for both species to date.

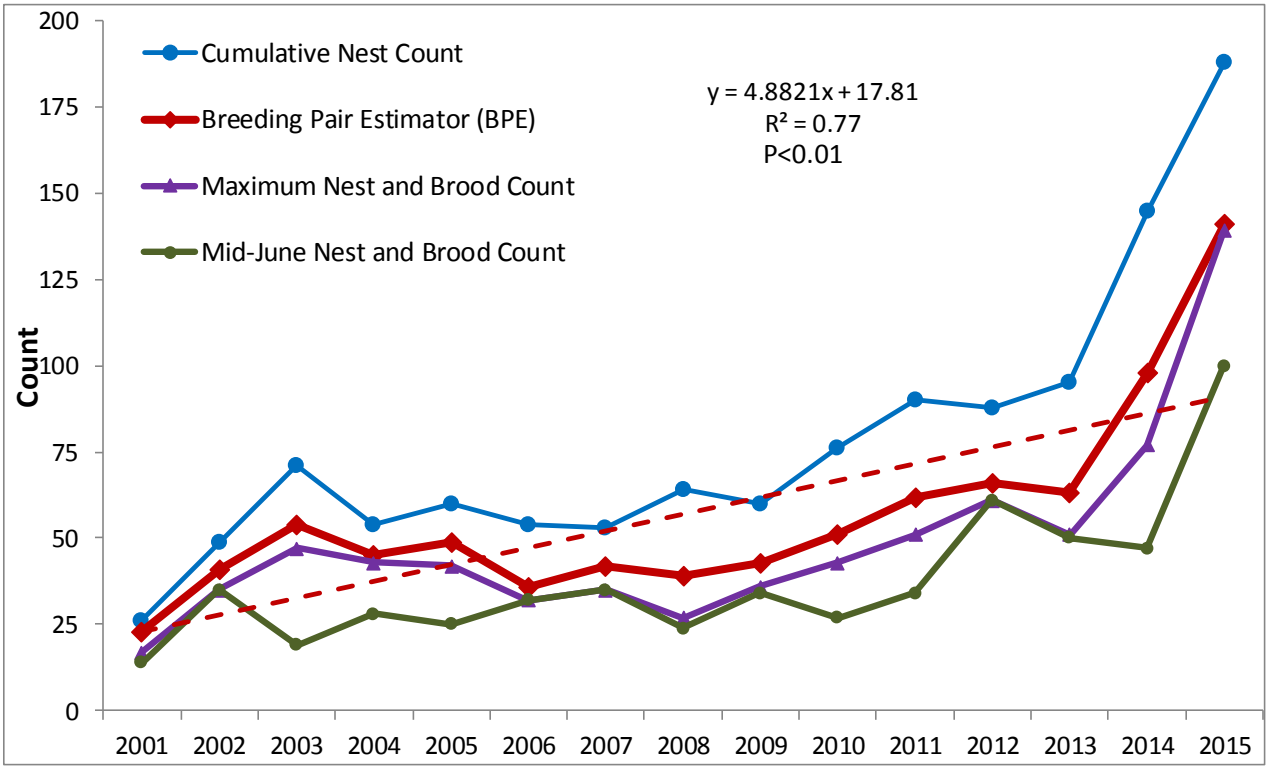


Figure 10. Comparison of numbers of least tern cumulative nests, Program defined breeding pairs, maximum nest and brood quantities, and the mid-June nest and brood quantities observed within the Program Associated Habitat Area, 2001-2015.

