



NEBRASKA
- GAME PARKS -
Nongame
Bird
Program

2017

**INTERIOR LEAST TERN AND
PIPING PLOVER ANNUAL REPORT
FOR THE LOWER PLATTE RIVER,
NEBRASKA**

2017 INTERIOR LEAST TERN AND PIPING PLOVER ANNUAL REPORT FOR THE LOWER PLATTE RIVER, NEBRASKA



PREPARED BY

Mary Bomberger Brown

Tern and Plover Conservation Partnership
School of Natural Resources
University of Nebraska
3310 Holdrege Street
Lincoln, Nebraska 68583
(402) 472-8878
mbrown9@unl.edu
<http://ternandplover.unl.edu>



Lauren R. Dinan

Joel G. Jorgensen
Nongame Bird Program
Wildlife Division

Nebraska Game and Parks Commission
2200 North 33rd Street
Lincoln, Nebraska 68521
(402) 471-5440

ngpc.nongamebird.temp@nebraska.gov
joel.jorgensen@nebraska.gov

RECOMMENDED CITATION

Brown, M.B., L.R. Dinan and J.G. Jorgensen. 2017. 2017 Interior Least Tern and Piping Plover Annual Report for the Lower Platte River, Nebraska. Joint report of the Tern and Plover Conservation Partnership and the Nongame Bird Program of the Nebraska Game and Parks Commission. Lincoln, NE.

Unless otherwise noted, all photographs were taken by Lauren R. Dinan.

ACKNOWLEDGEMENTS

We extend our thanks to everyone who helped with this project in anyway including collecting field data, reporting color bands, helping with education outreach activities, etc.

Linda Alley	Karie Decker	Brooke Hill	Melissa Panella	Jessica Schulz
Tony Amos	Roseanna Denton	Petra Hockey	Neil Paprocki	Roger Severin
Amanda Anderson	Rangel Diaz	Jack Huck	Gary Pearson	Mark Sherfy
Justin Arndt	Robin Diaz	Kelsi Hunt	Kris Petersen	Rachel Simpson
Melinda Averhart	Rick Drapal	TJ Hyland	Brian Peterson	Meghan Sittler
Tim Badow	Shaun Dunn	Dave Kendle	Andrea Pico Estrada	Al Smiley
Larry Barnes	Gil Eckrich	Joseph Kennedy	Joe Pille	Jon Sohl
Mark Bartosik	Thomas Econopouly	Mel Kucera	Larkin Powell	Kristal Stoner
Stephanie Bilodeau	Robert Finer	LaVern Kwapnioski	Raya Pruner	Jennifer Stucker
Dave Brakenhoff	Michael Forsberg	Dave Lanoha	Matt Rabbe	Marilyn Tabor
Ann Briggs	Jim Fraser	Greg Lasley	Kory Renaud	Brooke Talbott
Mark Brohman	Meryl Friedrich	Delaina LeBlanc	Amy Reznicek	Mary Thies
Lindsay Brown	Mark Garland	Sidney Maddock	Tim Reznicek	Dennis Thomas
Bryan Campbell	Kristine Grab	Lorraine Margeson	Troy Richter	Lezlie Thomas
Keith Carroll	Cheri Gratto-Trevor	Jess McClean	Mike Riley	Joel Throckmorton
Dan Catlin	Carey Grell	Tom Melton	Megan Ring	Dave Titterington
Michael Cerizo	Andrew Haffenden	Al Menk	Doug Ritthaler	Andrea Webb
Kevin Christman	Greg Hall	Mark Mesarch	Matt Rogosky	Bryan White
Amanda Ciurej	Alisa Halpin	Dan Muhleisen	Robert Roos	Carol White
Willard Clark	Monica Hardin	Conrad Muilenburg	Meg Rousher	Jennifer Wilson
James Conery	Robert Harms	John Murphy	Jeff Runge	Sara Zeigler
John Cooper	Susan Heath	David Newstead	Ben Sandstorm	Suzanne Zuckerman
Justin Cuevas	Leslie Hershberger	Scott Norman	Rick Schneider	Tim Zuehlke

We thank our partners for their contribution to this project in 2017.

Bluewater Development Corp.	Lower Platte North NRD	Old Castle Materials	Sandy Pointe Development
Central Sand and Gravel	Lower Platte South NRD	Overland Sand and Gravel	U.S. Army Corps of Engineers
Lake Allure HOA	Lyman-Richey Corp.	Papio-Missouri NRD	U.S. Fish and Wildlife Service
Lake Socorro HOA	Mallard Sand and Gravel	Preferred Sands of Geno	U.S. Geological Survey
Lanoha Development Co.	Nebraska Natural Legacy Project	Ritz Lake Development	Western Sand and Gravel
Loup Power District	Nebraska Public Power District	Riverview Shores HOA	

We thank the following organizations for their financial support for this project in 2017.



PREFACE

This document reports on our monitoring, research, management, and outreach activities during the past 12 months (Sep. 2016 – Aug. 2017). We prepared it to inform our partners, cooperating agencies, funding sources, and other interested parties of our activities and to provide a preliminary summary of our results.

The data, data analyses, results, summaries, and interpretations found in this document are not final and should be considered as such when being cited or referred to in documents, reports, proposals, or presentations. Please contact us before using any of this material and for additional information that may be available.

In an effort to make the information in this document more accessible, it is divided into five (5) sections: Introduction, Monitoring, Research, Management, and Outreach.

Introduction: This section describes the project area and summarizes conditions encountered during the 2017 field season.

Monitoring: This section describes the data we collect every year for basic demographic analyses and includes the number of nests and chicks found in the focus area. These data are collected and summarized in a form that allows comparison across the ranges of both species.

Research: This section describes our research objectives, research methods, data collection, and data analyses.

Management: This section describes our actions intended to protect Interior Least Terns and Piping Plovers and their nests from interference and disturbance.

Outreach: This section describes our efforts to increase public awareness and understanding of Interior Least Terns and Piping Plovers and to promote environmental literacy.



DEFINITIONS

OFF-RIVER SITE DEFINITIONS

Active mine – an off-river site managed by a sand and gravel mining company that is actively mined and is regulated by the Mine Safety and Health Administration (MSHA).

Inactive mine – an off-river site managed by a sand and gravel mining company but is no longer actively mined and is no longer regulated by the Mine Safety and Health Administration (MSHA).

Lakeshore housing development – an off-river site, usually managed by a homeowners association, with at least one house on the property that an individual or family occupies for all or part of the year.

Off-river site – Any area used as breeding habitat by terns and plovers located away from a river channel.

Transition site – an off-river site that is no longer managed by a sand and gravel mining company or regulated by the Mine Safety and Health Administration (MSHA) and does not have homeowners in residence on the property; transition sites are primarily managed by the real estate developer rather than a sand and gravel mining company or a homeowners association.

SURVIVAL DEFINITIONS

Annual survival probability – the probability that an animal alive during one time period (i.e., year) will still be alive the next equivalent time period (van der Toorn 1997).

Daily survival probability – the probability that a nest intact or animal alive one day will still be intact or alive the next day (van der Toorn 1997).

Recapture probability – the probability that a previously marked animal will be re-sighted or captured during a session (Lettink and Armstrong 2003).

Seasonal survival probability – the probability that a nest or animal will survive the entire incubation period (nests), incubation and chick-rearing period (adults), or pre-fledging period (chicks); it is estimated by extending the daily survival probability over the appropriate number of days.

AGE DEFINITIONS

Adult – life stage after completing first migration cycle (winter-spring); a bird is in adult plumage one year of age or older and capable of breeding.

After hatch year – a bird in at least its second calendar year of life (Pyle 1997).

Chick – life stage from hatching to when a bird is capable of flight (plover: hatch day to 27 days post-hatch; tern: hatch day to 20 days post-hatch).

Fledgling – Brief period when a juvenile bird is capable of short flights but is still dependent on parental care.

Hatch year – a bird in first-basic plumage during its first calendar year of life (Pyle 1997).

Juvenile – a bird in juvenal plumage, before the first prebasic molt (Pyle 1997).

INTRODUCTION

The lower Platte River and its major tributaries provide important nesting and migratory stopover habitat for two bird species of special conservation concern, the Endangered Species Act (ESA) – endangered Interior Least Tern (*Sternula antillarum athalassos*) and the ESA - threatened Piping Plover (*Charadrius melodus*). The Tern and Plover Conservation Partnership (TPCP), based at the University of Nebraska-Lincoln School of Natural Resources, and Nongame Bird Program (NBP), based at the Nebraska Game and Parks Commission (NGPC), work cooperatively on Interior Least Tern and Piping Plover monitoring, research, management, and outreach activities in Nebraska. Our monitoring and research efforts are primarily focused along the lower Platte, Loup, and Elkhorn rivers in the eastern part of the state. However, we also work on tern and plover issues across the state, including Lake McConaughy, and the region.

FOCUS ANIMALS

Piping Plovers are small, migratory shorebirds often seen running along sandy shorelines. Adults are approximately 18 cm in length, with a 48 cm wingspan. They feed on small invertebrates and insects and are frequently seen probing their bills into sandy substrates along the water's edge.

The species was first described in 1824 from a type specimen collected in New Jersey (American Ornithologists' Union 1998). Meriwether Lewis and William Clark saw Piping Plovers, and recorded their observations in what was to become the state of Nebraska, during their 1803–1805 “Voyage of Discovery” across North America. The species was placed on the Endangered Species List on 10 January 1986 (50 Federal Register 50726–50734), and the Northern Great Plains Recovery Plan (which covers Nebraska) was issued in May 1988. The listing status of this species is managed under the auspices of the Federal Endangered Species Act (1973) and the Nebraska Nongame and Endangered Species Conservation Act (Neb. Rev. Stat. § 37-801-11). Critical habitat for the Northern Great Plains breeding population was designated in Montana, Nebraska, South Dakota, and Minnesota on 11 September 2002 (67 Federal Register 57637). The United States District Court vacated the portion of critical habitat located in Nebraska on 13 October 2005; to date, it has not been reinstated. A review of the species' population status was completed in 2009 and a revised recovery plan is nearing completion (C. Aron, pers. comm.).

Our mission is to prevent and mediate conflicts between nesting terns and plovers and people, facilitate communication and promote proactive cooperation between agencies and people, and promote learning among all stakeholders.





“this bird is very noysey
when flying which it
does extremely swift...”

William Clark

*Description of the Interior Least Tern
while on this “Voyage of Discovery”
across North Americ.*

Interior Least Terns are the smallest tern found in North America. They are a feisty, swallow-shaped bird that is often seen in flight. Adults are approximately 20 to 23 cm in length, with a 50 cm wingspan. They feed on small fish and are often observed hovering over water before diving to catch a small fish in their bill. They are colonial nesters, meaning that they nest in close proximity to each other and place their nest and eggs directly on the ground.

