## **Platte River Recovery Implementation Program**

### 2012-2013 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



Final – 23 June, 2014

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### PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM

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





Hooker Bros. Sand & Gravel, Inc.

TOP DRESSING SAND - GRAVEL -LANDSCAPE RDCK - FILL DIRT - TOP SOIL

TAKING PRIDE IN ALL WE DO

#### 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 2012 and 2013. 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 provides details of the study area and summarizes conditions observed during the 2012	)
and 2013 nesting seasons.	

This section describes on- and off-river land management practices used to facilitate nesting and actions taken to protect least tern and piping plover colonies and nests from predation and disturbance.

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 2012 and 2013. These data are collected and summarized in a form that allows comparison across the entire range of each species and includes annual survey results.

This section contains a summary of least tern and piping plover research conducted since 2007. Once research projects are finalized, detailed methodologies and results for research projects can be found on the Program's website (www.platteriverprogram.org).

#### 



PRRIP 2012-2013 Tern and Plover Report

#### 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 Platte River between Lexington and Chapman, Nebraska by managing certain land and water resources following principles of adaptive management to provide benefits for 4 "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 3 main elements:

- Increasing stream flows in the central Platte River during relevant time periods through retiming 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 and include monitoring interior least tern (least tern) and piping plover use and productivity on midstream-river sandbars and sand and gravel mines along the central Platte River between Lexington and Chapman, Nebraska. The Program concluded a 2-year Foraging Habits Study in 2010 and in 2011 and 2013 the study plan was amended to include 4 additional years (2011-2014) of banding on the central Platte with 3 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 five consecutive years on the central Platte River (2009-2013) and we anticipate a final report documenting results of those efforts will be available on the Program's online Public Library in early 2014. Monitoring and research during 2012 and 2013 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 (2008-2011) and are available in the Program's online Public Library. Least tern and piping plover activity and reproductive success during 2012 and 2013 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-river sites. River habitat included midstream sandbars used for nesting and the river itself was used for foraging. Off-river habitat included spoil piles of sparsely- or non-vegetated sand and associated sandpit lakes at sand and gravel mines. Least terns nested on managed sandpit spoil piles and foraged in sandpit lakes and the river while 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.

#### 2012-2013 RIVER CONDITIONS

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

April to early-May daily flows were normal to slightly higher during 2012 and 2013 than average flows during the past 13-years. In April 2013, a release of approximately 4,000 cfs was made from the Environmental Account which can be attributed to some of the elevated flows that were observed. Flows were below normal from early May through August and downstream reaches of the river were dry much of the period from July through August (Figure 2). The 2010 and 2011 prolonged high-flow events eroded away most of the previously existing mechanically created in-channel nesting habitat. Nesting islands that were mechanically created by the Program prior to the 2012 and 2013 nesting seasons were not moated by water due to low flows which, for the fourth consecutive year limited nesting opportunities on the river. The season-long droughts and lack of in-channel sandbars may have negatively influenced least tern use of the river as we observed similar or fewer least tern adults while conducting river surveys during 2012 and 2013 than we did during high-flow years of 2010 and 2011 despite the overall increase in numbers of birds along the central Platte River. In 2012 and 2013, however, we generally observed more piping plover adults during river surveys than we did during 2010 and 2011.



Central Platte River flow conditions observed downstream of Kearney, Nebraska on the Audubon Rowe Sanctuary during the mid-July river survey. Image captured 14 July, 2012. Similar conditions were observed during 2013.



**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<sup>3</sup>/second; cfs) at Overton (USGS gage 06768000), Cottonwood Ranch near Overton (USGS gage 06768035), Kearney (USGS gage 06770200), and Grand Island, Nebraska (USGS gage 06770500), 1 April – 31 August, 2012 (top) and 2013 (bottom) and mean daily discharge at Kearney (USGS gage 06770200), 1 April – 31 August. 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.



Central Platte River flows observed downstream of Grand Island during the early-July river survey. Image captured 3 July, 2012. Similar conditions were observed much of June and July, 2013.

#### MANAGEMENT

Management actions designed to increase nesting habitat (bare sand) and productivity of least terns and piping plovers within Program associated habitats were taken at on- and off-river sites during fall 2011 and 2012 and spring 2012 and 2013. Management activities were site specific and included: mechanical actions to create nesting habitat (dozers, scrapers, and backhoes), mechanical actions to improve nesting conditions and remove vegetative cover (disking, tree removal, and mowing); chemical application to kill or prevent emergence of vegetation (spring or fall herbicide application); and predator control (fencing and trapping).

#### SANDPIT SITES:

Nine of the 14 off-channel sites monitored during 2012 and 2013 were actively managed to increase least tern and piping plover reproduction. One Program-owned off-channel site was constructed during 2012 and one site was being mined during the 2012 and 2013 nesting seasons.

- *Lexington Sandpit* –A pre-emergent herbicide was applied, the woven-wire predator fence with offset electric wires along the west side of the nesting areas was maintained, and predator trapping occurred during 2012 and 2013. No sand and gravel mining occurred during 2012 or 2013.
- *Paulsen's Lexington Sandpit* Sand and gravel mining occurred, but no management activities were applied during 2012 or 2013.
- *Dyer Sandpit* A contact herbicide was applied to kill existing vegetation primarily along the waterline during fall 2011 and fall 2012. A pre-emergent herbicide was applied, permanent 4-foot tall woven wire predator fences with offset electric wires across the south ends of each peninsula were electrified, and predator trapping occurred during 2012 and 2013. Sand and gravel mining occurred during 2013, but not during the 2012 nesting season.
- *Cottonwood Ranch Off-channel Sand and Water (OCSW)* A contact herbicide was applied to kill existing vegetation primarily along the waterline during fall 2012. A pre-emergent herbicide was applied, and predator trapping occurred during 2012 and 2013. A temporary 4-foot tall electrified predator fence was installed across the land bridge in 2012 and a permanent 4-foot tall woven wire predator fence with offset electric wires was installed in 2013. No sand and gravel mining occurred; this site was constructed with dozers and scrapers.
- *Blue Hole Sandpit* –A pre-emergent herbicide was applied, the existing permanent predator fence was maintained and electrified, a temporary 4-foot tall electrified predator fence was installed along the southwest edge of the peninsula and electrified, and predator trapping occurred during 2012 and 2013. Sand and gravel mining occurred northeast of the primary nesting peninsula during 2012 and 2013.
- *Johnson Sandpit* –A pre-emergent herbicide was applied, 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 2012 and 2013. No sand and gravel mining occurred during 2012 or 2013.

- **Broadfoot South Sandpit** A contact herbicide was applied to kill existing vegetation primarily along the waterline during fall 2011 and 2012. A pre-emergent herbicide was applied to the nesting area, a temporary 4-foot tall electrified predator fence was installed across the east end of the main peninsula, and a 4-foot tall hog-panel fence with chicken wire was placed across the land-bridge extending to one of the non-access islands located northwest of the main peninsula during 2012 and 2013. Sand and gravel mining occurred northwest of the main peninsula during 2012 and 2013.
- *Newark Sandpit* A contact herbicide was applied to kill existing vegetation along the waterline during fall 2011 and fall 2012. The nesting areas had a pre-emergent herbicide applied and predator trapping occurred during 2012 and 2013. Temporary, 4-foot tall electrified predator fences were installed across the land bridges in 2012 and permanent, 4-foot tall woven wire predator fences with offset electric wires were installed in 2013. No sand and gravel mining occurred at the west sandpit; however, the Program did mine a small sandpit on a neighboring property to the south and the marketable material was stockpiled outside the predator fenced area near the south end of an existing peninsula in 2012. The east sandpit was actively mined and the small peninsula area was monitored during 2012 and 2013.
- *Leaman East OCSW* A 22-acre off-channel nesting area (11 acres of water and 11 acres of bare sand; see below) was constructed with hydraulic scrapers and excavators during the 2012 nesting season. A contact herbicide was applied to kill existing vegetation along the waterline and tree removal occurred west of the constructed nesting area during fall 2012. Predator trapping occurred during 2012 and 2013 and a permanent, 4-foot tall woven wire predator fence with offset electric wires was installed in 2013. No sand and gravel mining occurred.
- *Follmer Sandpit* The Program-owned sand and gravel mining site was being mined to create least tern and piping plover nesting habitat during 2012 and 2013 and was monitored, but no suitable nesting habitat was available. No trapping occurred during 2012 or 2013.
- *Wild Rose Ranch East Sandpit* A contact herbicide was applied to kill existing vegetation on the nesting areas during fall 2011 and fall 2012 and a pre-emergent herbicide was applied to the nesting areas during spring 2012 and 2013. Vegetation was removed from the nesting areas during fall 2012. No sand and gravel mining occurred during 2012 or 2013.

Deweese-Alda Sandpit - Not managed. Sand and gravel mining occurred during 2012 and 2013.

- *Hooker Brothers West* Not managed. Sand and gravel mining occurred during 2012, but not 2013.
- *Hooker Brothers South* Not managed. Sand and gravel mining occurred during 2012, but not 2013.



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#### **RIVERINE SITES:**

Lexington Island – Pre-emergent herbicide was applied during 2012 and 2013.

- *Cottonwood Ranch Complex* Prior to the 2013 nesting season, the Program constructed 3 tern and plover 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). Pre-emergent herbicide was applied to the islands during 2013 and trapping occurred during 2012 and 2013.
- *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 2010 and the islands were overtopped by high flows during 2011. This river complex includes NPPD's constructed Elm Creek Island. No management occurred prior to the 2012 or 2013 nesting seasons.
- *Elm Creek Complex East* Encompasses a 2-mile stretch of river downstream of the Kearney Canal Diversion. The Program created 8 tern and plover nesting islands in this river complex. Two 4-5 acres islands and 2 1-2 acres islands were designed and constructed to be overtopped by a flow of 8,000 cfs and 2 4-5 acres islands and 2 1-2 acres islands were designed and constructed to be overtopped by a flow of 3,500 cfs. Pre-emergent herbicide was applied to the islands during 2013 and trapping occurred during 2012 and 2013.
- *Leaman West Complex* Prior to the 2013 nesting season, the Program mowed and disked the surfaces of 4 islands that were approximately 1, 2, 4, and 6 acres in size. A pre-emergent herbicide was applied to the islands during 2013 and trapping occurred during 2012 and 2013.
- Shoemaker Island Complex Prior to the 2012 nesting season, the Program mowed, disked, and used a rail to smooth the surfaces of 3 islands that were approximately 2, 8, and 37 acres in size. Pre-emergent herbicide was applied to the islands although it was not applied evenly so some areas became vegetated early in the 2012 nesting season (see image below). The Program disked the islands again during fall 2012 and applied pre-emergent herbicide to the islands during 2013. After disking, the large island contained areas with organic soils and may not have been appealing to terns and plovers. Trapping occurred during 2012 and 2013.