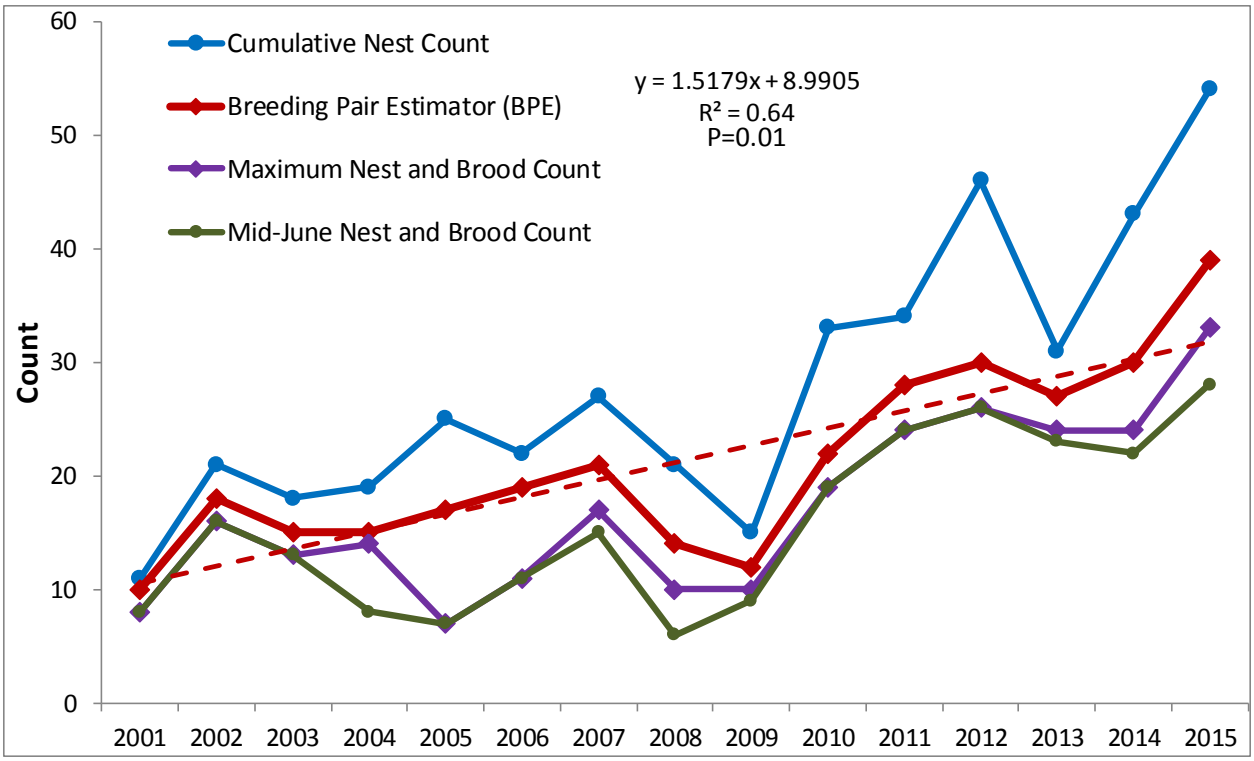


Figure 11. Comparison of numbers of piping plover cumulative nests, Program defined breeding pairs, maximum nest and brood quantities, and the mid-June nest and brood quantities observed within the Program Associated Habitat Area, 2001−2015.

Species Response to Habitat Creation and Maintenance

Changing habitat at Bluehole sand pit

The total number of breeding pairs has increased for both species during the First Increment of the Program (Table 10). In 2015, a total of 141 breeding pairs of terns and 39 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 10 and 11). 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 did respond to subsequent Program habitat construction efforts in 2014 (Table 11) during the 2015 season. Despite an increase in on-channel nesting, productivity remained low as many of the nests located on islands were lost due to habitat erosion during high flow occurrences that happened throughout the season. 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 12). Overall, the Program has observed a species response to off-channel habitat construction, while the species response to on-channel habitat construction is still undetermined.

Table 10. Least tern and piping plover nesting incidence by year, 2007−2015.

	Least Tern					Piping Plover				
Year	**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
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
2015	141	188	116	146	1.04	39	54	34	52	1.33
Mean	**67.2**	**95.9**	**51.8**	**74.2**	**1.1**	**24.8**	**33.8**	**21.7**	**37.3**	**1.4**

Table 11. Least tern and piping plover on-channel nesting incidence and productivity by year, 2007−2015.

	Least Tern					Piping Plover				
Year	**Br. Pairs***	**Nests**	**Succ. Nests**	**Fledglings**	**Fledglings Per Pair**	**Br. Pairs***	**Nests**	**Succ. Nests**	**Fledglings**	**Fledglings Per Pair**
2007	11	13	2	2	0.18	1	4	2	7	7
2008	10	20	7	9	0.9	3	5	1	3	1
2009	3	8	5	4	1.33	2	2	1	1	0.5
2010	0	0	0	0	0	4	11	4	10	2.5
2011	0	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	1	1	1	4	4
2013	0	0	0	0	0	0	0	0	0	0
2014	0	2	0	0	0	1	2	1	4	4
2015	8	14	3	0	0	5	7	1	1	0.2
Mean	**3.6**	**6.3**	**1.9**	**1.7**	**0.3**	**1.9**	**3.6**	**1.2**	**3.3**	**2.1**

*Breeding pairs within the table represent numbers of breeding pairs present on river islands the day breeding pairs within the system were maximized; therefore, nests and fledglings per breeding pair are occasionally disproportionately large. See Table 8 for maximum in-channel breeding pairs by site.

Table 12. Least tern and piping plover off-channel nesting incidence and productivity by year, 2007−2015.

	Least Tern					Piping Plover				
Year	**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
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
2015	133	174	113	146	1.09	34	47	33	51	1.50
Mean	**63.7**	**89.6**	**49.9**	**72.6**	**1.2**	**22.9**	**30.2**	**20.4**	**34.0**	**1.4**

*Breeding pairs within the table represent numbers of breeding pairs present on sandpit sites the day breeding pairs within the system were maximized; therefore, nests and fledglings per breeding pair are occasionally disproportionately large. See Table 8 for maximum off-channel breeding pairs by site.