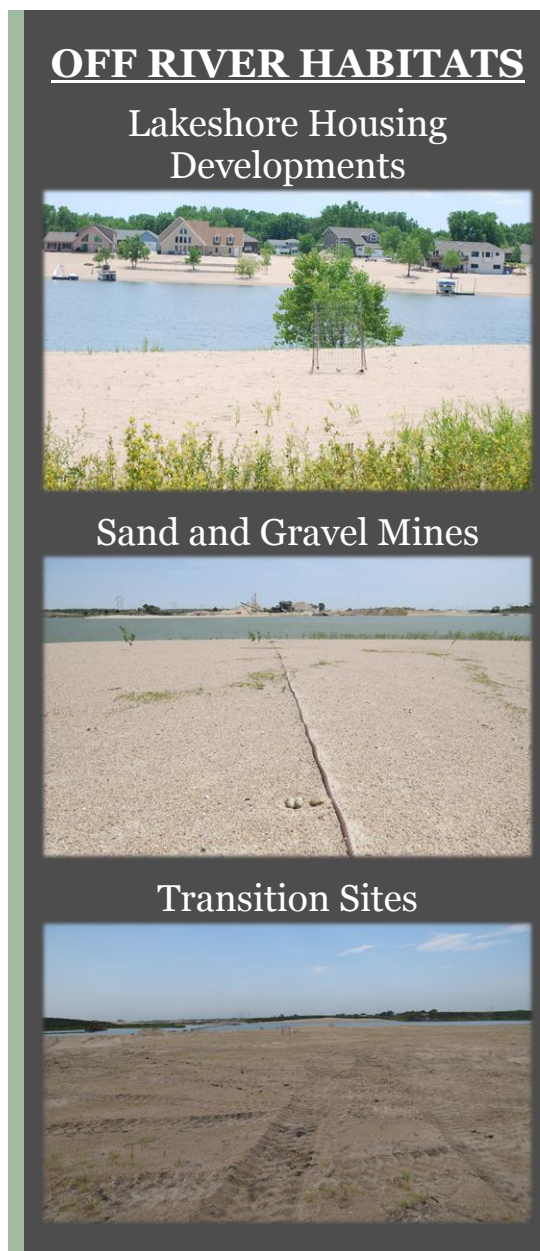
The Least Tern was first described in 1847 from a type specimen collected in Guadeloupe, West Indies (American Ornithologists’ Union 1998). Meriwether Lewis and William Clark recorded their first observation of an Interior Least Tern on 5 August 1804 along the Missouri River, near present day Omaha, Nebraska while on their 1803–1805 “Voyage of Discovery” across North America. The species was placed on the Endangered Species List on 27 June 1985 (50 Federal Register 21784–21792), and a Recovery Plan was issued in September 1990. As a result of their listing status, Interior Least Terns are protected by the Federal Endangered Species Act (1973) and the Nebraska Nongame and Endangered Species Conservation Act (Neb. Rev. Stat. § 37-801-11). A review of the species’ population status has recently been completed by the U.S. Fish and Wildlife Service (USFWS; P. Hatfield, pers. comm.) and on-going monitoring plans are being developed (J. Bart, pers. comm.).

Both Piping Plovers and Interior Least Terns are an integral part of the fauna of Nebraska. Terns and plovers were described by all of the major expeditions that passed through the region (e.g., Lewis and Clark, John James Audubon, Stephen Long, Duke Paul Wilhelm, Governor Kemble Warren, and Ferdinand Hayden), but they were known by Native Americans well before that period of time. Historically, terns and plovers flourished on sparsely-vegetated midstream sandbars of the Platte, Missouri, Loup, Elkhorn, and Niobrara rivers. However, much of this natural habitat has been lost due to broad-scale alterations of natural river systems. The amount of suitable sandbar habitat has been reduced by the presence of invasive plant species, construction of dams and reservoirs, river channelization, bank stabilization, hydropower generation, and water diversion. Terns and plovers frequently nest on human-created habitats that occur outside of the river channel. These habitats are created by industrial and commercial activities such as sand and gravel (aggregate) mining, dredging, and construction operations. This change in nesting habitat from exclusively river sandbars to a combination of on-river and off-river habitats is the result of the decrease in available river nesting habitat and the increase in available human-created off-river nesting habitat.

Piping Plovers and Interior Least Terns are migratory birds that spend significant portions of the year in different parts of the Western Hemisphere. They are in their nesting areas for about four months of the year. The other eight months are spent on migration and on their overwintering areas. Piping Plovers spend the winter along the Gulf of Mexico, southern Atlantic Coast, in the Bahamas, and on other Caribbean Islands. These habitats are characterized by wide sandy beaches and a combination of sand flats, mudflats, tide pools, marshes, lagoons, and large inlets. Interior Least Terns spend the winter well off-shore and along coasts, bays, estuaries, and river mouths near Central and South America. Loss of overwintering habitat contributed to the decline of both species. The principal threats to tern and plover overwintering habitat include habitat loss and degradation, increased coastal residential and industrial development, and stochastic events (e.g., global sea level rise, oil spills, water pollution, and hurricanes).

FOCUS AREA

We define our study area as the lower Platte River system in eastern Nebraska, including a portion of the Loup River and numerous off-river sites (Fig. 1, Table 1). We concentrate our monitoring and research efforts in our primary study area, from the Loup Power District diversion to the Missouri-Platte River confluence; throughout the remainder of this report our primary study area is referred to as the lower Platte River (Fig. 2). The TPCP concentrates its monitoring and research efforts on off-river nesting habitats in our primary study area. These off-river nesting habitats include lakeshore housing developments, active and inactive sand and gravel mines, and transition sites. During some years, additional monitoring and research efforts have occurred on off-river nesting habitats along the Middle Loup, Elkhorn, and North Platte rivers. The NBP concentrates its monitoring and research efforts on river sandbars along the lower Platte River proper which does not include the Loup or Elkhorn rivers. We define the lower Platte River proper as the 103 river miles lying between the Loup-Platte River confluence (near Columbus, Platte County) and the Missouri-Platte River confluence (near Plattsmouth, Cass County). The lower Platte River passes through eight counties (Platte, Colfax, Butler, Dodge, Saunders, Douglas, Sarpy, and Cass) and four Natural Resources Districts (Lower Platte South, Lower Platte North, Papio-Missouri, and Lower Loup).



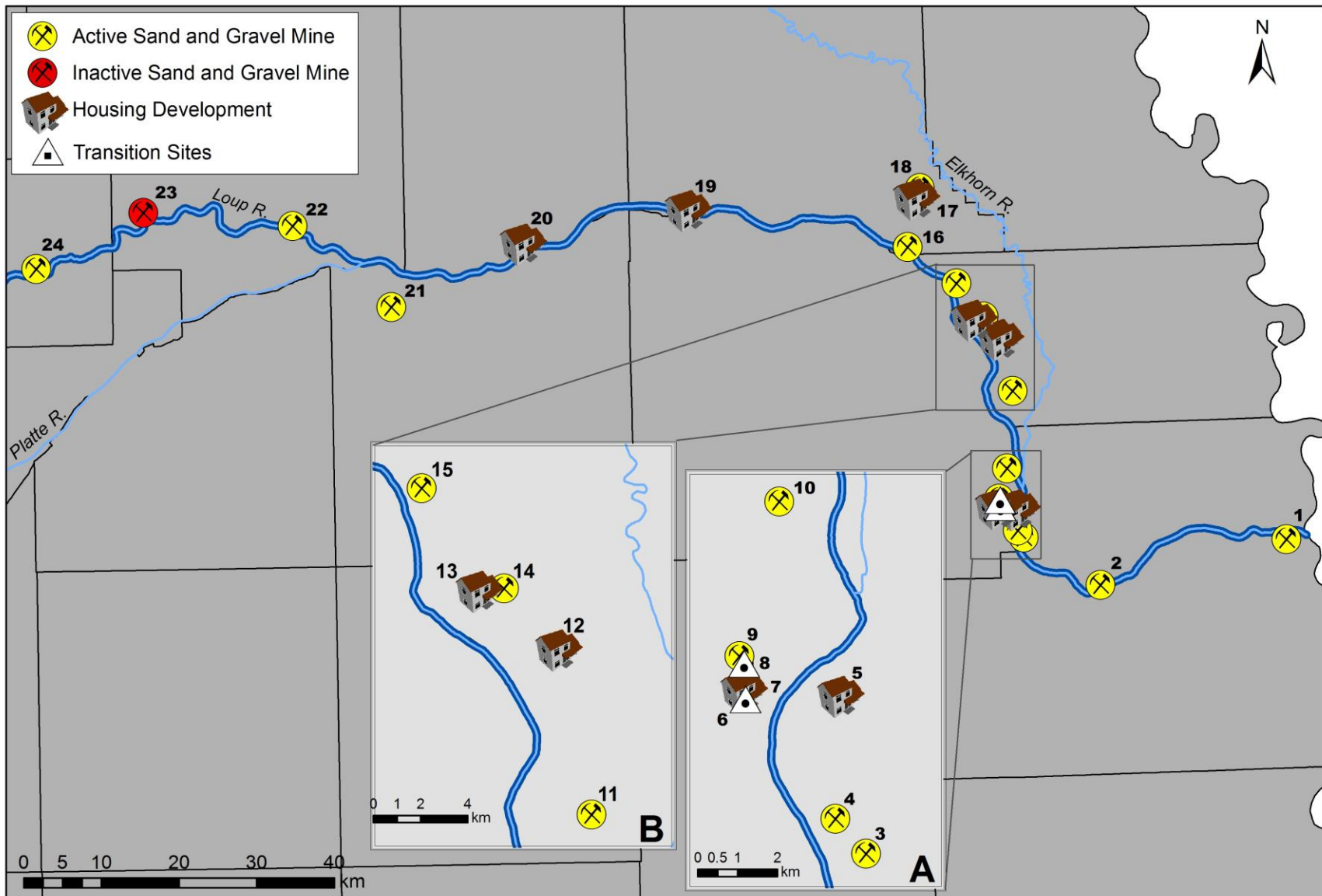


Figure 1. Our study area is highlighted in dark blue. Locations of off-river Interior Least Tern and Piping Plover nesting areas within our study area are marked. Off-river sites can be matched to numbers in Table 1.

Table 1. Off-river tern and plover nesting sites; site numbers correspond with Figure 1.

#	Site Name	River	Owner	Site Type	County	2017 Nesting
1	Oreapolis #8	Platte	Lyman Richey	Active Mine	Cass	No
2	Louisville Lakes	Platte	Western Sand and Gravel	Active Mine	Sarpy	Yes
3	Linoma Beach #50	Platte	Lyman Richey	Active Mine	Sarpy	Yes
4	Linoma Beach #51	Platte	Lyman Richey	Active Mine	Sarpy	Yes
5	Melia	Platte	Private Lake	Housing	Sarpy	No
6	Sandy Pointe	Platte	Sandy Pointe Development	Transition	Saunders	Yes
7	Lake Allure (South)	Platte	Homeowners' Association	Housing	Saunders	Yes
8	Lake Allure (North)	Platte	Lake Allure Development	Transition	Saunders	Yes
9	Sand Creek	Platte	Western Sand and Gravel	Active Mine	Saunders	Yes
10	G Plant	Platte	Western Sand and Gravel	Active Mine	Saunders	Yes
11	OMG-Graske Pit	Platte	Old Castle Materials Group	Active Mine	Douglas	Yes
12	Mallard Landing	Platte	Homeowners' Association	Housing	Douglas	No
13	Bluewater	Platte	Bluewater Dev. Corporation	Housing	Douglas	Yes
14	Valley #7	Platte	Lyman Richey	Active Mine	Douglas	Yes
15	KMG	Platte	Mallard Sand and Gravel	Active Mine	Dodge	Yes
16	Western Fremont	Platte	Western Sand and Gravel	Active Mine	Dodge	Yes
17	Ritz Lake	Platte	Homeowners' Association	Housing	Dodge	Yes
18	NE Fremont North	Platte	Lyman Richey	Active Mine	Dodge	Yes
19	Riverview Shores	Platte	Homeowners' Association	Housing	Dodge	Yes
20	Socorro Lake	Platte	Homeowners' Association	Housing	Colfax	No
21	Bellwood #73	Platte	Central Sand and Gravel	Active Mine	Butler	Yes
22	Columbus #71	Loup	Central Sand and Gravel	Active Mine	Platte	Yes
23	Genoa North #95	Loup	Central Sand and Gravel	Inactive Mine	Platte	Yes
24	LPPD-Loup Diversion	Loup	Preferred Rocks - LPPD	Active Mine	Nance	Yes