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#### 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 attempted to conduct 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) and 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 2012 and 2013. We estimated tern and plover breeding pair numbers 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 determined least tern breeding pair counts by assuming: 1) tern nests did not hatch within 21 days of being initiated; 2) terns did not renest within 5 days of losing a nest or brood; 3) tern chicks fledged at 21 days of age (fledging age 2010-2012); 4) tern chicks that survived to 15 days of age (fledging age 2007-2009) also fledged; and 5) terns did not re-nest after fledging chicks. We determined plover breeding pair counts by assuming: 1) plover nests did not hatch within 28 days of being initiated; 2) plovers did not re-nest within 5 days of losing a nest or brood; 3) plover chicks fledged at 28 days of age (fledging age 2010-2012); and 4) 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 snapshots of the numbers observed during the 2012 and 2013 nesting seasons. Additional sandpit sites were observed prior to or during the 1 May survey periods each year, but were determined to be unsuitable nesting habitat for least terns and piping plovers and thus were not monitored. All counts of adults, breeding pairs, nests, chicks, and fledglings reported during semi-monthly surveys represent minimums present.

Semi-monthly River Surveys – 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. Program staff and USGS personnel conducted semi-monthly river surveys between the J2 Return and the Chapman Bridge on 1–2 May; 15–16 May; 30 May–1 June; 13–14 June; 2–3 July; 12–14 July; and 28–30 July during 2012. Due to no flow, 15 July and 1 August river surveys between the west end of Mormon Island (between Alda and Grand Island) and the Chapman Bridge were not conducted. Personnel from NPPD conducted semi-monthly surveys of Lexington Island (Lexington–Overton bridge segment) on 7 May; 22 May; 5 June; 14 June; 2 July; and 16 July during 2012; however, this managed 'island' was attached to the bank.

Program staff, USGS, and USFWS personnel conducted semi-monthly river surveys between the J2 Return and the Chapman Bridge on 29–30 April; 14–15 May; 30–31 May; 13–14 and 17 June; 1–2 July; 12 and 14 July; and 31 July during 2013. Due to no flow, 15 July river surveys between Highway 281 (Grand Island) and Chapman Bridges and 1 August river surveys between the Shelton and Chapman Bridges were not conducted. Personnel from NPPD conducted semi-monthly surveys of Lexington Island (Lexington–Overton bridge segment) on 23 May; 13 June; 28 June; 11 July; and 23-24 July during 2013; however, this mechanically created 'island' was attached to the bank.

*Semi-monthly Sandpit Surveys* – We conducted semi-monthly surveys from outside the nesting colony at 14 sandpit sites as well as from within the nesting area at 7 of these sites to count individual birds and document least tern and piping plover nests, chicks, and fledglings during 2012. Semi-monthly sandpit surveys were conducted outside the nesting area on 2–4 May; 14–16 May; 28, 29 and 31 May and 1 and 6 June; 13–15 June; 28 June and 2–3 July; 12 and 16–17 July; and 30 July and 1–3 and 7 August during 2012. Semi-monthly sandpit surveys were conducted inside the nesting area on 1–3 May; 14–16 May; 29 May and 31 May–2 June; 11 and 13–15 June; 2–3 and 5 July; 12 and 16–18 July; and 30 July–1 August during 2012. Program staff, technicians and personnel from USGS, CPNRD, and NPPD conducted semi-monthly sandpit surveys during 2012.

We conducted semi-monthly surveys from outside the nesting colony at 14 sandpit sites as well as from within the nesting area at 7 of these sites during 2013. Semi-monthly sandpit surveys were conducted outside the nesting area on 29-30 April and 2 and 8 May; 14–16 May; 30–31 May and 3 June; 13 and 17–18 June; 28 June and 1–3 and 8 July; 11–12 and 15–16 and 20 July; and 29 July–1 August during 2013. Semi-monthly sandpit surveys were conducted inside the nesting area on 29-30 April and 3 May; 14–17 May; 30–31 May and 3 June; 13–14 and 17–18 June; 1–2 July; 15–16 July; and 29–30 July during 2013. Program staff and personnel from USGS, CPNRD, and NPPD conducted semi-monthly sandpit surveys during 2013.

*Semi-monthly Survey Totals* – To obtain estimates of minimum numbers of least tern and piping plover adults, breeding pairs, nests, chicks, and fledglings within the Program Associated Habitat Area throughout the 2012 and 2013 nesting seasons, we summed numbers detected during semi-monthly river and sandpit surveys nearest 1 and 15 May, June, and July and 1 August.

#### RESULTS

Semi-monthly River Surveys – Each of the 7 semi-monthly river surveys between Lexington and Chapman, Nebraska during 2012 required 2–3 days to conduct and spanned a maximum of 3 days during 3 survey periods in 2012 and 5 days during 1 survey in 2013. The 15 July and 1 August river surveys were not completed during 2012 due to no flow in the channel from a point ~4 miles upstream of the Highway 281 Bridge near Grand Island downstream to the Chapman Bridge (~22 river miles). Attempts were made to survey this area following a Fish and Wildlife Service target flow release, but unfortunately the water saturated upstream channel areas and never made it to the downstream reaches of the river. Surveys below the Highway 281 (near Grand Island) and Shelton bridges were not possible due to low flows during the 15 July and 1 August, 2013 river surveys, respectively.

We observed the most least tern adults (38) on the river during the 1 June river survey and the most piping plover adults (17) during the 1 July river survey in 2012 (Table 1). We observed the most least tern adults (45) on the river during the 15 July river survey and the most piping plover adults (22) during the 1 July river survey in 2013 (Table 1). During the 2012 mid-June river survey, we observed 1 piping plover breeding pair and nest within the Elm Creek Complex on an island that had been disked in the past and that was overtopped by flow during the 2011 high-flow event. Four piping plover chicks that hatched from this nest were observed during the early- and mid-July river survey and 4 fledglings from this nest were observed during the species nested on the river in 2013. All other least tern and piping plover adults and fledglings observed during semi-monthly river surveys in 2012 and 2013 were either known (banded) or were presumed (near areas with sandpits that fledged chicks) to be associated with sandpit nesting sites. Due to foraging activities observed near the Shelton Bridge, we attempted to confirm the presence of nesting birds at the Bruner-Shelton Sandpit near Shelton, but were denied access. Observations made from the public road indicate nesting likely occurred at the Bruner-Shelton sandpit in 2013, but we were not able to confirm the presence of nests or chicks from our vantage point.

2013 (bottom	nontniy ai ı).	rdoat su	rveys of	the Platte	e River betweet	n Lexington	and Cha	apman, 1	Nebraska,	2012 (top) a
			Interi	or least te	<u>ern</u>			<u>Pipi</u>	ing plove	<u>r</u>
<u>Survey</u>	Adults	Pair*	Nests	Chicks	Fledglings	Adults	Pair*	Nests	Chicks	Fledglings
1-May-12	0	0	0	0	0	12	0	0	0	0
15-May-12	14	0	0	0	0	6	0	0	0	0
1-Jun-12	38	0	0	0	0	6	0	0	0	0
15-Jun-12	28	0	0	0	0	7	1	1	0	0
1-Jul-12	17	0	0	0	0	17	1	0	4	9
15-Jul-12	29	0	0	0	0	15	1	0	4	7

Table 1. Number of least tern and piping plover adults, breeding pairs (pair), nests, chicks, and fledglings observed D1 ( D' 1 (

\* 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.

Semi-monthly Sandpit Surveys - Each of the 7 semi-monthly sandpit surveys from inside and outside the nesting area required 3–6 days to complete and spanned a maximum of 10 days during a couple of surveys. 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 4 least tern breeding pairs and nests at the unmanaged Deweese-Alda sandpit in 2012. We observed the most adult least terns during early-July (94) and mid-June (105) sandpit surveys in 2012 and 2013, respectively (Table 2). We observed the most least tern breeding pairs (63) and active nests (60) during the mid-June sandpit survey in 2012. In 2013, we observed the most least tern breeding pairs (56) during the mid-July survey, but the most active nests (48) during the mid-June sandpit survey (Table 2). In 2012 we observed the most piping plover adults (50) and nests (24) during the mid-May sandpit survey and observed the most piping plover breeding pairs (26) during mid-June sandpit surveys when there were 13 active nests and 28 chicks present at sandpit sites. We observed the most piping plover adults (51) during the mid-June sandpit survey, but the most nests (24) and breeding pairs (27) during the early-June sandpit survey in 2013.

Semi-monthly Survey Totals – Semi-monthly sandpit and river survey totals include observations of adults, breeding pairs, nests, chicks, and fledglings observed during the 7 semi-monthly sandpit and river surveys and represent an estimate of the numbers present within Program Associated Habitats during 7 time periods in the 2012 and 2013 nesting season. Inside and outside sandpit surveys generally overlapped or occurred within 1–2 days of river surveys; however, 1 sandpit site without nesting birds or adults present

all season long was surveyed 8 days after the 1 August, river survey in 2012.

In 2012 we observed 60 active least tern nests during mid-June surveys when 63 breeding pairs and 116 adults were observed (Table 3). We observed 52 least tern chicks during the early-July survey when there were 18 active nests and no fledglings observed. We observed 24 active piping plover nests during mid-May surveys when 50 adults and 25 breeding pairs were observed; however, we observed the most breeding pairs (27) during the early-July survey when 42 adults were observed (Table 3).



Least tern nest and eggs

1-Aug-12

1-Mav-13

1-Jun-13

15-Jun-13

1-Jul-13

15-Jul-13

1-Aug-13

15-May-13

In 2013 we observed 48 active least tern nests during mid-June surveys when 136 adults were observed (Table 3). The most least tern breeding pairs (56) in 2013 occurred during the mid-July survey when there were 21 nests, 32 chicks, and 25 fledglings observed. We observed 49 least tern chicks during the early-July survey when there were 33 active nests and 1 fledgling observed. We observed 24 active piping plover nests during early June survey in 2013 when 41 adults and 27 breeding pairs were observed; however, we observed the most piping plover adults (68) during the early-July survey (Table 3).