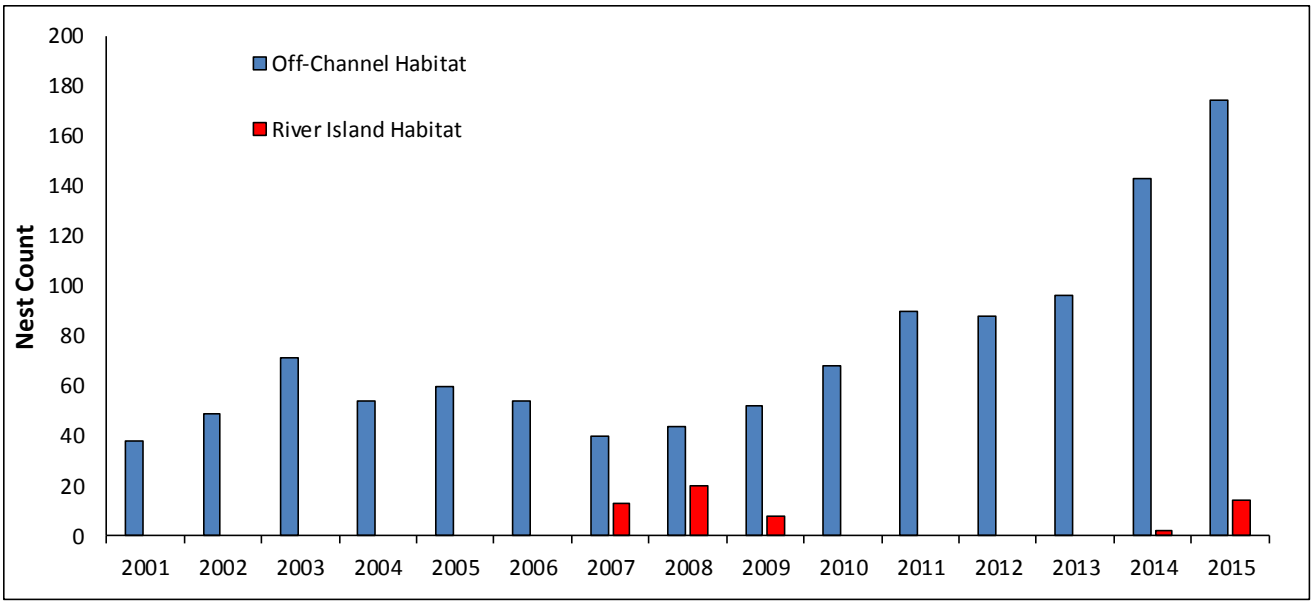


Figure 12. Comparison of least tern off-channel (sandpits, blue bars) nests and the on-channel (river island, red bars) nests within the Program Associated Habitat Area, 2001-2015.

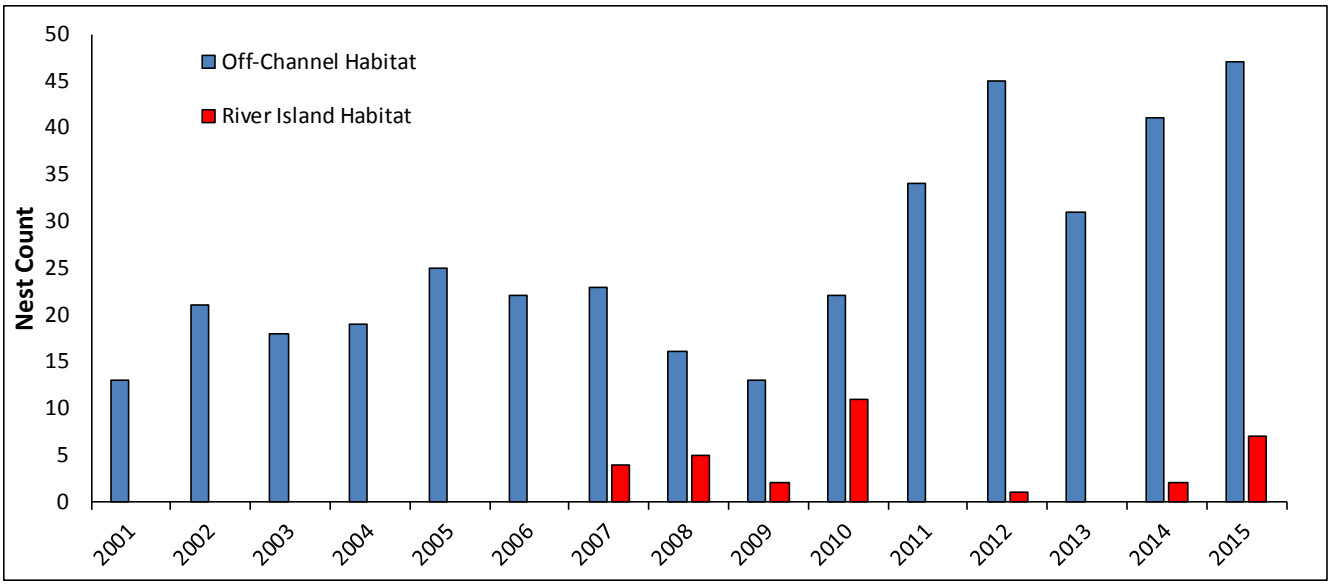


Figure 13. Comparison of piping plover off-channel (sandpits, blue bars) nests and the on-channel (river island, red bars) nests within the Program Associated Habitat Area, 2001-2015.

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 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 late 2015 and in the Final Research Project Report that will be produced after the 2018 nesting season that will include banding and resighting data from continued efforts performed during 2009–2018.

Piping plover nesting at Bluehole sand pit originally banded in South Dakota

Adult and Chick Band Observations – As part of Program-funded research implemented by USGS field crews, 152 adult and 685 juvenile least terns and 85 adult and 501 juvenile piping plovers have been banded along the central Platte River to date (Table 13).

Table 13. Summary of numbers of interior least tern and piping plover adults and chicks banded along the central Platte River, 2009−2015.

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
2015	56	162	21	88
Total	152	685	85	501

After seven 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 piping plover chicks observed to date that returned to nest have nested at non-natal sites. On multiple occasions we 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 will be available in 2019.