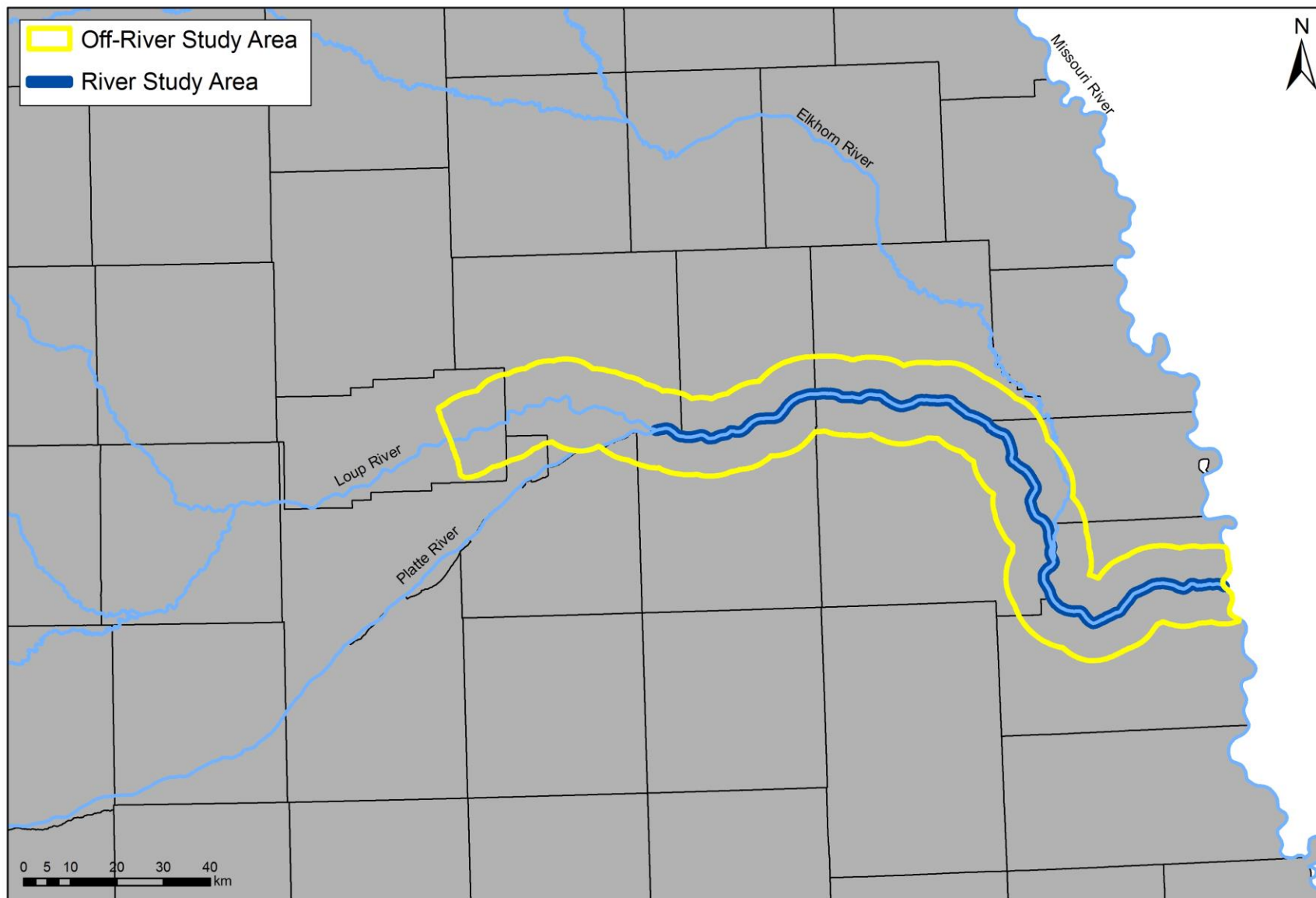
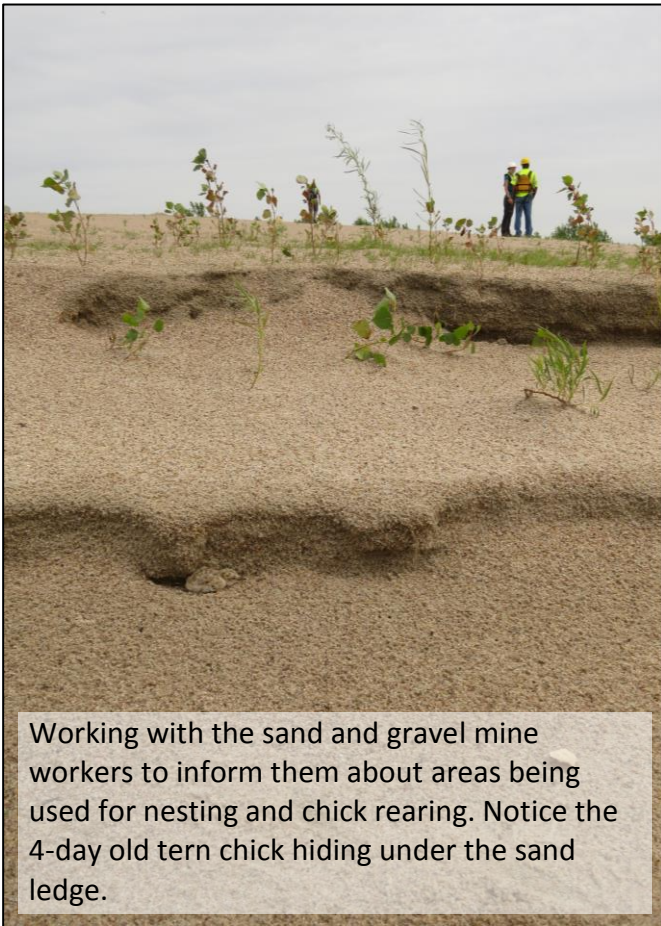


Figure 2. Our primary study area – the yellow box outlines the area where the TPCP concentrates its off-river monitoring and research efforts, and the dark blue outlines the area where the NBP concentrates its on-river monitoring and research efforts.



Working with the sand and gravel mine workers to inform them about areas being used for nesting and chick rearing. Notice the 4-day old tern chick hiding under the sand ledge.



Roped off area around a tern nest at a new lakeshore housing development in Dodge County.

2017 OFF-RIVER CONDITIONS

Overall, conditions at off-river sites were similar to previous years. In 2017, we continued to work closely with sand and gravel mining companies and their staff, developers, construction workers, and homeowners.

Sand and gravel mines are more frequently being converted to housing developments once aggregate extraction is completed. The conversion of a sand and gravel mine to a housing development usually extends the duration in which a site provides habitat and is used by Piping Plovers and Interior Least Terns. In some instances, sand and gravel mines are abandoned or filled back in with aggregate after mining is complete. After a site is filled back in it no longer provides tern and plover nesting habitat.

In 2017, we monitored a total of 24 off-river sites. We stopped monitoring three sites that were monitored in the past (one mine and two housing developments) due to the lack of suitable nesting habitat. Two sites defined as transition sites last year had a number of newly constructed houses and were defined as housing developments in 2017. Both of these sites still had some nesting activity, however, one site became over grown with vegetation and had minimal nesting activity while the other continued to have large expanses of open lots with unvegetated sand and continued to provide nesting habitat for many terns and plovers in 2017. One site mine site that had been inactive for several years became active again in 2017 and another mine site that had been active for the last several years became inactive mine in 2017.

2017 RIVER CONDITIONS

The amount of suitable sandbar nesting habitat on the lower Platte River varies from year to year. Daily and seasonal fluctuations in the volume of water flowing in the river caused by annual rainfall, ice and snow accumulation, ground water levels, and river channel morphology influence sandbar development and maintenance. General water flow conditions on the lower Platte River are monitored by the United States Geological Survey (USGS) stream gages (<http://waterdata.usgs.gov/ne/nwis/rt>). In addition to the USGS data, we monitored flow conditions by visual inspection of the river at bridge crossings and by direct inspection of the river via kayak.

In 2017, condition and availability of sandbar nesting habitat was moderate, characterized by high flows in late May and overall low elevation sandbars throughout the 103 mile stretch of the river.

The average maximum daily water discharge at the North Bend gage (USGS 06796000 Platte River) from 15 April to 12 August was 6,037 cfs (cubic feet per second) with water levels peaking at 16,200 cfs on 22 May. The average maximum daily water discharge at the Louisville gage (USGS 06805500 Platte River) from 15 April to 12 August was 11,129 cfs with water levels peaking at 56,800 cfs on 20 May. After peak water flows in late May, water levels steadily decreased. Most sandbars were inundated until early to mid-June.

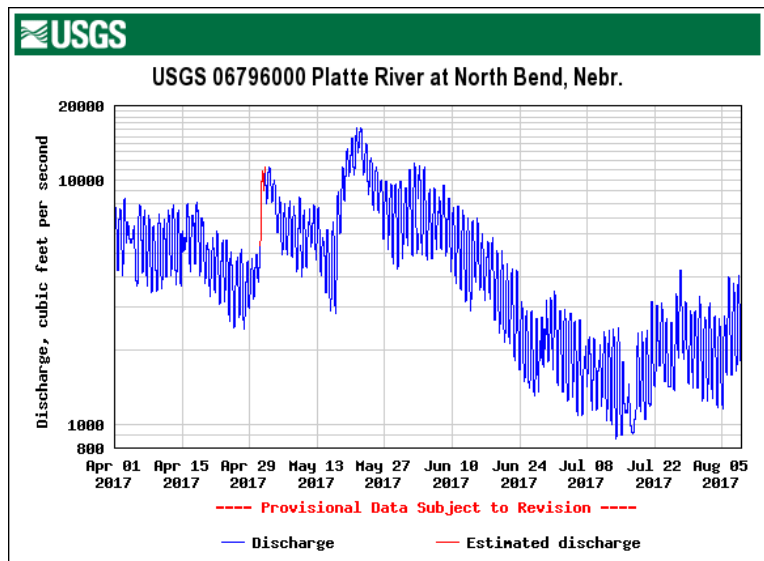


Figure 3. Daily water discharge (cubic feet per second; cfs) measured at the North Bend gage, Dodge County, NE from 1 April 2017 through 8 August 2017.

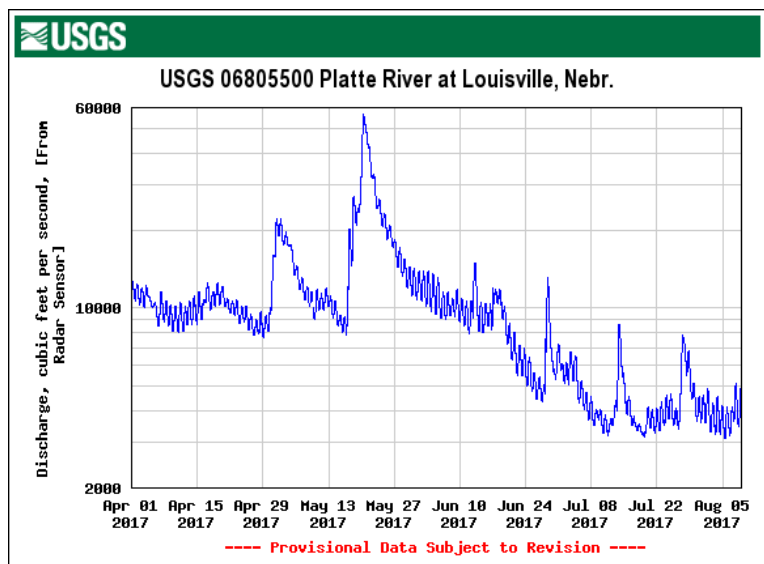


Figure 4. Daily water discharge (cubic feet per second; cfs) measured at the Louisville gage, Cass County, NE from 1 April 2017 through 8 August 2017.

COLOR BANDING SCHEMES ACROSS THE U.S. AND CANADA

Piping Plovers and Interior Least Terns are banded across their ranges. Plovers have longer legs than terns which makes it much easier to mark them with color bands. Throughout their range plovers receive anywhere between one to six leg bands and terns generally receive one or two leg bands depending on where they are banded (Fig. 5). Piping Plover research groups, throughout the U.S., place different colored flags on a plover's upper leg to indicate where there were originally banded (Fig. 6).