**Table 2.** 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, 2012 (top) and 2013 (bottom).

			Inte	rior lea	<u>st tern</u>				Piping 1	<u>plover</u>	
Survey	Sites	Adults	Pair*	Nests	Chicks	Fledglings	Adults	Pair*	Nests	Chicks	Fledglings
1 May-12	14	0	0	0	0	0	35	13	12	0	0
15 May-12	14	15	0	0	0	0	50	25	24	0	0
1 Jun-12	14	61	27	28	0	0	48	23	10	10	0
15 Jun-12	14	88	63	60	0	0	42	26	13	28	0
1 Jul-12	14	94	55	18	52	0	43	26	8	27	6
15 Jul-12	14	76	58	15	16	30	28	16	3	27	1
1-Aug-12	14	38	58	5	11	36	11	13	0	11	13
1 Mav-13	13	0	0	0	0	0	26	0	0	0	0
15 May-13	13	23	0	0	0	0	34	11	14	0	0
1 Jun-13	13	57	21	20	0	0	49	27	24	0	0
15 Jun-13	14	105	53	48	0	0	51	25	18	37	0
1 Jul-13	14	95	55	33	49	1	46	23	7	31	7
15 Jul-13	14	88	56	21	32	21	26	18	3	6	11
1-Aug-13	12	43	39	6	9	16	6	4	0	4	4

\* Pair represents the number of breeding pairs, as defined above, present on sandpit sites on 1 and 15 May, June, and July and 1 August.

**Table 3.** Number of least tern and piping plover adults, breeding pairs (pair), nests, chicks, and fledglings observed within Program Associated Habitats during semi-monthly river and sandpit surveys, 2012 (top) and 2013 (bottom).

		Inte	rior leas	st tern		Piping ployer						
<b>Survey</b>	Adults	Pair*	Nests	Chicks	Fledglings	Adults	Pair*	Nests	Chicks	Fledglings		
1 May-12	0	0	0	0	0	47	13	12	0	0		
15 May-12	29	0	0	0	0	56	25	24	0	0		
1 Jun-12	99	27	28	0	0	54	23	10	10	0		
15 Jun-12	116	63	60	0	0	49	27	14	28	0		
1 Jul-12	111	55	18	52	0	60	27	8	31	15		
15 Jul-12	105	58	15	16	30	43	17	3	31	8		
1-Aug-12	66	58	5	11	63	16	13	0	11	19		
1 May-13	0	0	0	0	0	41	0	0	0	0		
15 May-13	39	0	0	0	0	41	11	14	0	0		
1 Jun-13	97	21	20	0	0	58	27	24	0	0		
15 Jun-13	136	53	48	0	0	57	25	18	37	0		
1 Jul-13	126	55	33	49	1	68	23	7	31	7		
15 Jul-13	133	56	21	32	25	45	18	3	6	17		
1-Aug-13	53	39	6	9	24	6	4	0	4	14		

\* Pair represents the number of breeding pairs, as defined above, observed during semi-monthly river and sandpit surveys.



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 2012 and/or 2013. Names of sites are located in Tables 5 and 6.

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#### MID-MONTH AND SEMI-MONTHLY SURVEYS

*River Surveys, 2001–2013:* We observed moderate use of the river by least terns and piping plovers throughout the nesting season despite the season-long droughts and shallow-water conditions in 2012 and 2013 (Figures 4 and 5). Counts of least tern and piping plover adults observed during river surveys in 2012, however, were generally similar to, or slightly higher than numbers observed prior to Program implementation (2001-2006). The trend in numbers of adult least terns and piping plovers observed during mid-month river surveys of the central Platte River has increased slightly during the 2001–2013 timeframe. It is important to note, however, that several surveys were not completed because of low or no flow conditions in the river. The increase in numbers of least tern and piping plover adults observed during 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 semimonthly surveys of the Platte River between Lexington and Chapman, Nebraska, 2001-2013. \* indicates minimum numbers present as river surveys downstream of: 1) the Kearney Canal Diversion during mid-June and mid-July 2003, 2004, and 2006 and mid-July 2005, 2) Mormon Island during mid-July and early-August 2012 river surveys, and 3) HWY 281 during the mid-July river survey and the Shelton Bridge during the early-August river surveys in 2013 were not conducted due to no flow. 2008 river surveys below Kearney Canal Diversion only include observations of least terns and piping plovers at managed or constructed islands; USFWS data for other observations below the Kearney Canal Diversion were lost. *Sandpit- Surveys*, 2001–2013: We observed similar to slightly more least tern adults on sandpits within the Program Associated Habitat Area the past 2 years than we had the previous 5 years of Program implementation; especially during the mid-June surveys (Figure 5). In 2012 and 2013, we observed the most adult least terns (94 and 105) during semi-monthly sandpit surveys that occurred during early-July and mid-June, respectively. In 2012, 71% of adult least tern and 91% of adult piping plover observations occurred at sandpits sites during semi-monthly and mid-month surveys. In 2013, 70% of adult least tern and 83% of adult piping plover observations occurred at sandpits sites during semi-monthly and mid-month surveys. A total of 183 (100%) least tern nests and 76 (99%) plover nests observed during 2012 and 2013 were located on off-channel sandpits.



**Figure 5.** Numbers of least tern (top) and piping plover (bottom) adults observed during mid-month and semimonthly surveys of sandpits along the Platte River between Lexington and Chapman, Nebraska, 2001-2013.

Sandpit-River Surveys, 2001–2013: We observed slightly more least tern and piping plover adults within the Program Associated Habitat Area during the dry conditions of 2012 and 2013 than we did during high-flow years of 2010 or 2011 (Figure 6). In 2012 and 2013, we observed the most adult least terns (116 and 136) and piping plovers (60 and 68) during semi-monthly sandpit and river surveys that occurred during mid-June and early-July, respectively. Though the river was used fairly intensively for foraging by both species, we only observed 1 piping plover nest and zero least tern nests on riverine habitat during 2012 and 2013 combined. The lack of nesting was likely due to a shortage of suitable nesting habitat caused by the season-long drought which resulted in a lack of moated islands throughout much of the system and vegetation emergence on exposed sand within the channel. It is also interesting to note that least tern counts seemed to peak and taper-off a little earlier in the year during drought years of 2012 and 2013 than they did during the high-flow years of 2010 and 2011 (Figure 6).



**Figure 6.** Numbers of adult least tern (top) and piping plover (bottom) adults observed during mid-month and semimonthly surveys of sandpits and the Platte River between Chapman and Lexington, Nebraska, 2001–2013. Counts represent minimum numbers present as several river surveys were not completed due to a lack of flow in the channel (see Figure 4).

Numbers of adult least terns and piping plovers observed during midmonth surveys of the Program Associated Habitat Area declined sharply after 2007, but have since rebounded to where counts observed during 2012 and 2013 were generally slightly higher than numbers observed prior to Program implementation (Figure 7). Program analyses indicate tern and plover adult and breeding pair counts are positively correlated with habitat availability, however, it is a bit premature to say for certain whether the recent increases in least tern and piping plover breeding pair counts along the central Platte River are a direct result of increased management and habitat availability or natural population cycles.



Least Tern Adult at a sandpit.

Analyses of future data will be used to confirm the relationship between breeding pair counts and habitat availability.



**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, 2001-2013.

#### 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/week until the nest or chicks failed or the chicks fledged. We conducted surveys of adults, nests, chicks, and fledglings from both outside and within the nesting area, and attempted to conduct these surveys during the same day. Program staff and technicians, USGS field crews, and Program partners monitored nesting

sites from outside the nesting colonies and USGS field crews conducted nest and brood searches from within the nesting colonies during 2012 and 2013. Program staff and technicians assisted USGS field crews with inside surveys on a few occasions, but only at sites where they were not responsible for conducting outside surveys. Observations of adults, nests, chicks, and fledglings collected from outside and inside the nesting area were documented on separate data sheets; final counts reported represent maximum numbers counted by either method of observation during each site visit.



Piping plover chicks and egg

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  $\geq 6$  inches tall within a  $1 \cdot yd^2$  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  $1 \cdot yd^2$  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 and surface area of the water surrounding the nesting area using a GIS. We delineated exposed bare-sand areas present within CIR imagery captured 18 June, 2012 when flows at Overton, Kearney, and Grand Island ranged from 146 cfs to 277 cfs. We used CIR imagery that was captured 27 and 28 June, 2013 when flows at Overton, Kearney, and Grand Island ranged from 53 cfs to 238 cfs to delineate bare-sand areas in 2013. Summaries of habitat metrics are not included in this report, but can be found in the habitat selection study that will be produced in 2014.

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



*Inside Monitoring* – A systematic grid-search pattern was used to conduct inside surveys (Figure 8). To initiate this search method, investigators formed a straight line on the edge of and parallel to the side of



the sandpit pond (pictured to the right). Investigators were evenly spaced and the spacing was adjusted to ensure all nests and chicks were detected; the distance between individuals did not exceed 10 yards unless chicks were detected at which point the spacing was widened to allow the chicks to pass between observers to prevent driving chicks out of their natal territory. When visibility was low due to vegetation or because the substrate was similar in size and shape to the eggs, then the distance between technicians was decreased.



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 2012 and 2013 by Program staff and technicians, USGS field crews, and personnel from CPNRD and NPPD to determine survival rates. Nest success was defined as any nest that hatched  $\geq 1$  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 assign 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 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 censored the nest at 27 days (midpoint of the 2 observation periods) and assigned a "success" 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  $\geq 1$  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 censored data at 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 success 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 21<sup>st</sup> or 28<sup>th</sup> 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 0.5275 (0.97<sup>21</sup>). 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<sub>S</sub>) and 95% confidence intervals (CI<sub>95</sub>) 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  $CI_{95} = S \pm 1.96(SE_S)$ . 95% confidence intervals for the corresponding Mayfield incubation-period and brood-rearing period estimates were calculated by raising the confidence limits for S to the power of 21 or 28 for least terns and piping plovers, respectively.

#### **RESULTS:**

*Mortality:* We did not observe any research-related mortality during 2012 or 2013; however, when a crew was walking along the waterline to leave a sandpit site they witnessed a piping plover chick attempt to fly over the pond, but it lit in the water and was consumed by what was believed to be a predatory fish. The incident was immediately reported to the USFWS-Grand Island Field Office; this is the second such incident that has occurred since banding was initiated in 2009.



Predated piping plover chick remains

Eleven least terns (5 adults and 6 chicks) and 11 piping plovers (1 adult and 10 chicks) were found dead in 2012 and 2013. The intact specimens as well as 2 abandoned eggs from an unsuccessful 3-egg piping plover nest, 1 egg from an abandoned 1-egg least tern nest, and 4 abandoned eggs from 3 successful least tern nests were collected and delivered to the USFWS-Grand Island Field Office during 2012 and 2013. Weather was attributed as the cause of 9 piping plover nest failures during 2012 and 2013. Predation was documented as the cause of loss for 7 least tern nests and 1 piping plover nest and was suspected in the loss of several additional least tern and piping plover nests and chicks during 2012 and 2013. Twenty-seven least tern and 8 piping plover nest failures were attributed to unknown causes and the fate of 22 least tern nests and 1 piping plover nests were empty on or near the expected hatch date, but no chicks were observed and associated with the nests. Seven least tern and 2 piping plover nests were attributed to weather (3/28), predation (3/28), or unknown causes (22/28). Observed deaths of adults were attributed to weather (3/6) and unknown causes (3/6).