NEST DATA

Over the past nine years we have collected habitat measures believed to influence nest placement and productivity. We used a GIS and LiDAR to determine elevation of each nest above the waterline, determined distances to predator perch, nearest waterline, and nearest non-habitat for all nests, determined the wetted widths to the north and south of nests located on islands within the river channel, and determined the presence of nest furniture at each nest location. Summaries of the habitat metrics for Off-Channel and On-Channel least tern and piping plover nests from 2007–2015 can be found in Tables 14-17. Summaries of the habitat metrics for On- and Off-Channel least tern and piping plover nests from 2015 are included in this report in Tables 18 & 19. This data can also be found in the Habitat Selection Study that is currently underway and will be finalized in 2016.

HABITAT SELECTION STUDY

The EDO plans to use nest location and habitat assessment data collected through 2015 to evaluate least tern and piping plover nest site selection on the Central Platte River. Results of these evaluations will be available the beginning of 2016.

Table 14. Average of Off-Channel least tern elevations above water in inches, distances to edge of water, distances to predator perch, and distances to non-suitable habitat in yards, and number of least tern nests with nest furniture present by site from 2007-2015.

	Least Terns					
Site Name	**Years Collected**	**Average Elevation Above Water**	**Average Distance To Edge Of Water**	**Average Distance To Predator Perch**	**Average Distance To Non-Suitable Habitat**	**Nests With Nest Furniture Present**
Blue Hole	2007−2015	75	43	177	128	82
Broadfoot - Kearney South	2010−2015	64	22	299	134	33
Broadfoot - Newark West	2011−2015	96	31	205	134	31
Cottonwood Ranch Sandpit	2013−2015	204	46	272	104	11
DeWeese - Alda	2011−2012, 2015	115	50	121	71	3
Dyer Sandpit	2011−2013, 2015	89	41	225	106	21
Hooker Brothers - South East	2014−2015	Unknown	26	219	47	2
Johnson Sandpit	2007−2011, 2014−2015	71	26	171	81	14
Leaman East (Sandpit)	2013−2015	72	42	231	89	22
Lexington Sandpit	2007−2013, 2015	105	40	147	106	25
Trust Wildrose - East	2010−2015	49	20	190	55	33

Table 15. Average of On-Channel least tern elevations above water in inches, distances to edge of water, distances to predator perch, and distances to non-suitable habitat, wetted widths north of nesting islands, wetted widths south of nesting islands in yards, and number of least tern nests with nest furniture present by site from 2007−2015.

	Least Terns							
Site Name	**Years Collected**	**Average Elevation Above Water**	**Average Distance To Edge Of Water**	**Average Distance To Predator Perch**	**Average Distance To Non-Suitable Habitat**	**Average of Wetted Width South**	**Average of Wetted Width North**	**Nests With Nest Furniture Present**
Alda Farms Island	2008	75	15	334	129	131	265	0
Shoemaker Islands Complex	2015	19	24	192	78	179	238	10
Dinan Tract	2007–2009	Unknown	9	286	84	86	185	0
Dippel Tract	2007–2009	33	16	327	118	331	114	0
Mormon Island	2009	65	10	200	53	201	50	0
Triplett Trail Tract	2008	48	3	144	135	137	140	0
Wild Rose Ranch Islands	2014	Unknown	12	404	2	161	227	0

Table 16. Average of Off-Channel piping plovers elevations above water in inches, distances to edge of water, distances to predator perch, and distances to non-suitable habitat in yards, and number of least tern nests with nest furniture present by site from 2007-2015.

	Piping Plover					
Site Name	**Years Collected**	**Average Elevation Above Water**	**Average Distance To Edge Of Water**	**Average Distance To Predator Perch**	**Average Distance To Non-Suitable Habitat**	**Nests With Nest Furniture Present**
Blue Hole	2007–2015	71	43	168	126	26
Broadfoot - Kearney South	2010–2015	68	29	300	155	9
Broadfoot - Newark West	2012–2015	98	33	180	93	4
Cottonwood Ranch Sandpit	2013–2015	230	53	242	110	4
Dyer Sandpit	2010–2015	86	48	209	112	12
Johnson Sandpit	2007–2011, 2014–2015	65	26	139	87	3
Leaman East (Sandpit)	2013–2015	81	49	259	104	2
Lexington Sandpit	2007–2015	99	41	131	114	19
Paulsen's Lexington Pit	2013–2014	Unknown	53	340	134	1
Trust Wildrose - East	2010–2015	49	19	201	49	16

Table 17. Average of On-Channel piping plover elevations above water in inches, distances to edge of water, distances to predator perch, and distances to non-suitable habitat, wetted widths north of nesting islands, wetted widths south of nesting islands in yards, and number of least tern nests with nest furniture present by site from 2007-2015.