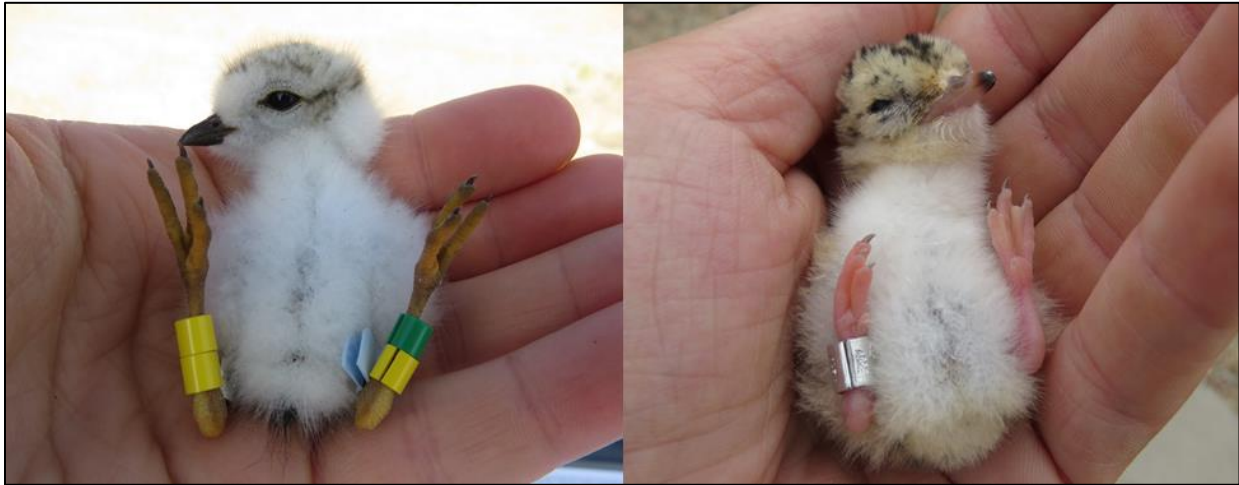


Figure 5. Piping Plover chick (left) and Interior Least Tern chick (right).

Piping Plover Banding Regions

Breeding Range

- Canada = Black, Gray, or White Flag
- Great Lakes = Orange Flag
- Northern Missouri River = Yellow Flag
- Southern Missouri River = Green Flag
- Platte River = Light Blue Flag
- Atlantic Coast = no bands

Wintering Range

- Gulf Oil Spill Study = Green Flag
- Texas = Red Flag
- Bahamas = Pink Flag

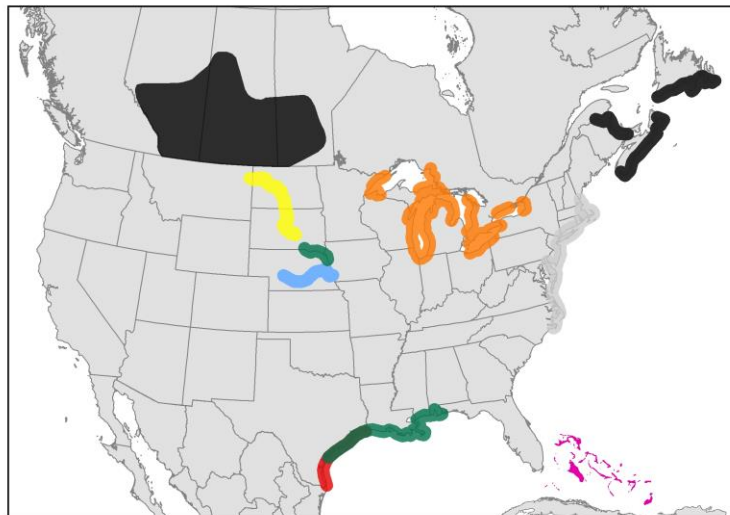


Figure 6. Piping Plover research groups place different colored flags on Piping Plovers to indicate where they were originally banded.



MONITORING

MONITORING REGIONAL MOVEMENTS OF BANDED TERNS & PLOVERS

Piping Plover Breeding Season Observations

This was the tenth year we captured and color-banded Piping Plovers along the lower Platte River. To date, we have banded 809 plovers; 157 adults and 652 chicks (Table 2). The majority of plovers (804) color-banded in our primary study area were captured at off-river sites; we banded five plover chicks with metal USGS bands only on river sandbars in 2009. Since 2008, we observed plovers in our primary study area that were originally banded in locations throughout the Great Plains and US Gulf Coast. During the 2017 breeding season, we observed plovers that were originally banded along the lower Platte River, the central Platte River, the Missouri River between South Sioux City, NE and Yankton, SD, and the US Gulf Coast. Plovers banded along the central Platte River are banded by USGS. Plovers banded along the Missouri River between South Sioux City, NE and Yankton, SD and some plovers banded along the US Gulf Coast are banded by the Virginia Tech University Shorebird Program. Some plovers banded along the US Gulf Coast in Texas are banded by the Coastal Bend Bays and Estuaries Program.

In 2017, we observed 81 previously banded Piping Plovers in our primary study area. We observed 68 light blue-flagged plovers originally banded along the lower Platte River, three blue-flagged plovers originally banded along the central Platte River, seven green-flagged plovers originally banded along the Niobrara River and Missouri River south of Yankton, SD, two green-flagged plovers banded along the US Gulf Coast, and one red-flagged plover banded near Galveston Island, Texas.

Over the last ten years, a number of Piping Plovers originally banded along the lower Platte River have been re-sighted nesting in other locations across the Great Plains (Table 3). Of the 685 plovers banded on the lower Platte River prior to 2017, 260 (38%) have been re-sighted during the breeding season at least one year after they were banded; 223 returned to nest along the lower Platte River, four have been observed on the central Platte River, 25 have been observed on the Missouri River, five have been observed on the Niobrara River, and three have been observed in the alkali lakes region of North Dakota. A majority (60%) of lower Platte River plovers that returned to the lower Platte River to nest were originally banded as adults. A majority (81%) of lower Platte River plovers reported outside of the lower Platte River study area during the nesting season were originally banded as chicks. Overall, 74% of the lower Platte River plovers banded as adults and 26% of the lower Platte River plovers banded as chicks have been re-sighted at least once during a breeding season at least one year after they were banded.

In 2017, three lower Platte River plovers were reported outside of the lower Platte River study area during the nesting season. All three were observed nesting in the alkali lake region in North Dakota and all of these plovers were originally banded as chicks. As of this writing we have not received any reports of Lower Platte River plovers observed on along the Missouri or Niobrara rivers in 2017.

Table 2. Number of Piping Plovers banded along the lower Platte River each year.

Year	Adults	Chicks	TOTAL
2008	19	12	31
2009	18	23	41
2010	9	48	57
2011	15	31	46
2012	11	73	84
2013	15	58	73
2014	27	72	99
2015	17	93	110
2016	15	129	144
2017	11	113	124
TOTAL	157	652	809

Table 3. Number of Piping Plovers previously banded along the lower Platte River and re-sighted during the breeding season at least one year after they were originally banded.

Age Banded	lower Platte River	central Platte River	Missouri River	Niobrara River	North Dakota	TOTAL
Adults	134	1	6	0	0	141
Chicks	89	3	19	5	3	119
TOTAL	223	4	25	5	3	260

Interior Least Tern Breeding Season Observations

To date, we have banded 1440 terns; 27 adults and 1413 chicks (Table 4). All of the adult terns and the majority of the tern chicks (1070) were banded at off-river sites.

In 2017, we did not capture or band adult terns. Over the last ten years, we have received three reports of our Interior Least Terns nesting outside of the lower Platte River. Two terns were observed nesting along the Missouri River in 2012 and one was observed nesting along the central Platte River in 2015 and 2016.

Table 4. Number of Interior Least Terns banded on the lower Platte River each year.

Year	Adults	Chicks	TOTAL
2008	0	168	168
2009	0	199	199
2010	0	118	118
2011	0	120	120
2012	0	76	76
2013	0	93	93
2014	0	190	190
2015	20	202	222
2016	7	121	128
2017	0	126	126
TOTAL	27	1287	1440

Piping Plover Non-Breeding Season Observations

Winter Range

Every year a number of Piping Plovers banded along the lower Platte River are observed in wintering areas during the non-breeding season (Fig. 7). As of 15 September 2017, we received six reports of lower Platte River plovers in their winter range following the 2017 breeding season; all observed along the US Gulf Coast. The first lower Platte River plover reported in its winter range following the 2017 breeding season was observed along the coast of Texas on 11 July 2017. This plover was banded along the lower Platte River as a 1-day old chick at a sand and gravel mine near Fremont, Dodge County, Nebraska in 2013. In 2017, this plover was observed nesting at a sand and gravel mine near Valley, Douglas County, Nebraska, and was last observed in Nebraska on 22 June 2017.

Over the course of this study, 96 plovers originally banded in our primary study area have been re-sighted in their winter range during the nonbreeding season, with several birds observed more than once. Of the 96 plovers, 42 were originally banded as adults and 54 were originally banded as chicks. Winter sightings of lower Platte River plovers extend from the southern tip of Texas to the Florida Keys and north along the US Atlantic Coast to South Carolina. Lower Platte River plovers have been reported in seven states and 30 counties along the coast (Table 5). The majority of winter re-sightings have occurred along the US Gulf Coast. The first reports of lower Platte River plovers along the US Atlantic Coast occurred during the winter of 2012–2013. To date, seven lower Platte River Plovers have been observed wintering along the US Atlantic Coast.

Since 2008, we have received a total of 415 reports of lower Platte River plovers observed during the non-breeding seasons (2008–2017), with most reports provided by resident and visiting birders and recreational wildlife photographers.

Two green-flagged plovers and one red-flagged plover, observed along the lower Platte River in 2017, were originally banded along the US Gulf Coast. The green-flagged plovers were banded as a part of a BP-Deepwater Horizon Oil Spill (NRDA) recovery study conducted by the Virginia Tech Shorebird Program (D. Catlin, pers. comm.). A total of seven plovers banded as a part of this oil spill study have been observed along the lower Platte River.

Table 5. States where lower Platte River plovers have been observed overwintering.

State	Number of LPR Plovers Reported	Percent of Total
Alabama	2	2%
Florida	24	25%
Georgia	1	1%
Louisiana	10	10%
Mississippi	5	5%
South Carolina	2	2%
Texas	52	54%
TOTAL	96	100%

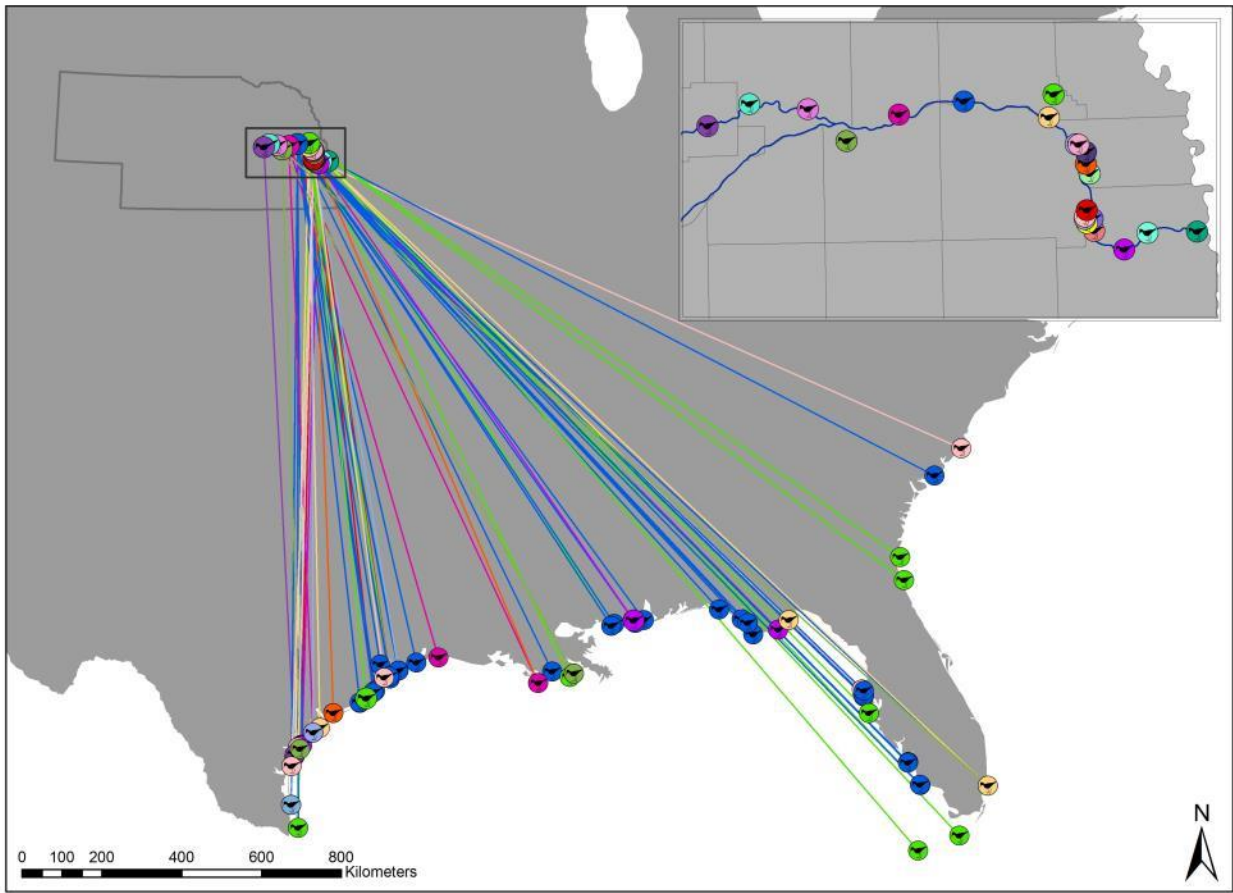


Figure 7. Locations where light blue-flagged plovers, originally banded in our primary study area, have been observed during the non-breeding season on the US Gulf and Atlantic coasts from 2008 to 2017. Each colored marker in Nebraska represents a nesting site where plovers have been banded and each marker on the coast shows the location where an individual light blue-flagged plover has been re-sighted during the winter.