Least Terns: Least tern nests were observed and monitored at 7 of the 14 sandpits and none of the riverine sites monitored during 2012 (Table 5, Figure 9). All counts of adults, nests, chicks, and fledglings reported in Tables 5 and 6 represent maximum numbers observed from inside and outside the nesting colony during all surveys. The first observation of least tern nests occurred on 25 May, 2012 and the last nest initiated was first observed on 23 July, 2012. The first observation of a least tern chick occurred on 17 June and the last nest known to hatch did so on 11 August, 2012 (estimated hatch date; chicks first observed 13 August). At least 1 egg from 72% (63/88) of least tern nests hatched which resulted in 144 chicks and an overall nest-success rate of 1.64 chicks/nest or 2.25 chicks/breeding pair (144 chicks/64 breeding pairs) during 2012 (Table 7). Average daily survival rate of least tern nests at sandpit sites during 2012 was 0.9872 (range = 0.9782-1.0000; Appendix 1) with no differences observed between sites  $[\gamma^2(5, N = 82) = 4.955; p = 0.42];$  average survival rate over the 21-day incubation period was 0.7631 (range = 0.6302 - 1.0000). We observed the first least tern fledgling on 6 July, 2012 and the last known least tern chick to fledge did so on 16 August, 2012. Apparent fledge success at all sites monitored was 0.95 fledglings/nest (84 fledglings/88 nests) or 1.31 fledglings/breeding pair (84 fledglings/64 breeding pairs) with all nests occurring on sandpit sites during 2012. Average daily survival rates for least tern broods across all sites during 2012 was 0.9901 (range = 0.9837-1.0000; Appendix 2) with no differences observed between sites  $[\chi^2(4, N = 61) = 6.304; p = 0.18]$ ; average brooding-period survival rate across all sites was 0.8116 (range = 0.7077 - 1.0000).

Least tern nests were observed and monitored at 8 of the 14 sandpits and no river sites during 2013 (Table 6, Figure 10). The first observation of least tern nests occurred on 28 May, 2013 and the last nest initiated was first observed on 2 August, 2013. The first observation of a least tern chick occurred on 7 June and the last nest known to hatch did so on 12 August, 2013. At least 1 egg from 54% (51/95) of least tern nests hatched which resulted in 118 chicks and an overall nest-success rate of 1.24 chicks/nest or 2.03 chicks/breeding pair (118 chicks/58 breeding pairs) during 2013 (Table 7). Average daily survival rate of least tern nests at sandpit sites during 2013 was 0.9729 (range = 0.9363-1.0000; Appendix 5) with significant differences observed between sites [ $\chi^2(5, N = 95) = 4.955$ ; p = 0.0024]; average survival rate over the 21-day incubation period was 0.5621 (range = 0.2511-1.0000). We observed the first least term fledgling on 10 July, 2013 and the last known least tern chick to fledge did so on 3 September, 2013. Apparent fledge success at all sites monitored was 0.67 fledglings/nest (64 fledglings/95 nests) or 1.10 fledglings/breeding pair (64 fledglings/58 breeding pairs) with all nests occurring on sandpit sites during 2013. Average daily survival rates for least tern broods across all sites during 2013 was 0.9749 (range = 0.8333–1.0000; Appendix 6) with significant differences observed between sites  $[\chi^2(6, N = 51) = 16.469;$ p = 0.01]; average brooding-period survival rate across all sites was 0.5864 (range = 0.0217-1.0000). We tested for an effect of ownership (i.e., Program or other) on nest and brood survival rates during 2012 and 2013 and, though daily survival rates were generally lower at Program owned and managed nesting areas than other nesting areas, the differences were not significant at the  $\alpha$ =0.05 level and consequently results are not included in this report.

**Table 5.** 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 2012. 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 #'s correspond with Figure 3.

				<u>Least tern</u> <u>Piping plover</u>															
Site #	<u>Site Name</u>	Habitat Type <sup>A</sup>	Management <sup>A</sup>	Surveys	Survey Time (hr)	Breeding Pairs <sup>B</sup>	Adults (Max) <sup>B</sup>	Nests	Nests Hatched	Chicks 0-14 Days	Chicks 15-21 Days	Fledglings	<b>Breeding Pairs</b>	Adults (Max)	Nests	Nests Hatched	Chicks 0-14 Days	Chicks 15-28 Days	Fledglings
1	Lexington Pit	SP	PFT	95	145	6	14	8	8	16	13	12	5	12	$8^{\rm C}$	6	22	11	10
2	Paulsen's Lexington Pit	SP	Ν	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	Lexington Island <sup>D</sup>	RI	Р	6	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	Dyer Pit	SP	HPFT	86	123	6	18	9	6	12	9	7	6	9	7	4	10	8	6
5	Cottonwood Ranch OCSW	OC	HPFT	15	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	Blue Hole Pit	SP	PFT	90	173	16	27	18	13	33	22	19	11	21	$18^{\rm E}$	12	32	24	22
8	Johnson Pit	SP	PFT	20	14	0	4	0	0	0	0	0	0	3	0	0	0	0	0
9	Elm Creek Complex West <sup>D</sup>	RI	Ν	20	21	0	9	0	0	0	0	0	1	9	1	1	4	4	4
11	Broadfoot South Pit	SP	HPFT	85	151	22	30	32 <sup>F</sup>	21	48	22	18	3	9	$6^{\rm F}$	5	16	12	9
12	Newark Pit	SP	HPFT	65	82	5	11	6	4	9	7	7	2	4	3	2	8	5	4
15	Leaman East OCSW	OC	CRT	6	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	Shoemaker Island Complex <sup>D</sup>	RI	RPT	7	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	Wild Rose Ranch East Pit	SP	HP	27	23	7	16	11	8	19	14	13	3	6	3	2	8	8	8
18	Follmer Pit	SP	С	5	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	Deweese – Alda Pit	SP	Ν	20	11	2	8	4	3	8	8	8	0	0	0	0	0	0	0
20	Hooker Brothers – GI West Pit	SP	Ν	7	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	Hooker Brothers – GI South Pit	SP	Ν	7	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0

<sup>A</sup> Habitat types include sandpits (SP), off-channel sand and water (OC), or river islands (RI). Management actions applied to each site following the 2011 nesting season and prior to the 2012 nesting season could include: mowed (M), burned (B), disked (D), graded (G), tree/vegetation removal (R), or herbicide (H) during fall 2011; pre-emergent herbicide (P), predator fencing (F), or predator trapping (T) during spring 2012; 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.

<sup>B</sup> Breeding pair counts determined on 17 June for least terns and 18 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. Adults (Max) represent the maximum number adults observed during any single survey at the site.

<sup>C</sup> Includes 2 piping plover nests that were outside the managed nesting areas and thus were not surrounded by electrified fence and water. One nest hatched 4 chicks and banding confirmed 2 fledged.

<sup>D</sup> Lexington Island encompasses an NPPD managed area that was attached to the bank. Elm Creek Complex West encompasses a 1.5-mile stretch of river between Elm Creek Bridge and the Kearney Canal Diversion and includes NPPD's managed Elm Creek Island. The Shoemaker Island Complex includes a 2-mile stretch of river encompassing the area between 1 and 3 miles upstream of the Alda Bridge.

<sup>E</sup> Includes 1 piping plover nest that was located outside the managed nesting area and thus was not surrounded by electrified fence and water. The nest is believed to have failed; no chicks observed. <sup>F</sup> Includes 6 least tern and 1 piping plover nest that were located on the non-access islands. One least tern nest hatched 2 chicks that were observed during 1 survey and the other nest hatched 1 chick that

was last observed at 13 days of age; 4 nests had an unknown fate. One plover chick was observed during a single survey at 3 days of age. Two additional least tern nests at the site had an unknown fate.



Figure 9. Distribution and numbers of least tern and piping plover nests, chicks, and fledglings observed within Program associated habitats during 2012 surveys of sandpits and managed, constructed, or naturally occurring river islands.

**Table 6.** 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 2013. 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 #'s correspond with Figure 3.

								Le	<u>ast ter</u>	<u>n</u>		Piping plover							
Site #	<u>Site Name</u>	Habitat Type <sup>A</sup>	Management <sup>A</sup>	Surveys	Survey Time (hr)	Breeding Pairs <sup>B</sup>	Adults (Max) <sup>B</sup>	Nests	Nests Hatched	Chicks 0-14 Days	Chicks 15-21 Days	Fledglings	<b>Breeding Pairs</b>	Adults (Max)	Nests	Nests Hatched	Chicks 0-14 Days	Chicks 15-28 Days	Fledglings
1	Lexington Pit	SP	PFT	65	93	1	8	1	1	3	0	0	4	9	5	3	11	0	0
2	Paulsen's Lexington Pit	SP	Ν	5	3	0	16	0	0	0	0	0	1	2	1	1	2	2	1
3	Lexington Island <sup>C</sup>	RI	Р	6	3	0	1	0	0	0	0	0	0	1	0	0	0	0	0
4	Dyer Pit	SP	HPFT	102	178	12	20	13	9	20	9	5	4	10	4	4	15	10	3
5	Cottonwood Ranch OCSW	OC	HPFT	72	76	8	11	8	1	2	0	0	1	4	2	1	4	0	0
6	Cottonwood Ranch Islands <sup>C</sup>	OC	HPFT	29	21	0	2	0	0	0	0	0	0	3	0	0	0	0	0
7	Blue Hole Pit	SP	PFT	97	197	6	22	20	10	27	19	19	6	10	6	5	17	12	11
8	Johnson Pit	SP	PFT	12	6	0	1	0	0	0	0	0	0	2	0	0	0	0	0
9	Elm Creek Complex West	RI	Ν	7	5	0	10	0	0	0	0	0	0	4	0	0	0	0	0
10	Elm Creek Complex East	RI	GPT	30	38	0	11	0	0	0	0	0	0	3	0	0	0	0	0
11	Broadfoot South Pit <sup>D</sup>	SP	HPFT	105	231	16	21	31	11	26	15	14	6	17	7	4	14	6	4
12	Newark Pit	SP	HPFT	76	103	0	7	1	1	2	2	2	2	5	2	2	8	3	2
13	Rowe Island Complex	RI	RPT	7	5	0	3	0	0	0	0	0	0	5	0	0	0	0	0
14	Leaman West Island Complex <sup>C</sup>	RI	RBPT	15	17	0	4	0	0	0	0	0	0	1	0	0	0	0	0
15	Leaman East OCSW	OC	RFPT	74	86	1	15	6	4	3	0	0	1	6	1	1	4	4	4
16	Shoemaker Island Complex <sup>E</sup>	RI	DGPT	13	15	0	6	0	0	0	0	0	0	2	0	0	0	0	0
17	Wild Rose Ranch East Pit	SP	HRP	47	38	14	28	15	14	35	25	24	2	6	3	2	7	6	3
18	Follmer Pit	SP	С	7	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	Deweese – Alda Pit	SP	Ν	7	4	0	2	0	0	0	0	0	0	0	0	0	0	0	0
20	Hooker Brothers – GI West Pit	SP	Ν	7	3	0	7	0	0	0	0	0	0	4	0	0	0	0	0
21	Hooker Brothers – GI South Pit	SP	Ν	7	3	0	2	0	0	0	0	0	0	0	0	0	0	0	0

<sup>A</sup> Habitat types include sandpits (SP), off-channel sand and water (OC), or river islands (RI). Management actions applied to each site following the 2012 nesting season and prior to the 2013 nesting season could include: mowed (M), burned (B), disked (D), graded (G), tree/vegetation removal (R), or herbicide (H) during fall 2012; pre-emergent herbicide (P), predator fencing (F), or predator trapping (T) during spring 2013; 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.