		Piping Plover						
Site Name	**Years Collected**	**Average Elevation Above Water**	**Average Distance To Edge Of Water**	**Average Distance To Predator Perch**	**Average Distance To Non-Suitable Habitat**	**Average of Wetted Width South**	**Average of Wetted Width North**	**Nests With Nest Furniture Present**
Alda Farms Island	2010	Unknown	29	234	159	156	314	1
Shoemaker Islands Complex	2015	18	21	191	113	224	196	4
Cottonwood Ranch PRRIP Island	2014–2015	37	2	190	70	202	225	2
Dinan Tract	2007–2010	32	6	281	87	90	185	0
Dippel Tract	2007–2008, 2010	42	12	325	119	361	116	4
Elm Creek Island Complex West	2012	Unknown	158	144	102	105	148	1
Mormon Island	2010	8	1	164	83	165	87	0
Triplett Trail Tract	2008	42	9	156	122	126	152	0
Younkin Tract	2010	Unknown	4	253	68	67	267	1

Table 18. Average of On-Channel and Off-Channel least tern elevations above water in inches, distances to edge of water, distances to predator perch, and distances to non-suitable habitat, wetted widths north of nesting islands, wetted widths south of nesting islands in yards, and number of least tern nests with nest furniture present by site during 2015.

			Least Terns						
Site Name	**Year**	**On or Off Channel**	**Average Elevation Above Water**	**Average Distance To Edge Of Water**	**Average Distance To Predator Perch**	**Average Distance To Non-Suitable Habitat**	**Average of Wetted Width South**	**Average of Wetted Width North**	**Nests With Nest Furniture Present**
Shoemaker Islands Complex	2015	On	19	24	192	78	179	238	10
Blue Hole	2015	Off	74	37	182	128	NA	NA	17
Broadfoot - Kearney South	2015	On	54	25	354	123	NA	NA	9
Broadfoot - Newark West	2015	Off	98	36	207	118	NA	NA	12
Cottonwood Ranch Sandpit	2015	On	196	41	257	100	NA	NA	4
DeWeese - Alda	2015	Off	22	30	156	84	NA	NA	1
Dyer Sandpit	2015	Off	94	42	292	109	NA	NA	5
Hooker Brothers - South East	2015	Off	Unknown	25	222	31	NA	NA	0
Johnson Sandpit	2015	Off	65	29	258	87	NA	NA	6
Leaman East (Sandpit)	2015	Off	77	42	231	95	NA	NA	8
Lexington Sandpit	2015	Off	106	54	148	99	NA	NA	4
Trust Wildrose - East	2015	Off	50	23	202	55	NA	NA	7

Table 19. Average of On-Channel and Off-Channel piping plover elevations above water in inches, distances to edge of water, distances to predator perch, and distances to non-suitable habitat, wetted widths north of nesting islands, wetted widths south of nesting islands in yards, and number of least tern nests with nest furniture present by site during 2015.

Site Name	Year	On or Off Channel	Piping Plover Average Elevation Above Water	Average Distance To Edge Of Water	Average Distance To Predator Perch	Average Distance To Non-Suitable Habitat	Average of Wetted Width South	Average of Wetted Width North	Nests With Nest Furniture Present
Shoemaker Islands Complex	2015	On	18	21	191	113	224	196	4
Blue Hole	2015	Off	63	34	172	128	NA	NA	2
Broadfoot - Kearney South	2015	Off	72	32	325	158	NA	NA	3
Broadfoot - Newark West	2015	Off	97	31	161	76	NA	NA	4
Cottonwood Ranch PRRIP Island	2015	On	37	6	190	55	163	312	0
Cottonwood Ranch Sandpit	2015	Off	186	36	198	109	NA	NA	0
Dyer Sandpit	2015	Off	94	46	245	120	NA	NA	1
Johnson Sandpit	2015	Off	91	33	250	92	NA	NA	1
Leaman East (Sandpit)	2015	Off	82	46	252	105	NA	NA	0
Lexington Sandpit	2015	Off	76	30	137	126	NA	NA	2
Trust Wildrose - East	2015	Off	53	19	196	33	NA	NA	2

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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 2015. 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
Blue Hole	29	13	503	0.9729	0.0074	0.9540	0.9842	0.5621	0.3856	0.7241
Johnson	7	1	152	0.9931	0.0069	0.9527	0.9990	0.8647	0.4377	0.9813
Lexington	5	1	105	0.9900	0.0010	0.9325	0.9986	0.8097	0.3261	0.9740
Dyer	6	0	132	1.0000	0.0000	1.0000	1.0000	1.0000	0.0000	1.0000
Broadfoot Kearney South[1]	31	16	520	0.9678	0.0079	0.9480	0.9802	0.5260	0.3390	0.6656
Newark West	27	9	525	0.9821	0.0059	0.9659	0.9907	0.6841	0.4969	0.8261
Leaman OCSW[2]	42	18	767	0.9755	0.0057	0.9614	0.9845	0.5935	0.4466	0.7255
Cottonwood Ranch OCSW[2]	8	0	176	1.0000	0.0000	1.0000	1.0000	1.0000	0.0000	1.0000
DeWeese Alda	1	0	22	1.0000	0.0000	1.0000	1.0000	1.0000	0.0000	1.0000
Wild Rose Ranch East Sandpit	14	3	271	0.9884	0.0067	0.9646	0.9963	0.7826	0.5012	0.9280
Hooker Brothers Southeast Sandpit	4	0	88	1.0000	0.0000	1.0000	1.0000	1.0000	0.0000	1.0000
Shoemaker Island Complex	14	11	161	0.9264	0.0216	0.8713	0.9590	0.2007	0.0704	0.4542
All Sites	188	72	3,421	0.9780	0.0026	0.9723	0.9825	0.6262	0.5565	0.6911

[1] 'Broadfoot Kearney South' represents the main peninsula as well as the non- access islands at Broadfoot Kearney South.