This plover was banded as a 1-week old chick on 14 June 2013 in Dodge County, NE. It was observed along the Texas coast in 2017. Photo taken by Greg Lasley.

MONITORING NESTS & CHICKS

Methods: Off-River Habitat

In 2017, we began conducting Interior Least Tern and Piping Plover surveys at off-river sites in late April. Throughout the breeding season (late April – early August) we surveyed each off-river site at least once every five to seven days. During each visit to off-river sites, we counted the number of terns and plovers present, located new nests, checked the status of known nests, and searched for and banded tern and plover chicks. Every time a new nest was found, we assigned it a unique identification number and recorded the nest location using a handheld GPS unit (Garmin Oregon 550t, Garmin Ltd., Olathe, KS, USA). We recorded the number of eggs in each nest and “floated” the eggs in water to determine the nest initiation date (Hays and LeCroy 1972). Using the egg floating data, we calculated the eggs’ expected hatch date, assuming a 28-day incubation period for plovers and a 21-day incubation period for terns. A majority of the nests were located one to seven days after the first egg was laid. During each subsequent nest check, after the day the nest was found, we checked eggs for any damage and recorded the status of each nest. We determined the status of each tern and plover nest based on the following criteria:

Confirmed Successful: ‘pipped’ eggs or newly-hatched chick(s) observed in or in the immediate vicinity (< 1 meter) of the nest cup

Likely Successful: empty, but intact nest cup located on or after the expected hatch date; nest cup may contain small pieces of eggshell

Confirmed Failed: nest cup and/or eggs found destroyed or abandoned

Likely Failed: nest not relocated on repeat visits prior to expected hatch date

Undetermined: nest not re-checked prior to hatch date or not enough evidence to determine nest fate

At some off-river sites, Interior Least Terns and Piping Plovers placed their nests in areas not accessible to us for safety reasons. In these cases, we only recorded the number of nests, eggs, adults, chicks, fledglings and juveniles that were visible from a distance.

We recorded the total number of active nests and the total number of terns and plovers in each of the following age classes:

Adults: birds one year or older, in adult plumage, and capable of breeding

Chicks: young birds incapable of flight (plovers < 28 days old and terns < 21 days old)

Fledglings: young birds capable of flight but still dependent on parents

Juveniles: birds capable of sustained flight and independent from parents but not in adult plumage (within the first year of life)

We recorded any notable observations including weather conditions, bird injuries, and evidence of disturbance caused by humans, dogs, cats, vehicles, natural predators, or recent severe weather events. We recorded the band combinations of all terns and plovers observed or recaptured with leg bands.

Results: Off-River Habitat

In 2017, we located 83 Piping Plover nests and 175 Interior Least Tern nests at off-river sites in our primary study area (Table 6). These nests were distributed across 20 sites, three sites along the Loup River and 17 sites along the lower Platte River (Figs. 8–9). This included four lakeshore housing developments, two transition sites, and 14 sand and gravel mines. In 2017, 61% of plover nests and 33% of tern nests were confirmed successful, while 28% of plover nests and 42% of tern nest were confirmed failed (Tables 7–8). We observed 135 plover chicks and 129 tern chicks on off-river sites (Table 6).

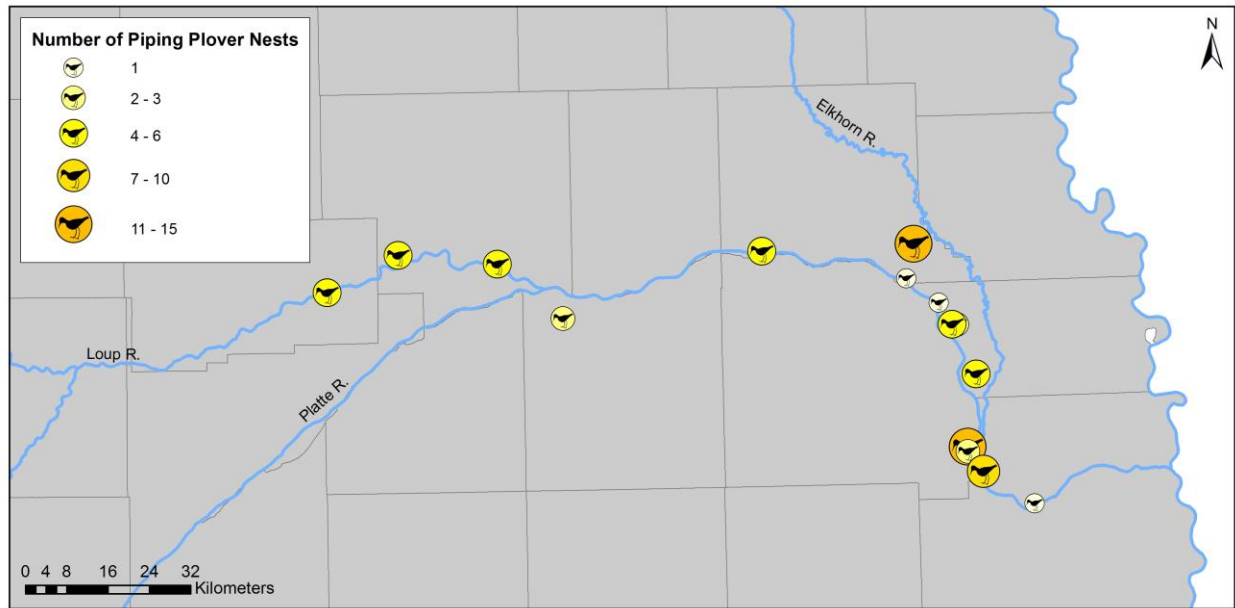


Figure 8. Location of off-river Piping Plover nest sites in 2017.

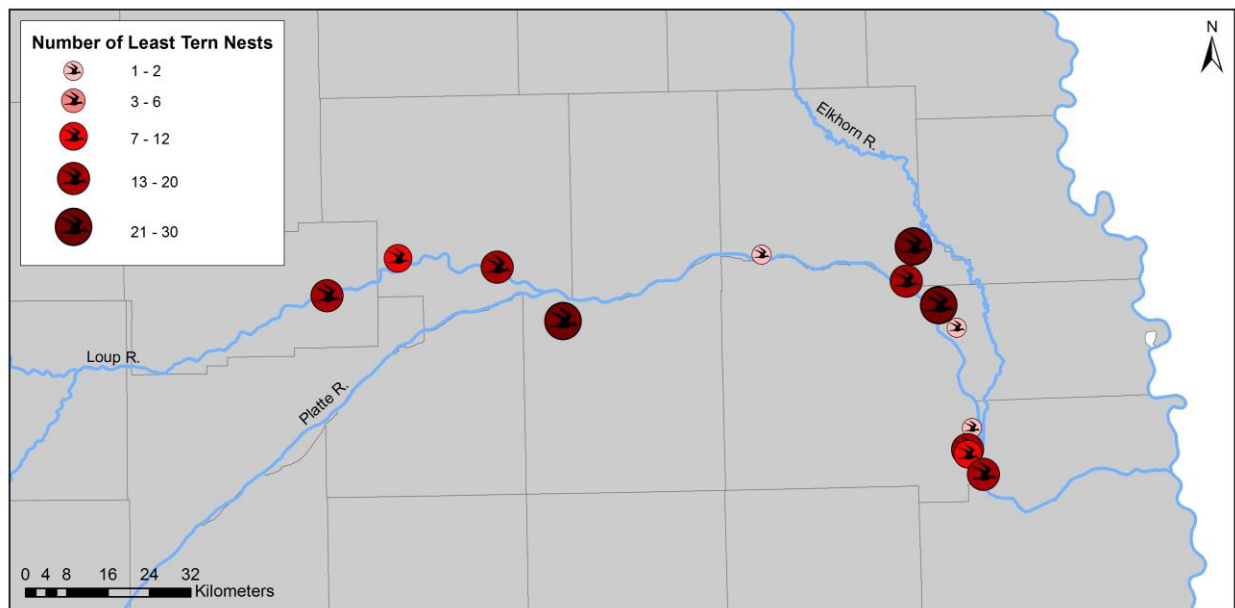


Figure 9. Location of off-river Interior Least Tern nest sites in 2017.

Table 6. The number of Interior Least Tern and Piping Plover nests and chicks observed at each off-river site along the lower Platte River 2017.

Site Name	Site Type	Piping Plover		Interior Least Tern	
		# Nests	# Chicks	# Nests	# Chicks
Louisville Lakes	Active Mine	1	3	0	0
Linoma Beach #50	Active Mine	7	6	13	8
Linoma Beach #51	Active Mine	1	0	1	0
Sandy Pointe	Transition	3	4	7	3
Lake Allure (South)	Housing	1	2	0	0
Lake Allure (North)	Transition	13	29	14	16
Sand Creek	Active Mine	4	11	3	3
G Plant	Active Mine	0	0	2	5
OMG-Graske Pit	Active Mine	5	5	0	0
Bluewater	Housing	4	12	0	0
Valley #7	Active Mine	3	2	2	0
KMG	Active Mine	1	4	23	11
Western Fremont	Active Mine	1	1	18	4
Ritz Lake	Housing	13	21	27	42
NE Fremont North	Active Mine	1	4	1	0
Riverview Shores	Housing	6	11	2	0
Bellwood #73	Active Mine	3	6	21	8
Columbus #71	Active Mine	6	2	16	7
Genoa North #95	Inactive Mine	6	10	8	11
LPPD-Loup Diversion	Active Mine	4	2	17	11
TOTAL		83	135	175	129

Table 7. Piping Plover nest fates on off-river sites along the lower Platte River in 2017.

Nest Fate	Mines		Housing		Transition		Total	
	#	%	#	%	#	%	#	%
Confirmed Hatched	22	27%	13	16%	16	19%	51	61%
Likely Hatched	4	5%	0	0%	4	5%	8	10%
Confirmed Failed	15	18%	5	6%	3	4%	23	28%
Likely Failed	0	0%	0	0%	0	0%	0	0%
Undetermined	1	1%	0	0%	0	0%	1	1%
TOTAL	42	51%	18	22%	23	28%	83	100%

Table 8. Interior Least Tern nest fates on off-river sites along the lower Platte River in 2017.