<sup>B</sup> Breeding pair counts determined on 20 June for least terns and 31 May for piping plovers when numbers observed within the Program Associated Habitat area first peaked. Breeding pair counts, however, do not 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. Adults (Max) represent the maximum number adults observed during any single survey at the site.

<sup>C</sup> Lexington Island encompasses an NPPD managed area that was attached to the bank. Cottonwood Ranch Islands encompasses a 3 mile stretch of river where 3 islands were created prior to the 2013 nesting season. Elm Creek Complex West encompasses a 1.5-mile stretch of river between Elm Creek Bridge and the Kearney Canal Diversion and includes NPPD's Elm Creek Island. Elm Creek Complex East encompasses a 2-mile stretch of river downstream of the Kearney Canal Diversion where 8 islands were constructed prior to the 2013 nesting season. Leaman West Island Complex encompasses a 1.5 mile stretch of river upstream of the Wood River Bridge and the Shoemaker Island Complex includes a 2-mile stretch of river encompassing the area between 1 and 3 miles upstream of the Alda Bridge where islands were cleared prior to the 2013 nesting season.

<sup>D</sup> Includes 17 least tern and 1 piping plover nest that were located on the non-access islands and that were not monitored on a regular basis like nests on the main peninsula were.

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Figure 10. Distribution and numbers of least tern and piping plover nests, chicks, and fledglings observed within Program associated habitats during 2013 surveys of sandpits and managed, constructed, or naturally occurring river islands.

**Table 7.** Summary of least tern reproductive success at sandpit and river-island sites on the central Platte River in Nebraska, 2007–2013. Site-specific details on numbers of adults, nest, chicks, and fledglings observed during 2012 and 2013 are provided in Tables 5 and 6, respectively. Habitat- and site-specific details of daily, incubation- and brooding-period survival rates for 2012 and 2013 are provided in Appendices 1–2 and 5–6 (Program Mark estimates) and Appendices 9–10 and 13–14 (Mayfield estimates).

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

<sup>A</sup> "-----" indicates these data were not reported.

<sup>B</sup> Brood survival rates are not comparable to past data because 15 day old tern chicks were considered fledged during 2007–2009 and in 2010 the Program began to use 21 days as the fledge age for tern chicks.

*Piping Plovers*: Piping plover nests were observed at 6 of 14 sandpits and 1 river site monitored during 2012 (Table 5; Figure 9). The island where the piping plover pair nested was not managed during 2012, but was disked prior to the 2011 nesting season and was overtopped by the high-flow event during 2011. The first observation of a piping plover nest was made during an incidental survey on 24 April, 2012 and the last nest initiated was first observed on 6 July, 2012. The first observation of a piping plover chick occurred on 22 May, 2012 and the last successful nest observed hatched on 24 July, 2012. At least 1 egg from 70% (32/46) of piping plover nests hatched which resulted in 99



chicks and an overall nest-success rate of 2.15 chicks/nest or 3.30 chicks/breeding pair (99 chicks/30 breeding pairs) during 2012 (Table 8); 1 of these nests was located on a river island and hatched and fledged 4 chicks. Piping plover daily nest survival rate across all sites during 2012 was 0.9870 (range = 0.9813–1.0000; Appendix 3) with no difference observed between sites  $[\chi^2(6, N = 45) = 1.131; p = 0.98]$  or habitat type  $[\chi^2(1, N = 46) = 0.394; p = 0.53]$ ; average incubation-period survival rate was 0.6942 (range = 0.5895–1.0000). We first observed a piping plover fledgling on 19 June, 2012 and the last known piping plover chick to fledge did so on 21 August, 2012. We observed an apparent nest-based fledging rate of 1.28 (59 fledglings/46 nests) and a pair-based fledging rate of 1.97 (59 fledglings/30 breeding pairs) at all sites monitored during 2012 (Table 8). Average daily survival rates for piping plover

broods across all sites during 2012 was 0.9914 (range = 0.9708–1.0000; Appendix 4) with no difference observed between sites  $[\chi^2(6, N = 31) = 5.699; p = 0.46]$  or habitat type  $[\chi^2(1, N = 32) = 0.495; p = 0.48]$ ; average brooding-period survival rate across all sites was 0.7848 (range = 0.4357–1.0000).

Piping plover nests were observed at 9 of 14 sandpits sites we monitored during 2013 (Table 6; Figure 10). The first observation of a piping plover nest was made during an incidental survey on 8 May and the last nest initiated was first observed on 5 July, 2013. The first observation of a piping plover chick occurred on 6 June, 2013 and the last successful nest we observed hatched on 1 August, 2013. At least 1 egg from 74% (23/31) of piping plover nests hatched which resulted in 80 chicks and an overall nest-success rate of 2.58 chicks/nest or 2.96 chicks/breeding pair (80 chicks/27 breeding pairs) during 2013 (Table 8). Piping plover daily nest survival rate across all sites during 2013 was 0.9892 (range = 0.9802– 1.0000; Appendix 7) with no difference observed between sites [ $\chi^2(4, N = 31) = 5.867$ ; p = 0.21]; average incubation-period survival rate was 0.7373 (range = 0.5708–1.0000). We first observed a piping plover fledgling on 5 July, 2013 and the last known piping plover chick to fledge did so on 29 July, 2013. We observed an apparent nest-based fledging rate of 0.68 (21 fledglings/31 nests) and a pair-based fledging rate of 0.78 (21 fledglings/27 breeding pairs) at all sites monitored during 2013 (Table 8). Average daily survival rates for piping plover broods across all sites during 2013 was 0.9831 (range = 0.9231–1.0000; Appendix 8) with significant differences observed between sites [ $\chi^2(4, N = 23) = 15.815$ ; p = 0.0033]; average brooding-period survival rate across all sites was 0.6205 (range = 0.1063–1.0000).

**Table 8.** Summary of piping plover reproductive success at sandpit and river-island sites along the central Platte River in Nebraska, 2007–2012. Site-specific details on numbers of adults, nest, chicks, and fledglings observed during 2012 and 2013 are provided in Tables 5 and 6. Site-specific details of daily, incubation- and brooding-period survival rates for 2012 and 2013 are provided in Appendices 3–4 and 11–12 (Program Mark estimates) and Appendices 7–8 and 15–16 (Mayfield estimates).

	Piping Plover										
<b>Reproductive Parameter</b>	2007	2008	2009	2010	2011	2012	2013				
Adults Observed	52	23	31	46	55	60	68				
Breeding Pairs	19	13	12	20	27	30	27				
Total Nests Observed	27	21	15	33	34	46	31				
Successful Nests (≥1 egg hatched)	15	8	9	21	27	32	23				
Apparent Nest Success	0.56	0.38	0.60	0.64	0.79	0.70	0.74				
Daily Nest Survival Rate (All sites)	0.99	0.98	0.99	0.98	0.99	0.99	0.99				
Incubation-period Survival Rate (All sites)	0.71	0.58	0.67	0.54	0.77	0.69	0.73				
Chicks Observed	44	26	27	76	87	99	80				
Hatch Ratio (Chicks/Nest)	1.63	1.24	1.80	2.30	2.56	2.15	2.58				
Hatch Ratio (Chicks/Breeding Pair)	2.32	1.24	2.25	3.80	3.22	3.30	2.96				
Chicks (15D)	27	10	18	53	61	68	43				
Fledglings (28D)	A			42	45	59	28				
Historic Fledge Ratio (15D Chicks/Nest)	1.00	0.48	1.20	1.61	1.79	1.48	1.39				
Fledge ratio (28D Chicks/Nest)				1.27	1.32	1.28	0.90				
Historic Fledge Ratio (15D Chicks/Breeding Pair)	1.42	0.77	1.50	2.65	2.26	2.27	1.59				
Fledge Ratio (28D Chicks/Breeding Pair)				2.10	1.67	1.97	1.04				
Daily Brood Survival Rate (All sites) <sup>B</sup>		0.94	0.98	0.99	0.99	0.99	0.98				
Brooding-period Survival Rate (All sites) <sup>B</sup>		0.42	0.79	0.70	0.73	0.78	0.62				

<sup>A</sup> "-----" indicates these data were not reported.

<sup>B</sup> Fledgling counts and brood survival rates are not comparable to past data because 15 day old plover chicks were considered fledged during 2007–2009 and in 2010 we began to use 28 days for the fledge age for plover chicks.

*Breeding Pair Counts:* We estimated numbers of tern and plover breeding pairs by adding the number of active and recently (within 5 days) failed nests to the number of active and recently failed or fledged tern and plover broods observed on each day of the nesting season as described above. Least tern breeding pair counts peaked at 64 pairs on 17 June, 2012 and peaked at 58 pairs on 20 June, 2013. Piping plover breeding pair counts peaked at 30 pair on 18 June, 2012 and peaked at 27 pair on 31 May, 2013; these dates were slightly earlier or similar to what we observed in 2010 and 2011. Similar to nest and adult counts, least tern breeding pair counts have increased steadily since 2001 (Figure 11). Piping plover breeding pair counts increased slightly from 2001-2007, declined during 2008 and 2009, and have since increased fairly quickly (Figure 11). Though nesting has occurred on riverine sandbars a few years since 2001, off-channel sandpits have provided the most consistent nesting habitat for both species to date.



**Figure 11.** Comparison of numbers of least tern (top) and piping plover (bottom) river nests, sandpit nests, total nests, 'pairs' (maximum adult count/2), and Program defined breeding pairs observed within the Program Associated Habitat Area, 2001-2013.

#### RESEARCH

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

#### FORAGING HABITS STUDY

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

http://www.platteriverprogram.org/PubsAndData/ProgramLibrary/Foraging%20Habits%20Study.pdf

#### HABITAT COLONIZATION STUDY

In 2011, the Program and USGS entered into an agreement for 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 3 specific objectives that will contribute to the understanding of habitat use by least terns and piping plovers in the CPRV:

#### 1. Dispersal

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

#### 2. Colonization

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

#### 3. Renesting

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

The research is jointly funded by the Program and the USGS-NPWRC. Details about findings of this research can be found in the Draft Research Project Report to be generated by the USGS-NPWRC in early 2014 and in the Final Research Project Report that will be produced after the 2014 nesting season.