[2] 'OCSW' represents 'Off Channel Sand and Water'

Appendix 2. Daily and brooding-period survival rates for least tern broods (1 or more chicks) monitored on sandpits and 1 river island during 2015. 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
Blue Hole	16	3	503	0.9897	0.0059	0.9684	0.9967	0.8038	0.5376	0.9352
Johnson	6	0	152	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Lexington	4	2	105	0.9694	0.0213	0.8859	0.9923	0.5212	0.1416	0.8778
Dyer	6	2	132	0.9804	0.0137	0.9249	0.9951	0.6596	0.2624	0.9134
Broadfoot Kearney South[1]	15	3	520	0.9869	0.0075	0.9602	0.9958	0.7581	0.4617	0.9200
Newark West	18	5	525	0.9829	0.0076	0.9597	0.9929	0.6966	0.4469	0.8671
Leaman OCSW[2]	24	8	767	0.9813	0.0065	0.9631	0.9906	0.6730	0.4707	0.8265
Cottonwood Ranch OCSW[2]	8	3	176	0.9783	0.0124	0.9349	0.9930	0.6310	0.2938	0.8754
DeWeese Alda	1	1	22	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Wild Rose Ranch East Sandpit	11	5	271	0.9661	0.0149	0.9210	0.9858	0.4842	0.2147	0.7631
Hooker Brothers Southeast Sandpit	4	0	88	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Shoemaker Island Complex	3	3	161	0.7828	0.1259	0.4579	0.9389	0.0058	0.0000	0.8206
All Sites	116	35	3,421	0.9815	0.0031	0.9744	0.9867	0.6761	0.5831	0.7570

[1] 'Broadfoot Kearney South' represents the main peninsula as well as the non- access islands at Broadfoot Kearney South.

[2] 'OCSW' represents 'Off Channel Sand and Water'

Appendix 3. Daily and incubation-period survival rates for piping plover nests monitored on sandpits and 2 river island sites during 2015. 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
Blue Hole	11	2	288	0.9928	0.0051	0.9717	0.9982	0.8167	0.4907	0.9537
Johnson	1	0	29	1.0000	0.0000	1.0000	1.0000	1.0000	0.0000	1.0000
Lexington	2	0	58	1.0000	0.0000	1.0000	1.0000	1.0000	0.0000	1.0000
Dyer	4	1	93	0.9888	0.0111	0.9250	0.9984	0.7300	0.2159	0.9637
Broadfoot Kearney South[1]	14	8	315	0.9737	0.0092	0.9483	0.9868	0.4745	0.2525	0.7070
Newark West	6	2	145	0.9857	0.0100	0.9447	0.9964	0.6683	0.2722	0.9157
Leaman OCSW[2]	6	1	174	0.9940	0.0059	0.9590	0.9992	0.8461	0.3955	0.9788
Cottonwood Ranch OCSW[2]	1	0	29	1.0000	0.0000	1.0000	1.0000	1.0000	0.0000	1.0000
Wild Rose Ranch East Sandpit	2	0	58	1.0000	0.0000	1.0000	1.0000	1.0000	0.0000	1.0000
Cottonwood Ranch Island Complex	1	0	29	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Shoemaker Island Complex	6	6	82	0.9229	0.0304	0.8382	0.9651	0.1057	0.0154	0.4713
All Sites	54	20	1,298	0.9840	0.0035	0.9754	0.9897	0.6375	0.5050	0.7519

[1] 'Broadfoot Kearney South' represents the main peninsula as well as the non- access islands at Broadfoot Kearney South.

[2] 'OCSW' represents 'Off Channel Sand and Water'

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 2015. 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
Blue Hole	9	0	250	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Johnson	1	1	2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Lexington	2	0	48	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Dyer	3	2	59	0.9646	0.0246	0.8690	0.9911	0.3641	0.0595	0.8383
Broadfoot Kearney South[1]	6	4	70	0.9392	0.0295	0.8488	0.9770	0.1727	0.0253	0.6265
Newark West	4	1	99	0.9895	0.0104	0.9294	0.9985	0.7447	0.2328	0.9656
Leaman OCSW[2]	5	2	114	0.9818	0.0128	0.9301	0.9954	0.5979	0.2015	0.8976
Cottonwood Ranch OCSW[2]	1	0	27	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Wild Rose Ranch East Sandpit	2	0	51	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Cottonwood Ranch Island Complex	1	0	29	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
All Sites	34	10	749	0.9861	0.0044	0.9744	0.9925	0.6757	0.4962	0.8151

[1] 'Broadfoot Kearney South' represents the main peninsula as well as the non- access islands at Broadfoot Kearney South.