Nest Fate	Mines		Housing		Transition		Total	
	#	%	#	%	#	%	#	%
Confirmed Hatched	34	19%	10	6%	14	8%	58	33%
Likely Hatched	27	15%	0	0%	4	2%	31	18%
Confirmed Failed	53	30%	3	2%	17	10%	73	42%
Likely Failed	11	6%	0	0%	0	0%	11	6%
Undetermined	2	1%	0	0%	0	0%	2	1%
TOTAL	127	73%	13	7%	35	20%	175	100%

Methods: On-River Habitat

Access to river sandbars differs from access to off-river sites, so we take a different approach to monitoring terns and plovers nesting on midstream river sandbars. We monitored river conditions for the presence of sandbar habitat early in the nesting season. In 2017, we surveyed the lower 25 miles of the river via kayak and cooperated with the USFWS to survey the upper 78 miles of the river via airboat.

We visually scanned for habitat, the presence of terns and plovers and behaviors suggestive of nesting or breeding. When a colony was located we stopped and surveyed the sandbar from the airboat/kayaking looking for adults, chicks and adults sitting on nests. Some sandbars were further surveyed on foot, but others were not if permission granting access was not acquired. In 2017, we focused on recording general colony information about the location and approximate size of nesting colonies rather than exact nest locations and nest success.

Results: On-River Habitat

Kayak surveys were conducted by the NBP in early-July. Kayak surveys were conducted from river mile 25 near Louisville, Cass/Sarpy County, to river mile 0 near Plattsmouth, Cass/Sarpy County. This portion of the lower Platte River (river mile 25 – river mile 0) was only surveyed once (July 10th) during the nesting season. Airboat surveys were conducted with the USFWS and were conducted from river mile 103 near Columbus, Platte County, to river mile 28 near Ashland, Saunders/Sarpy County. This portion of the lower Platte River (river mile 103 – river mile 28) was surveyed twice (June 20 – 21 and July 18 – 20) during the nesting season.

In 2017, we recorded a minimum of three Piping Plover nests, 70 Interior Least Tern nests, 16 Interior Least Tern chicks, and 13 Interior Least Tern fledglings/juveniles. These nests were distributed across 31 lower Platte River sandbars between Columbus and Plattsmouth (Fig. 10, Table 9).

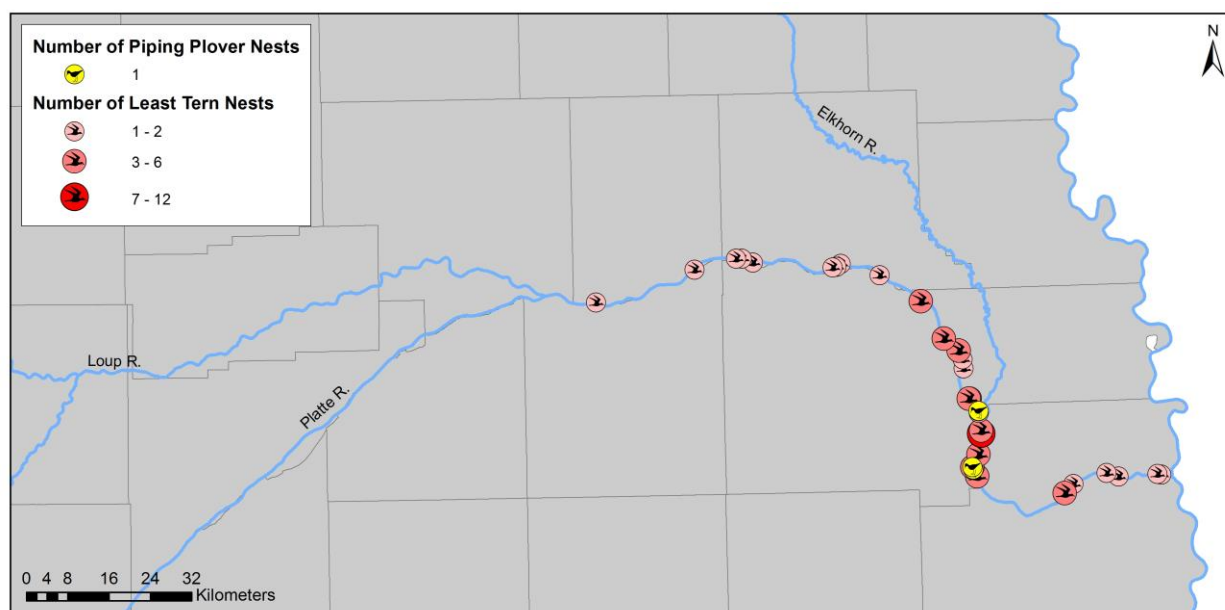


Figure 10. Location of Piping Plover and Least Tern nesting colonies on river sandbars in 2017.

Table 9. The minimum number of Interior Least Tern and Piping Plover nests and chicks observed at each river sandbar along the lower Platte River 2017.

Site Name	Piping Plover		Interior Least Tern	
	# Nests	# Chicks	# Nests	# Chicks
RM 1.25	0	0	1	0
RM 2.00	0	0	2	1
RM 7.00 – Cullom	0	0	1	0
RM 8.25	0	0	2	1
RM 12.50 - East Cedar Creek	0	0	1	0
RM 14.00	0	0	4	0
RM 28.00	0	0	1	0
RM 28.25	0	0	4	0
RM 29.25 - South Camp Ashland	1	0	1	2
RM 29.50 - South Camp Ashland	1	0	4	0
RM 31.25	0	0	4	2
RM 34.25	0	0	9	2
RM 34.50	0	0	3	0
RM 36.75	0	0	1	0
RM 37.00	1	0	2	3
RM 38.75	0	0	4	5
RM 39.00	0	0	3	0
RM 43.25	0	0	1	1
RM 44.25	0	0	1	0
RM 45.5	0	0	5	4
RM 47.75	0	0	3	2
RM 53.25	0	0	3	0
RM 59.25	0	0	1	1
RM 64.25	0	0	1	0
RM 64.75	0	0	2	0
RM 65.25	0	0	1	0
RM 75.50	0	0	1	2
RM 77.00	0	0	1	1
RM 77.75	0	0	1	0
RM 83.25	0	0	1	2
RM 96.50	0	0	1	0
TOTAL	3	0	70	29



RESEARCH

ESTIMATING SURVIVAL RATES

Accurately estimating demographic parameters, such as daily and seasonal survival probabilities for individual birds and nests, leads to a better understanding of Interior Least Tern and Piping Plover population dynamics. This allows us to develop and implement more effective management strategies for these two species. We constructed scatterplots of tern and plover chick growth (based on body mass) from hatching to fledging. We estimated nest, adult, and chick survival by using capture-mark-recapture and statistical modeling techniques (Program MARK; <http://www.cnr.colostate.edu/~gwhite/mark/mark.htm>).

Methods

Banding and Re-sighting

We conducted all bird capture and banding under the authorization of the USGS Bird Banding Laboratory (Patuxent Wildlife Research Center; <http://www.pwrc.usgs.gov/bbl>) and the USFWS through an inter-agency agreement with the NGPC (MBB holds Federal Master Bird Bander Permit # 23545 with Threatened and Endangered Species endorsements and Nebraska Educational and Scientific Permit # 241; the TPCP holds Federal Threatened and Endangered Species handling permit #TE 070027-1; JGJ holds Federal Master Bird Bander Permit #20259 with Threatened and Endangered Species endorsements). Color-band combinations were coordinated prior to the beginning of the field season with the Bird Banding Laboratory and others with an interest in tern and plover research.

At off-river sites, we captured and banded adult Piping Plovers during incubation; we did not capture adult terns in 2017. The capture, handling, and banding protocols used for plovers were the same as those used in previous years. Adult Piping Plovers were captured using a simple box trap placed over the nest. This method is effective and minimizes risk of injury to the adult and eggs. Box traps have no moving parts; the bird walks through the door, settles on its nest, and is captured. We captured plover and tern chicks by picking them up from the sand or from their nests.

We exercise great caution when handling and banding birds. We do not capture or band birds during extreme weather (cold, windy, rainy, or when inclement weather was forecast) or when the temperature was above 85° F (30° C). Birds are observed after banding and on subsequent visits to determine if there are any behavioral changes or signs of injury. As part of our protocol, we are to suspend all banding activities if problems or injuries were observed at any time. We did not observe any problems or injuries to birds as a result of monitoring, capture, handling, or banding in 2017.

In 2017, we banded each Piping Plover, adult and chick, with an individually numbered metal USGS band (size 1A) on one of the upper legs. We placed a light blue flag on the opposite upper leg; the light blue flag indicates that this bird was banded in Nebraska along the Platte River. We place a unique combination of color bands (yellow, green, black, gray) on the lower legs of each plover we band. We place two color bands on the lower right leg and two color bands on the lower left leg. The unique color band combination indicates each bird's individual identity (Fig. 11).

We measured the mass of each Piping Plover adult by placing the bird in a cloth bag and suspending it from a Pesola scale ($\pm 0.3\%$ accuracy). We measured the following morphological characters for adult plovers: length of the left and right flattened wing chord (wrist to the distal end of the outermost primary feather), length of the left, right, and middle tail feathers, length of the left and right tarsus (un-feathered leg above the hallux), length of the culmen (exposed midline ridge of the beak), width of the beak at the nostrils, and length of the total skull (distal end of the beak to the posterior end of the skull). All measurements were taken by one individual (LRD) to minimize measurement error. We measured the left and right sides of each bird so bilateral symmetry could be calculated. Symmetry is a commonly used measure of an individual bird's "quality." The symmetry of skeletal parts and feathers reflects an individual's nutrition and health during development; this gives us a metric to assess the "quality" of birds produced at different nesting habitats (on-river versus off-river) and in different years. Symmetry also gives us a way to assess the quality of overwintering habitat for birds; better foraging habitat provides better overwintering survival, nutrition, and health for nesting birds.

We banded each Interior Least Tern chick with an individually numbered metal USGS band (size 1A) on their lower right leg. We also placed a blue alpha-numeric band the lower left leg of a few older (7 – 21 days) tern chicks (Fig. 12). We measured each chick's body mass using a digital scale (Ohaus SP401, Parsippany, NJ, USA) that was accurate to ± 0.1 gram. Scales were calibrated using a standardized weight to ensure accuracy. We did not take any morphological measurements of tern or plover chicks.

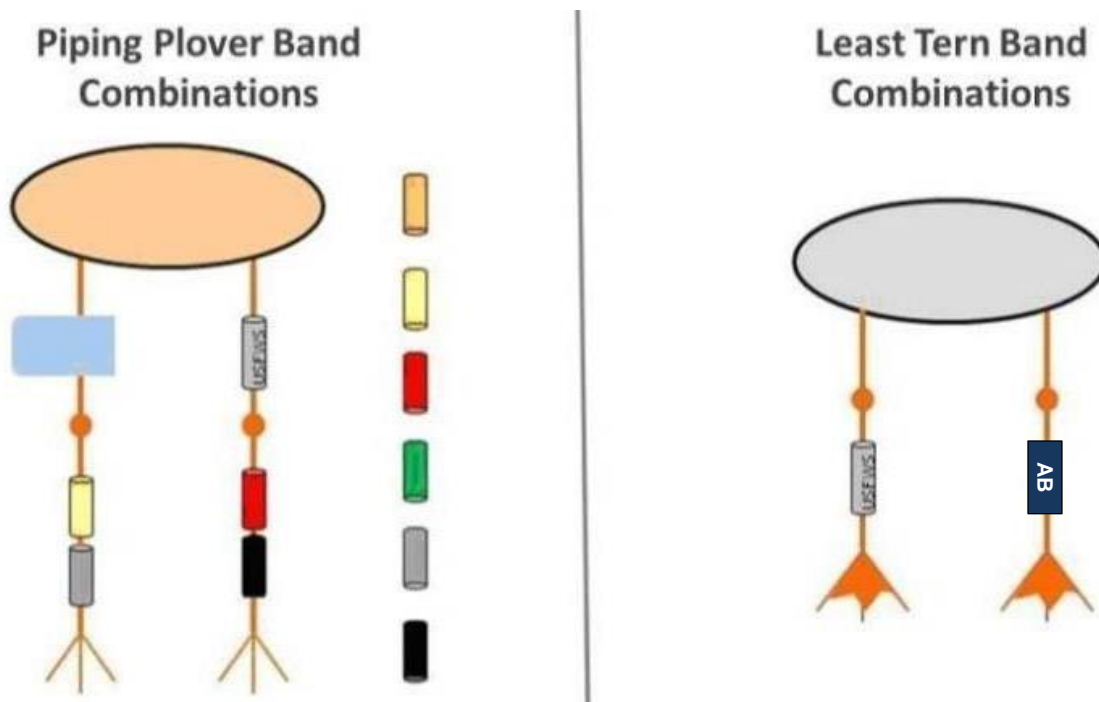


Figure 11. Diagram illustrating the banding scheme used on Piping Plovers and Interior Least Terns banded along the lower Platte River. The flags, color bands, and metal bands may be on either leg and plover color combinations vary.