Adult and Chick Band Observations – As part of Program-funded research implemented by USGS field crews, 68 adult and 409 juvenile least terns and 53 adult and 307 juvenile piping plovers have been banded along the central Platte River to date (Table 9).

**Table 9.** Summary of numbers of interior least tern and piping plover adults and chicks banded along the central Platte River, 2009–2013.

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
Total	68	409	53	307

After 5 years of banding on the central Platte River, we have compiled valuable information on site and habitat (sandpit or riverine) fidelity and philopatry, wintering ground locations for central Platte River piping plovers, survival and recruitment, re-nesting events, and disturbance. We have observed several adult least terns and piping plovers return to nest at the site where they were banded (and at other sites); however, all banded chicks observed to date that returned to nest have nested at non-natal sites. On multiple occasions, we have observed tern and plover fledglings at non-natal sites late in the nesting season, which may be an indication that fledglings begin selecting nesting habitat for the subsequent year prior to departing for the winter grounds. A detailed summary of what has been observed and learned from banding efforts implemented to date will be available in 2014.



#### SURVEY METHODOLOGY STUDY

*Inside-Outside Monitoring* – Inside and outside counts were obtained at 6 sandpit sites and 1 river island site during 2012 and 7 sandpit sites and 4 river island sites during 2013. Similar to past observations, outside monitoring generally resulted in fewer nests and chicks <5 days old and more chicks >5 days old and fledglings; however, inside counts of chicks >5 days old and fledglings were more similar to outside counts then previously reported. The biggest difference in inside and outside counts and observations during 2012 and 2013 appears to be in numbers of nests and chicks <5 days old that were observed and incorrect associations of chicks and fledglings with nests from outside the colony. The EDO plans to use inside and outside colony count data collected through 2013 to evaluate the potential of adjusting counts when only outside surveys were conducted to make them comparable to times when inside surveys were conducted. We plan to analyze and summarize findings from 2010–2014 following the 2014 nesting season.

#### HABITAT AVAILABILITY ASSESSMENTS

The Program has entered into a contract with Rainwater Basin Joint Venture to assess aerial imagery and LiDAR data and identify in-channel and off-channel habitat areas that conform to the Program's current minimum habitat criteria. Assessment results for 2007–2013 will be available in 2014.

#### HABITAT SELECTION STUDY

The EDO plans to use nest location and habitat assessment data collected through 2013 to evaluate least tern and piping plover habitat selection on the Central Platte River. Results of these evaluations will be available in 2014.

### Appendices

#### **Program Mark Survival Estimates**

Appendix 1. Daily and incubation-period survival rates for least tern nests monitored on sandpits during 2012. Incubation-period nest survival rate =  $(daily nest survival rate)^{21}$ .

	#	# Nests	Exposure	Daily Nest	Daily Nest	Daily Nes Rate 9:	t Survival 5% CI	Incubation Period	Incubation Survival R	Period Nest ate 95% CI
Site	Nests	Lost	Days	Survival Rate	Survival SE	Lower	Upper	Survival Rate	Lower	Upper
Lexington	8	0	171	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Dyer	9	2	174	0.9879	0.0085	0.9531	0.9970	0.7752	0.4178	0.9431
Blue Hole <sup>1</sup>	18	5	344	0.9848	0.0068	0.9640	0.9937	0.7246	0.4855	0.8800
Broadfoot <sup>2</sup>	26	6	482	0.9873	0.0051	0.9721	0.9943	0.7652	0.5669	0.8903
Newark	6	2	97	0.9782	0.0152	0.9172	0.9946	0.6302	0.2319	0.9058
Wild Rose <sup>3</sup>	11	3	209	0.9849	0.0086	0.9543	0.9951	0.7268	0.4150	0.9089
DeWeese <sup>3</sup>	4	1	67	0.9841	0.0158	0.8958	0.9978	0.7146	0.1994	0.9618
All Sites	82	19	1544	0.9872	0.0029	0.9800	0.9918	0.7631	0.6585	0.8433

<sup>1</sup> Includes 6 nests documented from inside the nesting area not observed during outside surveys; 5 of these nests failed and 1 hatched 3 chicks. <sup>2</sup> 'Broadfoot' represents the main peninsula at Broadfoot South and excludes 6 nests on islands that we could not access; 2 of which hatched; 4 had an 'unknown' fate. <sup>3</sup> 'Wild Rose' represents Wild Rose Ranch East Pit and 'DeWeese' represents the DeWeese-Alda Sandpit.

Appendix 2. Daily and brooding-period survival rates for least tern broods (1 or more chicks) monitored on sandpits during 2012. Brooding-period brood survival rate =  $(daily brood survival rate)^{21}$ .

						Daily Broo	d Survival		Brooding Pe	riod Survival
	#	# Broods	Exposure	Daily Brood	Daily Brood	Rate 95	5% CI	Brooding Period	Rate 9	95% CI
Site	Broods	Lost	Days	Survival Rate	Survival SE	Lower	Upper	Survival Rate	Lower	Upper
Lexington	8	2	130	0.9837	0.0115	0.9371	0.9959	0.7077	0.3196	0.9258
Dyer	6	2	96	0.9889	0.0111	0.9254	0.9984	0.7908	0.2954	0.9715
Blue Hole	13	1	257	0.9959	0.0041	0.9716	0.9994	0.9175	0.5899	0.9885
Broadfoot <sup>1</sup>	19	5	317	0.9865	0.0067	0.9645	0.9949	0.7514	0.4948	0.9032
Newark	4	0	77	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Wild Rose <sup>2</sup>	8	2	134	0.9842	0.0111	0.9392	0.9961	0.7165	0.3311	0.9280
DeWeese <sup>2</sup>	3	0	61	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
All Sites	61	12	1072	0.9901	0.0031	0.9817	0.9947	0.8116	0.6843	0.8954

<sup>1</sup> 'Broadfoot' represents the main peninsula at Broadfoot South and excludes 2 broods located on islands that we could not access; 1 of these chicks fledged. <sup>2</sup> 'Wild Rose' represents Wild Rose Ranch East Pit and 'DeWeese' represents the DeWeese-Alda Sandpit.

Site	#	# Nests	Exposure	Daily Nest	Daily Nest	Daily Nes Rate 9	st Survival 5% CI	_ Incubation Period	Incubation Survival Ra	Period Nest ate 95% CI
Site	Nests	Lost	Days	Survival Rate	Survival SE	Lower	Upper	Survival Rate	Lower	Upper
Lexington <sup>1</sup>	8	2	203	0.9898	0.0072	0.9601	0.9974	0.7504	0.3790	0.9367
Dyer	7	2	180	0.9885	0.0081	0.9552	0.9971	0.7234	0.3404	0.9298
Blue Hole <sup>2</sup>	18	6	397	0.9843	0.0064	0.9655	0.9929	0.6419	0.3996	0.8284
Broadfoot <sup>3</sup>	5	1	124	0.9916	0.0084	0.9428	0.9988	0.7896	0.2935	0.9713
Newark	3	1	67	0.9845	0.0154	0.8980	0.9978	0.6456	0.1394	0.9535
Wild Rose <sup>4</sup>	3	1	56	0.9813	0.0185	0.8788	0.9974	0.5895	0.1032	0.9471
All Sandpits	44	13	1027	0.9869	0.0036	0.9775	0.9923	0.6904	0.5377	0.8104
ECC Island <sup>5</sup>	1	0	16	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
All Sites	45	13	1043	0.9870	0.0036	0.9778	0.9925	0.6942	0.5426	0.8129

Appendix 3. Daily and incubation-period survival rates for piping plover nests monitored on sandpits and a river island site during 2012. Incubationperiod nest survival rate =  $(\text{daily nest survival rate})^{28}$ .

<sup>1</sup> Includes 2 nests located outside the fenced nesting areas; 1 nest failed and the other nest fledged at least 2 chicks.

<sup>2</sup> Includes 1 nest located outside the fenced nesting area that was believed to have failed as no chicks were ever observed. Also includes 3 nests observed from inside the nesting area, but not observed during outside surveys; 2 nests failed and 1 hatched.

<sup>3</sup> 'Broadfoot' represents the main peninsula at Broadfoot South and excludes 1 nest located on an island that we could not access; the nest hatched at least 1 chick that was observed during a single survey.

<sup>4</sup> 'Wild Rose' represents Wild Rose Ranch East Pit.
 <sup>5</sup> 'ECC Island' represents an island within the Elm Creek Complex between the Elm Creek Bridge and NPPD's Kearney Canal Diversion.

	#	# Broods	Exposure	Daily Brood	Dai d Daily Brood	Daily Broo Rate 95	d Survival 5% CI	Brooding Period	Brooding Pe Rate 9	riod Survival 95% CI
Site	Broods	# Dioods Lost	Days	Survival Rate	Survival SE	Lower	Upper	Survival Rate	Lower	Upper
Lexington <sup>1</sup>	6	1	141	0.9926	0.0074	0.9495	0.9990	0.8127	0.3312	0.9744
Dyer	4	0	107	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Blue Hole	12	2	282	0.9926	0.0052	0.9709	0.9982	0.8124	0.4826	0.9526
Broadfoot <sup>2</sup>	4	2	72	0.9708	0.0204	0.8904	0.9927	0.4357	0.0911	0.8561
Newark	2	1	52	0.9800	0.0198	0.8712	0.9972	0.5680	0.0917	0.9448
Wild Rose <sup>3</sup>	2	0	47	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
All Sandpits	30	6	701	0.9910	0.0036	0.9802	0.9960	0.7769	0.5847	0.8960
ECC Island <sup>4</sup>	1	0	29	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
All Sites	31	6	730	0.9914	0.0035	0.9810	0.9961	0.7848	0.5970	0.8998

Appendix 4. Daily and brooding-period survival rates for piping plover broods (1 or more chicks) monitored on sandpits and a river island site during 2012. Brooding-period survival rate =  $(\text{daily brood survival rate})^{28}$ .

<sup>1</sup> Includes 1 piping plover brood located outside the fenced nesting areas that fledged at least 2 chicks. <sup>2</sup> 'Broadfoot' represents the main peninsula at Broadfoot South and excludes 1 brood located on an island that we could not access; a brood of 1 chick was observed during a single survey.

<sup>3</sup> 'Wild Rose' represents Wild Rose Ranch East Pit.
 <sup>4</sup> 'ECC Island' represents an island within the Elm Creek Complex between the Elm Creek Bridge and NPPD's Kearney Canal Diversion.