[2] 'OCSW' represents 'Off Channel Sand and Water'

Appendix 5. Daily and incubation-period survival rates for least tern nests monitored on Program and non-Program Off-Channel sites during 2015. 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	60	18	831	0.9835	0.0039	0.9739	0.9896	0.7047	0.5798	0.8049
Program	114	43	2,220	0.9788	0.0032	0.9715	0.9842	0.6374	0.5480	0.7182
All Sites	174	61	3,051	0.9804	0.0025	0.9749	0.9847	0.6602	0.5884	0.7253

Appendix 6. Daily and brooding-period survival rates for least tern broods (1 or more chicks) monitored on Program and non-Program Off-Channel sites during 2015. 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	42	11	725	0.9840	0.0048	0.9714	0.9911	0.7128	0.5529	0.8328
Program	71	21	1,252	0.9824	0.0038	0.9731	0.9885	0.6882	0.5693	0.7865
All Sites	113	32	1,976	0.9830	0.0030	0.9760	0.9879	0.6971	0.6036	0.7767

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

Non-Program owned and managed sites include: Lexington, Blue Hole, Johnson, Wild Rose Ranch East Sandpit, DeWeese Alda Sandpit, & Hooker Brothers Southeast Sandpit

Appendix 7. Daily and incubation-period survival rates for piping plover nests monitored on Program and non-Program Off-Channel sites during 2015. 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	16	2	433	0.9952	0.0034	0.9811	0.9988	0.8742	0.6124	0.9683
Program	31	12	755	0.9836	0.0047	0.9713	0.9906	0.6287	0.4549	0.7745
All Sites	47	14	1,188	0.9878	0.0032	0.9795	0.9928	0.7091	0.5676	0.8191

Appendix 8. Daily and brooding-period survival rates for piping plover broods (one or more chicks) monitored on Program and non-Program Off-Channel sites during 2015. 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	14	1	351	0.9970	0.0030	0.9793	0.9996	0.9203	0.5995	0.9889
Program	19	9	369	0.9746	0.0084	0.9518	0.9867	0.4859	0.2741	0.7029
All Sites	33	10	720	0.9855	0.0045	0.9733	0.9922	0.6650	0.4827	0.8085

Program owned and managed sites include: Dyer, Cottonwood Ranch Off Channel Sand and Water (OCSW), Broadfoot Kearney South, Broadfoot Newark West, & Leaman OCSW
Non-Program owned and managed sites include: Lexington, Blue Hole, Johnson, & Wild Rose Ranch East Sandpit

Appendix 9. Daily and incubation-period survival rates for least tern nests monitored on sandpits and a river island site during 2015. 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
Blue Hole	29	13	503	0.9742	0.0071	0.9603	0.9880	0.5770	0.4045	0.7495
Johnson	7	1	152	0.9934	0.0066	0.9805	1.0063	0.8702	0.6330	1.1074
Lexington	5	1	105	0.9904	0.0095	0.9718	1.0091	0.8172	0.4937	1.1406
Dyer	6	0	132	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Broadfoot Kearney South[1]	31	16	520	0.9692	0.0076	0.9544	0.9841	0.5188	0.3519	0.6856
Newark West	27	9	525	0.9829	0.0057	0.9718	0.9940	0.6955	0.5305	0.8605
Leaman OCSW[2]	42	18	767	0.9765	0.0055	0.9658	0.9872	0.6073	0.4674	0.7472
Cottonwood Ranch OCSW[2]	8	0	176	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
DeWeese Alda	1	0	22	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Wild Rose Ranch East Sandpit	14	3	271	0.9889	0.0064	0.9765	1.0014	0.7915	0.5822	1.0009
Hooker Brothers Southeast Sandpit	4	0	88	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Shoemaker Island Complex	14	11	161	0.9315	0.0199	0.8924	0.9706	0.2252	0.0267	0.4236
All Sites	188	72	3,421	0.9790	0.0025	0.9741	0.9838	0.6397	0.5737	0.7057

[1] 'Broadfoot Kearney South' represents the main peninsula as well as the non- access islands at Broadfoot Kearney South.

[2] 'OCSW' represents 'Off Channel Sand and Water'

Appendix 10. Daily and brooding-period survival rates for least tern broods (1 or more chicks) monitored on sandpits and one island during 2015. 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
Blue Hole	16	3	503	0.9940	0.0034	0.9873	1.0008	0.8819	0.7566	1.0073
Johnson	6	0	152	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Lexington	4	2	105	0.9809	0.0134	0.9546	1.0071	0.6664	0.2916	1.0413
Dyer	6	2	132	0.9848	0.0106	0.9640	1.0057	0.7257	0.4032	1.0482
Broadfoot Kearney South[1]	15	3	520	0.9942	0.0033	0.9877	1.0007	0.8856	0.7638	1.0074
Newark West	18	5	525	0.9905	0.0042	0.9822	0.9988	0.8179	0.6739	0.9620
Leaman OCSW[2]	24	8	767	0.9896	0.0037	0.9824	0.9968	0.8024	0.6799	0.9248
Cottonwood Ranch OCSW[2]	8	3	176	0.9830	0.0098	0.9638	1.0021	0.6970	0.4122	0.9817
DeWeese Alda	1	1	22	0.9545	0.0444	0.8675	1.0416	0.3765	-0.3444	1.0974
Wild Rose Ranch East Sandpit	11	5	271	0.9815	0.0082	0.9655	0.9976	0.6763	0.4445	0.9082
Hooker Brothers Southeast Sandpit	4	0	88	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Shoemaker Island Complex	3	3	161	0.9813	0.0107	0.9604	1.0023	0.6728	0.3711	0.9745
All Sites	116	35	3,421	0.9898	0.0017	0.9864	0.9931	0.8057	0.7481	0.8634

[1] 'Broadfoot Kearney South' represents the main peninsula as well as the non- access islands at Broadfoot Kearney South.