Daily and Seasonal Survival Analyses

We monitored Piping Plover and Interior Least Tern nests throughout the nesting season (see Monitoring section for details). We used nest monitoring data to calculate daily and seasonal nest survival probabilities. We attempted to re-sight banded terns and plovers every five to seven days. We weighed birds when we recaptured them. We used this capture-mark-recapture dataset to calculate daily and seasonal survival probabilities for each individual.

We estimated survival probabilities using the software program MARK (White and Burnham 1999). We used the general methods of Lebreton et al. (1992), Burnham and Anderson (2002), and Dinsmore and Dinsmore (2007). We assessed model fit for each analysis using the Akaike's Information Criterion (AIC); the model with the lowest AIC value was considered the model that best fit the data.

Nest Survival Analysis

We used data from nest monitoring (see Monitoring section) to estimate nest survival. We estimated nest survival probabilities using the nest survival utility in Program MARK. We constructed encounter histories by summarizing the day each nest was found (k), the last day the nest was found active (l), the last day the nest was checked for activity (m), and the fate of the nest (f). Due to small sample sizes we did not include any covariates in our model and assumed constant survival across the season. We provide both daily survival probability and seasonal survival probability. Seasonal survival is the probability a nest will survive the 21- or 28-day incubation period and it is estimated by extending the daily survival probability to the appropriate number of incubation days.

Within Year Individual Survival Analysis

We constructed individual encounter histories for all terns and plovers captured, recaptured or observed at off-river sites. We used these data to determine the probability of adults and chicks surviving the 2017 nesting season. We provide both daily survival probability and seasonal survival probability for adults and chicks. Adult plovers included in this analysis were originally color-banded along the lower Platte River, central Platte River, Missouri River, or the US Gulf Coast. Tern and plover chicks included in this analysis were produced and banded in our primary study area. We did not include any covariates in the models. We attempted to fit models with varying degrees of time-dependence to the data, but the model that included constant survival and constant recapture probabilities $\{\phi(c), p(c)\}$ was always the best-fitting model based on AIC; this is most likely due to our relatively small sample sizes.

Annual Survival Analysis

We constructed individual encounter histories for all plovers captured, recaptured, or observed in our primary study area from 2008 through 2017. We used this data to determine the probability of Piping Plovers surviving from one year to the next. We do not have sufficient numbers of re-sightings of Interior Least Terns to consider them in this type of analysis.

Growth Scatterplots

Our growth scatterplots for 2017 included only tern and plover chicks produced at off-river sites. We weighed chicks every time they were encountered. We estimated chick age using an age-based time series of photographs.

Statistical Analysis

All statistical analyses were performed using Program R 3.1.3 (R Development Core Team 2014). Due to small sample sizes, we used nonparametric statistical tests; statistical significance was set at $P < 0.05$. Means (± 1 SE) are reported.

Results

Banding and Re-sighting

In 2017, we banded 124 Piping Plovers and 126 Interior Least Terns; all banding occurred at off-river sites. We captured and banded 11 adult plovers and 113 plover chicks. Most plover chicks (82%) were less than one week old when banded. Of the 126 Interior Least Tern chicks banded, most chicks (85%) were less than one week old when banded.

We re-sighted 68 plovers that were originally banded along the lower Platte River in previous years, seven that were originally banded along the Missouri River south of Yankton, SD, three that were originally banded along the central Platte River, and three originally banded along the U.S. Gulf Coast.

Daily and Seasonal Survival

Piping Plover Nest Survival

We estimated Piping Plover nest survival from 82 nests located at off-river sites (18 at lakeshore housing developments, 41 at sand and gravel mines, and 23 at transition sites). We did not include one plover nest in which nest fate was undetermined. In 2017, all off-river plover nests had a daily survival probability of 0.99 ± 0.00 and a seasonal survival probability of 0.63 ± 0.05 . Plover nests at lakeshore housing developments had a daily survival probability of 0.98 ± 0.01 and a seasonal survival probability of 0.64 ± 0.10 . Plover nests at sand and gravel mines had a daily survival probability of 0.99 ± 0.01 and a seasonal survival probability of 0.58 ± 0.09 . Plover nests at transition sites had a daily survival probability of 0.99 ± 0.01 and a seasonal survival probability was 0.68 ± 0.07 (Fig. 12).



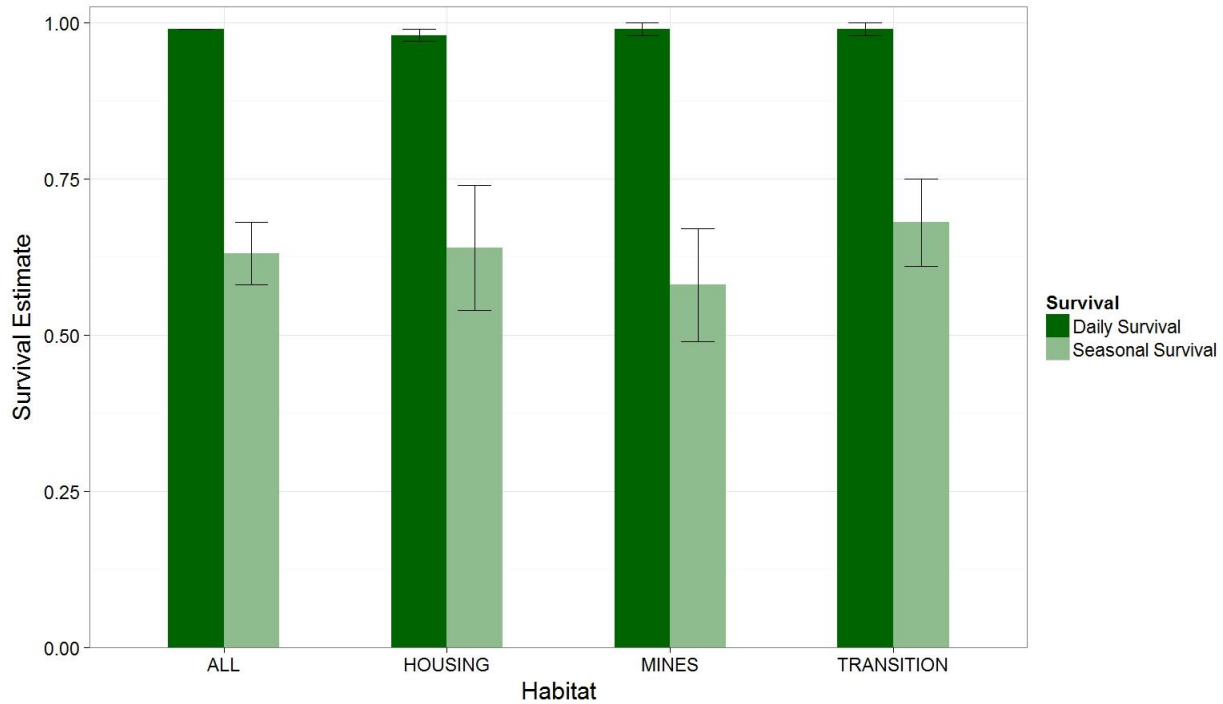


Figure 12. Daily and seasonal survival probabilities of Piping Plover nests at all off-river sites, lakeshore housing developments, sand and gravel mines, and transitions sites in 2017.

In 2017, we placed protective exclosures around 46 of the 82 off-river Piping Plover nests. Nests with protective exclosures had a daily survival probability of 0.99 ± 0.00 and a seasonal survival probability of 0.69 ± 0.09 ; while nests without protective exclosures had a daily survival probability of 0.98 ± 0.01 and a seasonal survival probability of 0.31 ± 0.12 (Fig. 13).

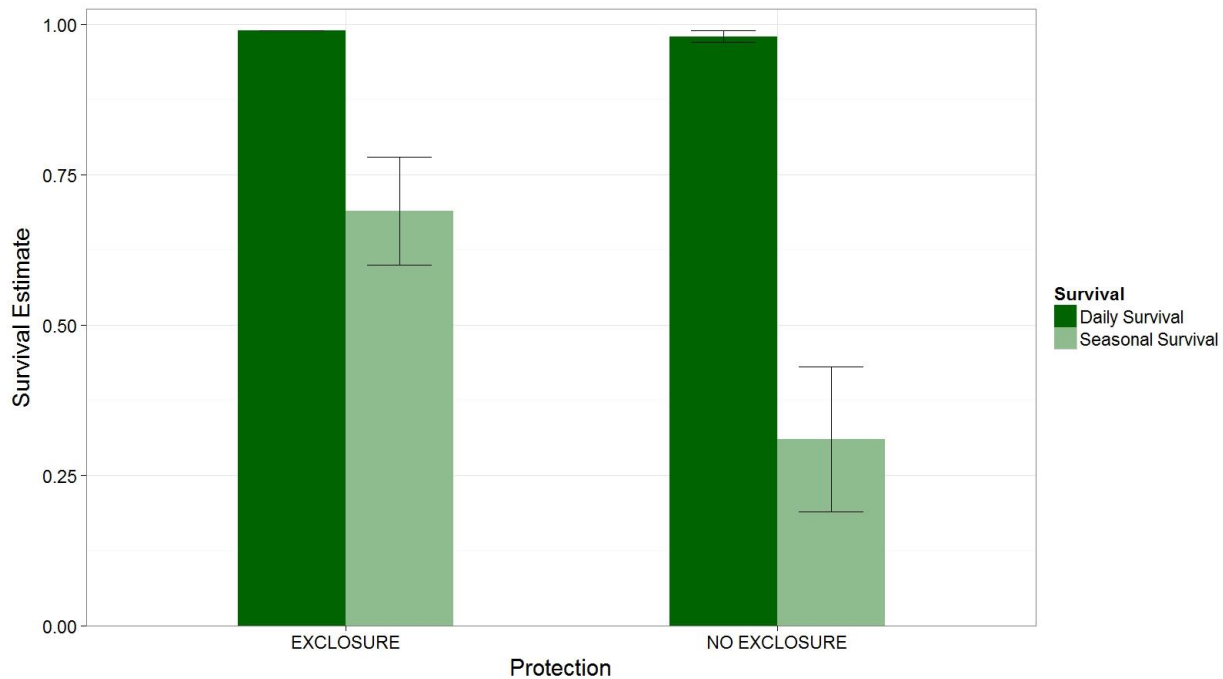


Figure 13. Daily and seasonal survival probabilities of Piping Plover nests at off-river sites with protective exclosures and those without protective exclosures in 2017.

Interior Least Tern Nest Survival

We estimated Interior Least Tern nest survival from 173 nests at off-river sites (13 at lakeshore housing developments, 125 at sand and gravel mines, and 35 at transition sites). We did not include two tern nests in which nest fate was undetermined. In 2017, the daily survival probability of off-river tern nests was 0.96 ± 0.00 and the seasonal survival probability was 0.47 ± 0.03 . Tern nests at lakeshore housing developments had a daily survival probability of 0.95 ± 0.01 and a seasonal survival probability of 0.41 ± 0.10 . Tern nests at sand and gravel mines had a daily survival probability 0.97 ± 0.01 and a seasonal survival probability of 0.58 ± 0.05 . Tern nests at transition sites had a daily survival probability 0.96 ± 0.01 and a seasonal survival probability of 0.43 ± 0.09 (Fig. 14). In 2017, we did not estimate nest survival for tern nests on river sandbars.