Daily Nest Survival Incubation Period Nest Rate 95% CI Survival Rate 95% CI # Exposure Daily Nest # Nests **Daily Nest Incubation** Period Site<sup>1</sup> Nests Days Survival Rate Survival SE Lower Upper Survival Rate Lower Upper Lost 21 0.0000 1.0000 1.0000 1.0000 Lexington 1 0 1.0000 1.0000 1.0000 13 0.0083 Dyer 4 250 0.9832 0.9562 0.9937 0.7010 0.4226 0.8825 8 0.8722 0.9694 Cottonwood 7 0.0234 115 0.9363 0.2511 0.0784 0.5691 Blue Hole 20 10 307 0.9657 0.0107 0.9375 0.9815 0.4808 0.2786 0.6894 Broadfoot 31 17 346 0.9629 0.0089 0.9409 0.9768 0.4517 0.2919 0.6221 0 1.0000 1.0000 Newark 1 19 0.0000 1.0000 1.0000 1.0000 1.0000 6 2 113 0.9815 0.0130 0.9290 0.9954 0.6752 0.2801 0.9174 Leaman 0.9995 0.9250 Wild Rose 15 1 285 0.9963 0.0037 0.9742 0.6167 0.9895 95 0.9729 0.0042 0.9634 0.5621 0.4618 0.6577 All Sites 41 1455 0.9800

**Appendix 5.** Daily and incubation-period survival rates for least tern nests monitored on sandpits during 2013. Incubation-period nest survival rate =  $(\text{daily nest survival rate})^{21}$ .

<sup>1</sup> 'Broadfoot' represents Broadfoot South; 'Cottonwood' represents the Cottonwood Ranch Off-channel Sand and Water; and 'Wild Rose' represents Wild Rose Ranch East Pit.

**Appendix 6.** Daily and brooding-period survival rates for least tern broods (1 or more chicks) monitored on sandpits during 2013. Brooding-period brood survival rate =  $(\text{daily brood survival rate})^{21}$ .

	#	# Broods	Exposure	Daily Brood	Daily Brood	Daily Brood Survival od <u>Rate 95% CI</u>		al Brooding Period	Brooding Period Survival Rate 95% CI	
Site <sup>1</sup>	Broods	Lost	Days	Survival Rate	Survival SE	Lower	Upper	Survival Rate	Lower	Upper
Lexington	1	1	7	0.8333	0.1521	0.3687	0.9772	0.0217	0.0001	0.9797
Dyer	9	3	155	0.9789	0.0120	0.9367	0.9932	0.6396	0.3036	0.8784
Cottonwood	1	1	11	0.9036	0.0922	0.5406	0.9868	0.1190	0.0011	0.9408
Blue Hole	10	1	184	0.9943	0.0057	0.9605	0.9992	0.8863	0.4932	0.9842
Broadfoot	11	5	171	0.9753	0.0122	0.9360	0.9907	0.5912	0.2908	0.8361
Newark	1	0	16	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Leaman	4	4	29	0.8466	0.0712	0.6532	0.9417	0.0303	0.0009	0.5258
Wild Rose	14	4	232	0.9036	0.0922	0.5406	0.9867	0.6176	0.3484	0.8298
All Sites	51	19	804	0.9749	0.0057	0.9610	0.9839	0.5864	0.4424	0.7170

<sup>1</sup> 'Broadfoot' represents Broadfoot South; 'Cottonwood' represents the Cottonwood Ranch Off-channel Sand and Water; and 'Wild Rose' represents Wild Rose Ranch East Pit. **Appendix 7.** Daily and incubation-period survival rates for piping plover nests monitored on sandpits during 2013. Incubation-period nest survival rate =  $(\text{daily nest survival rate})^{28}$ .

#		# Nasta	Exposure	Daily Nest	Daily Nest	Daily Nest Survival Rate 95% CI		In out of Daried	Incubation Period Nest Survival Rate 95% CI	
Site <sup>1</sup>	# Nests	# Nests Lost	Days	Survival Rate	Survival SE	Lower	Upper	Survival Rate	Lower	Upper
Lexington	5	2	115	0.9820	0.0126	0.9308	0.9955	0.6010	0.2044	0.8983
Paulsen	1	0	28	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Dyer	4	0	114	0.9926	0.0074	0.9495	0.9990	0.8126	0.3310	0.9744
Cottonwood	2	1	52	0.9802	0.0196	0.8721	0.9972	0.5708	0.0931	0.9452
Blue Hole	6	1	141	0.9926	0.0074	0.9495	0.9990	0.8126	0.3310	0.9744
Broadfoot	7	3	171	0.9819	0.0104	0.9453	0.9941	0.5991	0.2603	0.8639
Newark	2	0	58	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Leaman	1	0	29	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Wild Rose	3	1	84	0.9877	0.0122	0.9180	0.9983	0.7077	0.1925	0.9609
All Sites	31	8	765	0.9892	0.0038	0.9785	0.9946	0.7373	0.5567	0.8624

<sup>1</sup> 'Paulsen' represents Paulsen's Lexington sandpit; 'Broadfoot' represents Broadfoot South; 'Cottonwood' represents the Cottonwood Ranch Off-channel Sand and Water; and 'Wild Rose' represents Wild Rose Ranch East Pit.

**Appendix 8.** Daily and brooding-period survival rates for piping plover broods (1 or more chicks) monitored on sandpits during 2013. Brooding-period brood survival rate =  $(\text{daily brood survival rate})^{28}$ .

	#	# Broods	Exposure	Daily Brood	Daily Brood	Daily Brood Rate 95	d Survival	Brooding Period	Brooding Pe Rate 9	riod Survival 95% CI
Site <sup>1</sup>	Broods	Lost	Days	Survival Rate	Survival SE	Lower	Upper	Survival Rate	Lower	Upper
Lexington	3	3	31	0.8970	0.0567	0.7232	0.9667	0.0476	0.0013	0.6568
Paulsen	1	0	29	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Dyer	4	1	100	0.9895	0.0105	0.9291	0.9985	0.7435	0.2314	0.9654
Cottonwood	1	1	14	0.9231	0.0739	0.6094	0.9893	0.1063	0.0009	0.9420
Blue Hole	5	0	124	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Broadfoot	4	2	73	0.9712	0.0201	0.8921	0.9928	0.4415	0.0941	0.8574
Newark	2	0	50	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Leaman	1	0	25	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Wild Rose	2	1	49	0.9789	0.0208	0.8650	0.9970	0.5510	0.0833	0.9431
All Sites	23	8	494	0.9831	0.0059	0.9666	0.9915	0.6205	0.4062	0.7963

<sup>1</sup> 'Paulsen' represents Paulsen's Lexington sandpit; 'Broadfoot' represents Broadfoot South; 'Cottonwood' represents the Cottonwood Ranch Off-channel Sand and Water; and 'Wild Rose' represents Wild Rose Ranch East Pit.

#### PRRIP 2012-2013 Tern and Plover Report

#### **Mayfield Survival Estimates**

Appendi	x 9. Daily and incubation-period st	irvival rates for least tern nests	monitored on sandpits during 20	12. Incubation-period nest survival rate =
(daily nes	st survival rate) <sup>21</sup> .			

	#	# Nests	Exposure	Daily Nest	Daily Nest	Daily Nest Survival Rate 95% CI		Incubation Period	Incubation Period Nes Survival Rate 95% CI	
Site	Nests	Lost	Days	Survival Rate	Survival SE	Lower	Upper	Survival Rate	Lower	Upper
Lexington	8	0	171	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Dyer	9	2	174	0.9885	0.0081	0.9727	1.0043	0.7844	0.5588	1.0953
Blue Hole <sup>1</sup>	18	5	344	0.9855	0.0065	0.9728	0.9981	0.7353	0.5606	0.9611
Broadfoot <sup>2</sup>	26	6	482	0.9876	0.0051	0.9777	0.9975	0.7687	0.6221	0.9478
Newark	6	2	97	0.9794	0.0144	0.9511	1.0077	0.6456	0.3490	1.1738
Wild Rose <sup>3</sup>	11	3	209	0.9856	0.0082	0.9695	1.0018	0.7381	0.5220	1.0379
DeWeese <sup>3</sup>	4	1	67	0.9851	0.0148	0.9560	1.0141	0.7292	0.3890	1.3421
All Sites	82	19	1544	0.9877	0.0028	0.9822	0.9932	0.7710	0.6857	0.8664

<sup>1</sup> Includes 6 nests documented from inside the nesting area not observed during outside surveys; 5 of these nests failed and 1 hatched 3 chicks. <sup>2</sup> 'Broadfoot' represents the main peninsula at Broadfoot South and excludes 6 nests on islands that we could not access; 2 of these nests hatched, the fate of the other 4 nests was 'unknown'.

<sup>3</sup> 'Wild Rose' represents Wild Rose Ranch East Pit and 'DeWeese' represents the DeWeese-Alda Sandpit.

Appendix 10. Daily and brooding-period survival rates for least tern broods (1 or more chicks) monitored on sandpits during 2012. Brooding-period brood survival rate =  $(\text{daily brood survival rate})^{21}$ .

						Daily Broo	Brooding Period Survival			
	#	# Broods	Exposure	Daily Brood	Daily Brood	Rate 95	5% CI	Brooding Period	Rate 9	95% CI
Site	Broods	Lost	Days	Survival Rate	Survival SE	Lower	Upper	Survival Rate	Lower	Upper
Lexington	8	2	130	0.9846	0.0108	0.9635	1.0058	0.7221	0.4576	1.1285
Dyer	6	2	96	0.9792	0.0146	0.9506	1.0077	0.6427	0.3451	1.1757
Blue Hole	13	1	257	0.9961	0.0039	0.9885	1.0037	0.9214	0.7843	1.0811
<b>Broadfoot</b> <sup>1</sup>	19	5	317	0.9842	0.0070	0.9705	0.9979	0.7161	0.5333	0.9577
Newark	4	0	77	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Wild Rose <sup>2</sup>	8	2	134	0.9851	0.0105	0.9645	1.0056	0.7292	0.4686	1.1245
DeWeese <sup>2</sup>	3	0	61	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
All Sites	61	12	1072	0.9888	0.0032	0.9825	0.9951	0.7895	0.6903	0.9021

<sup>1</sup> 'Broadfoot' represents the main peninsula at Broadfoot South and excludes 2 broods located on islands that we could not access; 1 of these chicks fledged.
 <sup>2</sup> 'Wild Rose' represents Wild Rose Ranch East Pit and 'DeWeese' represents the DeWeese-Alda Sandpit.