[2] 'OCSW' represents 'Off Channel Sand and Water'

Appendix 11. Daily and incubation-period survival rates for piping plover nests monitored on sandpits and two river island sites during 2015. 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
Blue Hole	11	2	288	0.9930	0.0049	0.9834	1.0027	0.8225	0.6470	0.9979
Johnson	1	0	29	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Lexington	2	0	58	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Dyer	4	1	93	0.9892	0.0107	0.9683	1.0102	0.7388	0.3842	1.0934
Broadfoot Kearney South[1]	14	8	315	0.9746	0.0089	0.9572	0.9920	0.4860	0.2678	0.7043
Newark West	6	2	145	0.9862	0.0097	0.9672	1.0052	0.6778	0.3758	0.9798
Leaman OCSW[2]	6	1	174	0.9942	0.0057	0.9830	1.0055	0.8506	0.6398	1.0613
Cottonwood Ranch OCSW[2]	1	0	29	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Wild Rose Ranch East Sandpit	2	0	58	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Cottonwood Ranch Island Complex	1	0	29	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Shoemaker Island Complex	6	6	82	0.9264	0.0289	0.8697	0.9831	0.1175	-0.1405	0.3755
All Sites	54	20	1,298	0.9846	0.0034	0.9779	0.9913	0.6474	0.5443	0.7505

[1] 'Broadfoot Kearney South' represents the main peninsula as well as the non- access islands at Broadfoot Kearney South.

[2] 'OCSW' represents 'Off Channel Sand and Water'

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 2015. 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
Blue Hole	9	0	250	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Johnson	1	1	2	0.5000	0.3536	-0.1930	1.1930	0.0000	0.0000	0.0000
Lexington	2	0	48	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Dyer	3	2	59	0.9658	0.0238	0.9192	1.0124	0.3776	-0.1101	0.8652
Broadfoot Kearney South[1]	6	4	70	0.9429	0.0277	0.8885	0.9972	0.1925	-0.1595	0.5445
Newark West	4	1	99	0.9899	0.0100	0.9702	1.0096	0.7526	0.4149	1.0902
Leaman OCSW[2]	5	2	114	0.9825	0.0123	0.9584	1.0066	0.6092	0.2540	0.9644
Cottonwood Ranch OCSW[2]	1	0	27	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Wild Rose Ranch East Sandpit	2	0	51	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Cottonwood Ranch Island Complex	1	0	29	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
All Sites	34	10	749	0.9866	0.0042	0.9784	0.9949	0.6862	0.5542	0.8182

[1] 'Broadfoot Kearney South' represents the main peninsula as well as the non- access islands at Broadfoot Kearney South.

[2] 'OCSW' represents 'Off Channel Sand and Water'

Appendix 13. Daily and incubation-period survival rates for least tern nests monitored on Program and non-Program Off-Channel sites during 2015. 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	60	18	831	0.9783	0.0050	0.9684	0.9882	0.6314	0.4972	0.7655
Program	114	43	2,220	0.9806	0.0029	0.9749	0.9864	0.6632	0.5817	0.7446
All Sites	174	61	3,051	0.9800	0.0025	0.9750	0.9850	0.6543	0.5847	0.7240

Appendix 14. Daily and brooding-period survival rates for least tern broods (1 or more chicks) monitored on Program and non-Program Off-Channel sites during 2015. 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			Lower	Upper
Non-Program	42	11	725	0.9848	0.0045	0.9759	0.9937	0.7252	0.5875	0.8629
Program	71	21	1,252	0.9832	0.0036	0.9736	0.9903	0.7009	0.5944	0.8075
All Sites	113	32	1,976	0.9838	0.0028	0.9767	0.9894	0.7097	0.6254	0.7940

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

Non-Program owned and managed sites include: Lexington, Blue Hole, Johnson, Wild Rose Ranch East Sandpit, DeWeese Alda Sandpit, & Hooker Brothers Southeast Sandpit

Appendix 15. Daily and incubation-period survival rates for piping plover nests monitored on Program and non-Program Off-Channel sites during 2015. 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	16	2	433	0.9954	0.0033	0.9890	1.0018	0.8783	0.7559	1.0007
Program	31	12	755	0.9841	0.0046	0.9752	0.9930	0.6385	0.5025	0.7745
All Sites	47	14	1,188	0.9882	0.0031	0.9821	0.9944	0.7175	0.6159	0.8192

Appendix 16. Daily and brooding-period survival rates for piping plover broods (1 or more chicks) monitored on Program and non-Program Off-Channel sites during 2015. 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	14	1	351	0.9972	0.0028	0.9916	1.0027	0.9232	0.8126	1.0338
Program	19	9	369	0.9756	0.0080	0.9598	0.9913	0.5004	0.2986	0.7022
All Sites	33	10	720	0.9861	0.0044	0.9775	0.9947	0.6758	0.5400	0.8116

Program owned and managed sites include: Dyer, Cottonwood Ranch Off Channel Sand and Water (OCSW), Broadfoot Kearney South, Broadfoot Newark West, & Leaman OCSW
Non-Program owned and managed sites include: Lexington, Blue Hole, Johnson, & Wild Rose Ranch East Sandpit