	#	# Nests	Exposure	Daily Nest	Daily Nest	Daily Nest Survival Rate 95% CI		_ Incubation Period	Incubation Period Nest Survival Rate 95% CI	
Site	Nests	Lost	Days	Survival Rate	Survival SE	Lower	Upper	Survival Rate	Lower	Upper
Lexington <sup>1</sup>	8	2	203	0.9901	0.0069	0.9766	1.0037	0.8123	0.6077	1.0814
Dyer	7	2	180	0.9889	0.0078	0.9736	1.0042	0.7909	0.5699	1.0921
Blue Hole <sup>2</sup>	18	6	397	0.9849	0.0061	0.9729	0.9969	0.6263	0.5614	0.9366
Broadfoot <sup>3</sup>	5	1	124	0.9919	0.0080	0.9762	1.0077	0.8436	0.6029	1.1742
Newark	3	1	67	0.9851	0.0148	0.9560	1.0141	0.7292	0.3890	1.3421
Wild Rose <sup>3</sup>	3	1	56	0.9821	0.0177	0.9475	1.0168	0.6850	0.3219	1.4197
All Sandpits	44	13	1027	0.9873	0.0035	0.9805	0.9942	0.7653	0.6614	0.8846
ECC Island <sup>3</sup>	1	0	16	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
All Sites	45	13	1043	0.9875	0.0034	0.9808	0.9943	0.7684	0.6656	0.8863

**Appendix 11.** Daily and incubation-period survival rates for piping plover nests monitored on sandpits and a river island site during 2012. Incubationperiod nest survival rate =  $(daily nest survival rate)^{28}$ .

<sup>1</sup> Includes 2 nests located outside the fenced nesting areas; 1 nest failed and the other nest fledged at least 2 chicks.

 $^{2}$  Includes 1 nest located outside the fenced nesting area that was believed to have failed as no chicks were ever observed. Also includes 3 nests observed from inside the nesting area, but not observed during outside surveys; 2 nests failed and 1 hatched.

<sup>3</sup> 'Broadfoot' represents the main peninsula at Broadfoot South and excludes 1 nest located on an island that we could not access; the nest hatched at least 1 chick that was observed during a single survey; 'Wild Rose' represents Wild Rose Ranch East Pit; and 'ECC Island' represents an island within the Elm Creek Complex between the Elm Creek Bridge and NPPD's Kearney Canal Diversion.

	#	# Broods	Exposure	Daily Brood	Da d Daily Brood	Daily Brood Survival Rate 95% CI		Brooding Period	Brooding Period Survival Rate 95% CI	
Site	Broods	Lost	Days	Survival Rate	Survival SE	Lower	Upper	Survival Rate	Lower	Upper
Lexington <sup>1</sup>	6	1	141	0.9929	0.0071	0.9791	1.0068	0.8612	0.6412	1.1520
Dyer	4	0	107	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Blue Hole	12	2	282	0.9929	0.0050	0.9831	1.0027	0.8612	0.6993	1.0583
Broadfoot <sup>2</sup>	4	2	72	0.9722	0.0194	0.9343	1.0102	0.5534	0.2398	1.2371
Newark	2	1	52	0.9808	0.0190	0.9434	1.0181	0.6651	0.2944	1.4574
Wild Rose <sup>3</sup>	2	0	47	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
All Sandpits	30	6	701	0.9914	0.0035	0.9846	0.9983	0.8348	0.7222	0.9641
ECC Island <sup>4</sup>	1	0	29	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
All Sites	31	6	730	0.9918	0.0033	0.9852	0.9983	0.8409	0.7316	0.9655

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 2012. Brooding-period survival rate =  $(\text{daily brood survival rate})^{28}$ .

<sup>1</sup> Includes 1 piping plover brood located outside the fenced nesting areas that fledged at least 2 chicks. <sup>2</sup> 'Broadfoot' represents the main peninsula at Broadfoot South and excludes 1 brood located on an island that we could not access; the brood of 1 chick was only observed during a single survey.

<sup>3</sup> 'Broadfoot' represents the main peninsula at Broadfoot South; 'Wild Rose' represents Wild Rose Ranch East Pit; and 'ECC Island' represents an island within the Elm Creek Complex between the Elm Creek Bridge and NPPD's Kearney Canal Diversion.

Daily Nest Survival Incubation Period Nest Rate 95% CI Survival Rate 95% CI # Exposure Daily Nest # Nests **Daily Nest Incubation** Period Site<sup>1</sup> Nests Days Survival Rate Survival SE Lower Upper Survival Rate Lower Upper Lost 21 0.0000 1.0000 1.0000 1.0000 Lexington 1 0 1.0000 1.0000 1.0000 13 0.0079 0.9996 Dyer 4 250 0.9840 0.9684 0.7127 0.5100 0.9907 8 0.9391 0.9828 Cottonwood 7 0.0223 0.8954 0.2675 115 0.0983 0.6951 Blue Hole 20 10 307 0.9674 0.0101 0.9476 0.9873 0.4989 0.3227 0.7643 Broadfoot 31 17 346 0.9509 0.0116 0.9281 0.9736 0.3471 0.2086 0.5707 0 1.0000 Newark 1 19 0.0000 1.0000 1.0000 1.0000 1.0000 1.0000 6 2 113 0.9823 0.0124 0.9580 1.0066 0.6873 0.4060 1.1484 Leaman 1.0034 Wild Rose 15 1 285 0.9965 0.0035 0.9896 0.9288 0.8033 1.0729 95 0.9718 0.0043 0.9633 0.5487 0.4562 All Sites 41 1455 0.9803 0.6588

**Appendix 13.** Daily and incubation-period survival rates for least tern nests monitored on sandpits during 2013. Incubation-period nest survival rate =  $(\text{daily nest survival rate})^{21}$ .

<sup>1</sup> 'Broadfoot' represents Broadfoot South; 'Cottonwood' represents the Cottonwood Ranch Off-channel Sand and Water; and 'Wild Rose' represents Wild Rose Ranch East Pit.

**Appendix 14.** Daily and brooding-period survival rates for least tern broods (1 or more chicks) monitored on sandpits during 2013. Brooding-period brood survival rate =  $(\text{daily brood survival rate})^{21}$ .

	#	# Broods	Exposure	Daily Brood	Daily Brood	Daily Brood Survival d <u>Rate 95% CI</u>		Brooding Period	Brooding Period Survival Rate 95% CI	
Site <sup>1</sup>	Broods	Lost	Days	Survival Rate	Survival SE	Lower	Upper	Survival Rate	Lower	Upper
Lexington	1	1	7	0.8571	0.1323	0.5979	1.1164	0.0393	0.0000	10.0923
Dyer	9	3	155	0.9806	0.0111	0.9590	1.0023	0.6634	0.4147	1.0502
Cottonwood	1	1	11	0.9091	0.0867	0.7392	1.0790	0.1351	0.0018	4.3950
Blue Hole	10	1	184	0.9946	0.0054	0.9839	1.0052	0.8919	0.7118	1.1148
Broadfoot	11	5	171	0.9708	0.0129	0.9455	0.9960	0.5362	0.3083	0.9195
Newark	1	0	16	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Leaman	4	4	29	0.8621	0.0640	0.7366	0.9876	0.0443	0.0016	0.7691
Wild Rose	14	4	232	0.9828	0.0085	0.9660	0.9995	0.6940	0.4837	0.9897
All Sites	51	19	804	0.9764	0.0054	0.9659	0.9869	0.6052	0.4823	0.7576

<sup>1</sup> 'Broadfoot' represents Broadfoot South; 'Cottonwood' represents the Cottonwood Ranch Off-channel Sand and Water; and 'Wild Rose' represents Wild Rose Ranch East Pit. Appendix 15. Daily and incubation-period survival rates for piping plover nests monitored on sandpits during 2013. Incubation-period nest survival rate =  $(\text{daily nest survival rate})^{28}$ .

	#	# Nests	Exposure	Daily Nest	Daily Nest	Daily Nest Survival Rate 95% CI		- Incubation Period	Incubation Period Nest Survival Rate 95% CI	
Site <sup>1</sup>	Nests	Lost	Days	Survival Rate	Survival SE	Lower	Upper	Survival Rate	Lower	Upper
Lexington	5	2	115	0.9826	0.0122	0.9587	1.0065	0.6918	0.4126	1.1458
Paulsen	1	0	28	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Dyer	4	0	114	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Cottonwood	2	1	52	0.9808	0.0190	0.9434	1.0181	0.6651	0.2944	1.4574
Blue Hole	6	1	141	0.9929	0.0071	0.9791	1.0068	0.8612	0.6412	1.1520
Broadfoot	7	3	171	0.9825	0.0100	0.9628	1.0021	0.6896	0.4509	1.0458
Newark	2	0	58	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Leaman	1	0	29	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Wild Rose	3	1	84	0.9881	0.0118	0.9649	1.0113	0.7776	0.4722	1.2659
All Sites	31	8	765	0.9895	0.0037	0.9823	0.9968	0.8019	0.6878	0.9339

<sup>1</sup> 'Paulsen' represents Paulsen's Lexington sandpit; 'Broadfoot' represents Broadfoot South; 'Cottonwood' represents the Cottonwood Ranch Off-channel Sand and Water; and 'Wild Rose' represents Wild Rose Ranch East Pit.

**Appendix 16.** Daily and brooding-period survival rates for piping plover broods (1 or more chicks) monitored on sandpits during 2013. Brooding-period brood survival rate =  $(\text{daily brood survival rate})^{28}$ .

	#	# Broods	Exposure	Daily Brood	Daily Brood	Daily Brood Rate 95	d Survival 5% CI	Brooding Period	Brooding Pe Rate 9	riod Survival 95% CI
Site <sup>1</sup>	Broods	Lost	Days	Survival Rate	Survival SE	Lower	Upper	Survival Rate	Lower	Upper
Lexington	3	3	31	0.9032	0.0531	0.7991	1.0073	0.1180	0.0090	1.1651
Paulsen	1	0	29	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Dyer	4	1	100	0.9900	0.0099	0.9705	1.0095	0.8097	0.5332	1.2197
Cottonwood	1	1	14	0.9286	0.0688	0.7937	1.0635	0.2109	0.0078	3.6417
Blue Hole	5	0	124	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Broadfoot	4	2	73	0.9726	0.0191	0.9352	1.0100	0.5580	0.2447	1.2337
Newark	2	0	50	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Leaman	1	0	25	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Wild Rose	2	1	49	0.9796	0.0202	0.9400	1.0192	0.6486	0.2727	1.4903
All Sites	23	8	494	0.9838	0.0057	0.9727	0.9949	0.7097	0.5589	0.8989

All Sites 25 8 494 0.9838 0.0057 0.9727 0.9949 0.7097 0.5589 0.8989 <sup>1</sup> 'Paulsen' represents Paulsen's Lexington sandpit; 'Broadfoot' represents Broadfoot South; 'Cottonwood' represents the Cottonwood Ranch Off-channel Sand and Water; and 'Wild Rose' represents Wild Rose Ranch East Pit.