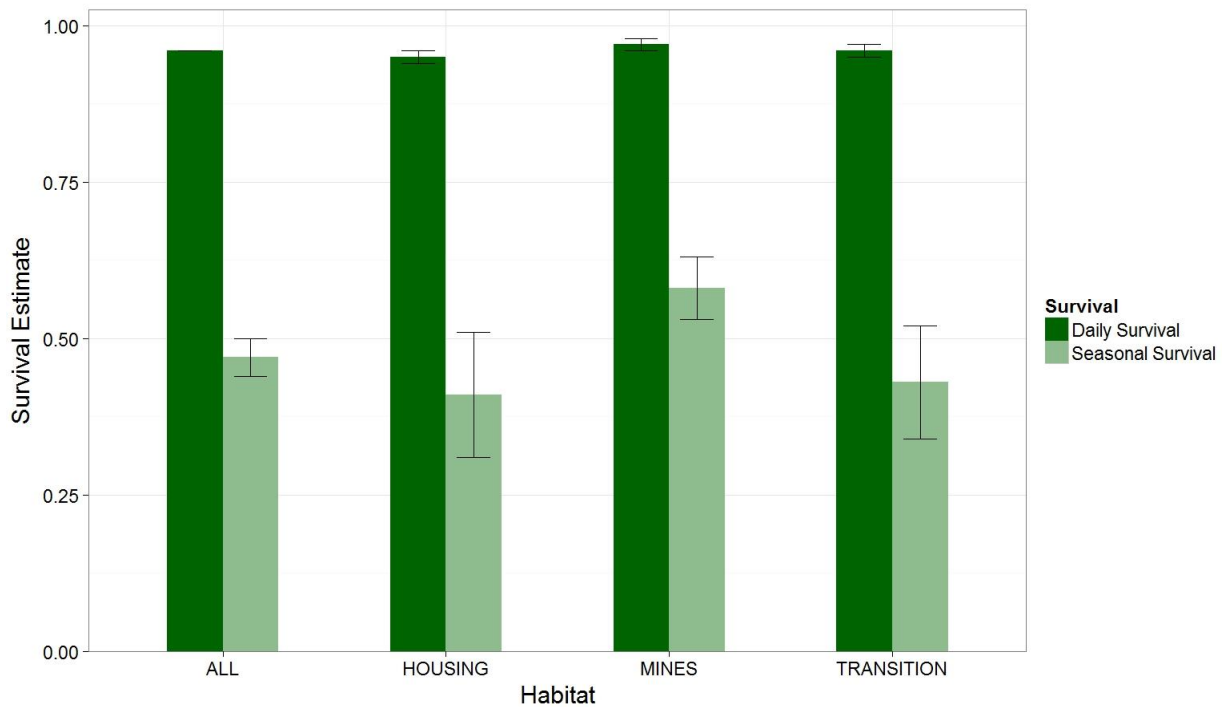


Figure 14. Daily and seasonal survival probabilities of Interior Least Tern nests at off-river sites in 2017.



Within Year Individual Survival

In 2017, the daily survival probability for adult plovers nesting at off-river sites was 0.98 ± 0.00 and the seasonal survival probability was 0.66 ± 0.06 . The daily survival probability for plover chicks reared at off-river sites was 0.95 ± 0.01 and the seasonal survival probability was 0.27 ± 0.10 . The daily survival probability for tern chicks reared on off-river sites was 0.92 ± 0.02 and the seasonal survival probability was 0.16 ± 0.11 (Figs. 15 - 17).

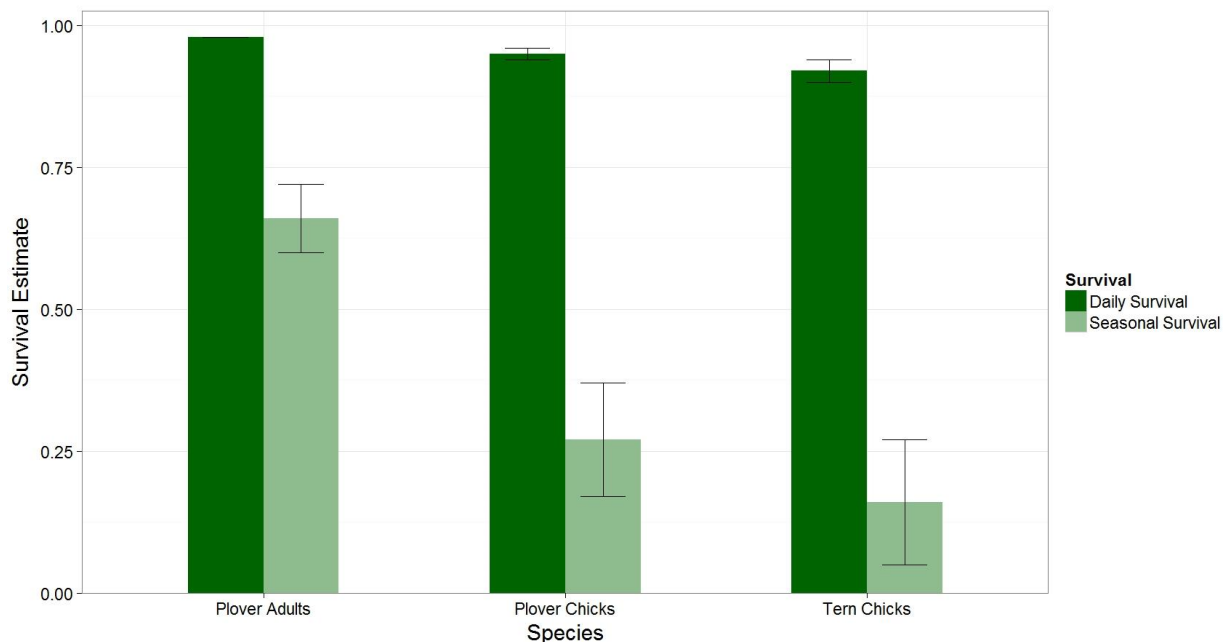


Figure 15. Piping Plover and Interior Least Tern within year daily and seasonal survival probabilities at off-river sites in 2017.

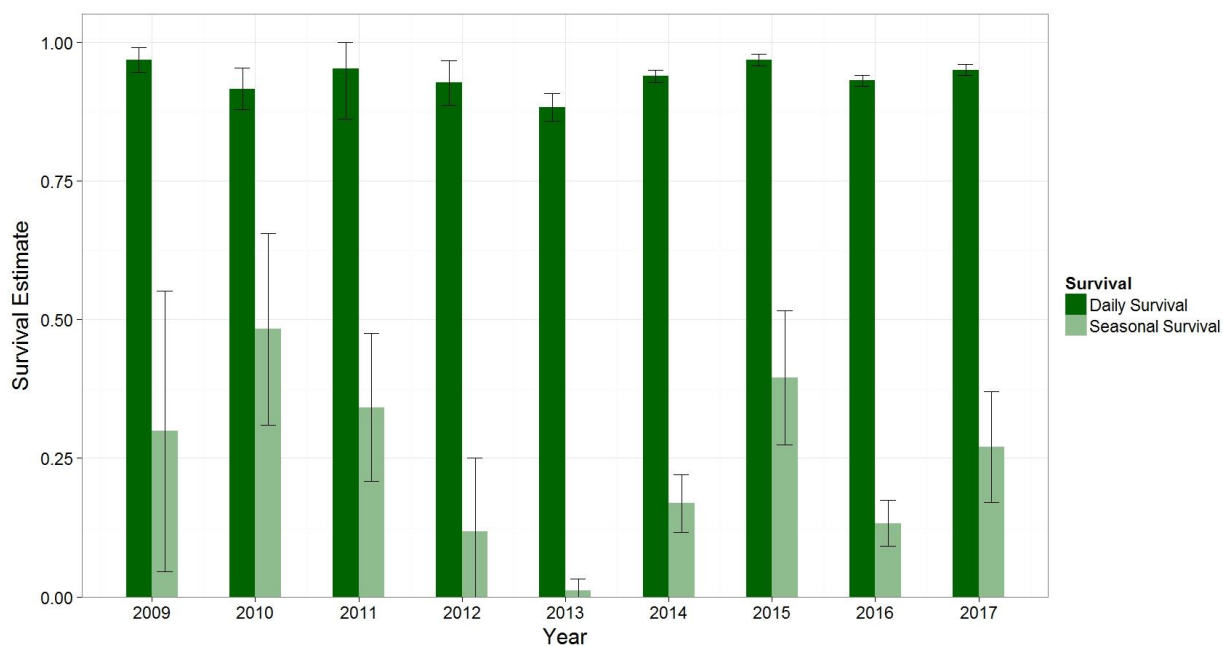


Figure 16. Piping Plover chick daily and seasonal survival at off-river sites each year.

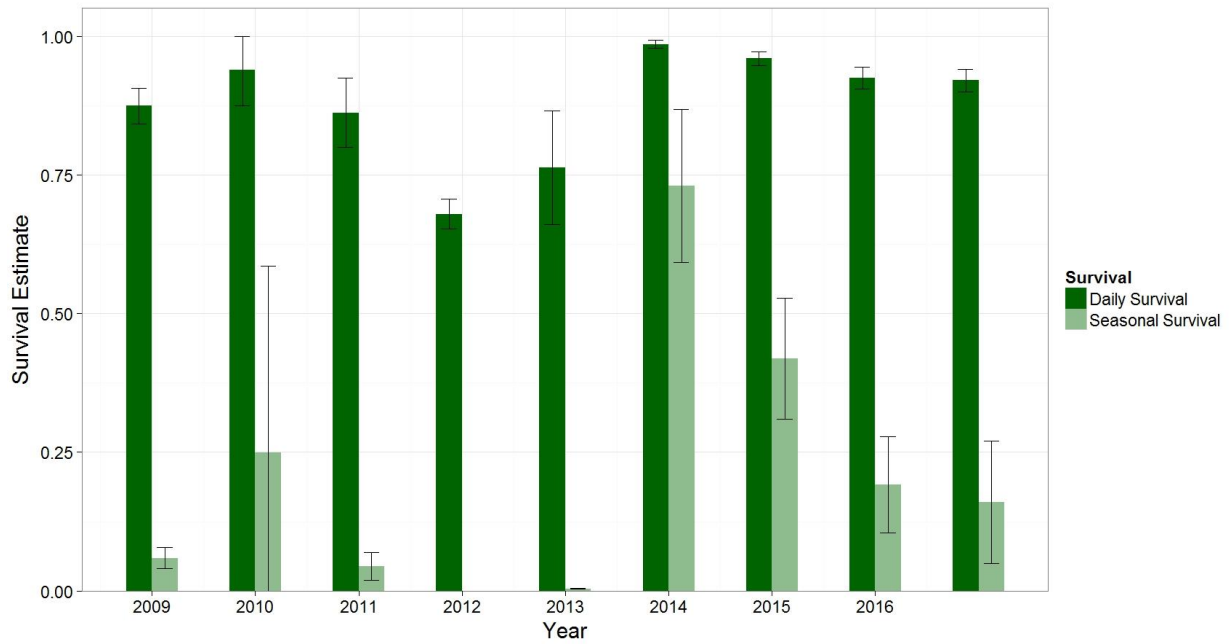


Figure 17. Interior Least Tern chick daily and seasonal survival at off-river sites each year.



Annual Survival

We estimated annual survival probabilities for plovers banded along the lower Platte River as adults and chicks from 2008 to 2017. The annual survival probability for adult plovers originally banded as adults along the lower Platte River, 2008 to 2017, was 0.72 ± 0.03 and the annual recapture probability was 0.78 ± 0.05 . The annual survival probability for adult plovers originally banded as chicks over their subsequent migration-winter cycles was 0.72 ± 0.05 and the recapture probability was 0.47 ± 0.05 . The annual survival probability for juvenile plovers originally banded as chicks over their first migration-winter cycle (hatch year) was 0.35 ± 0.07 and the recapture probability was 0.44 ± 0.07 (Fig. 18). These estimates do not distinguish between mortality and dispersal to breeding areas separate from their natal areas (e.g., away from our study area), so they are likely biased low.

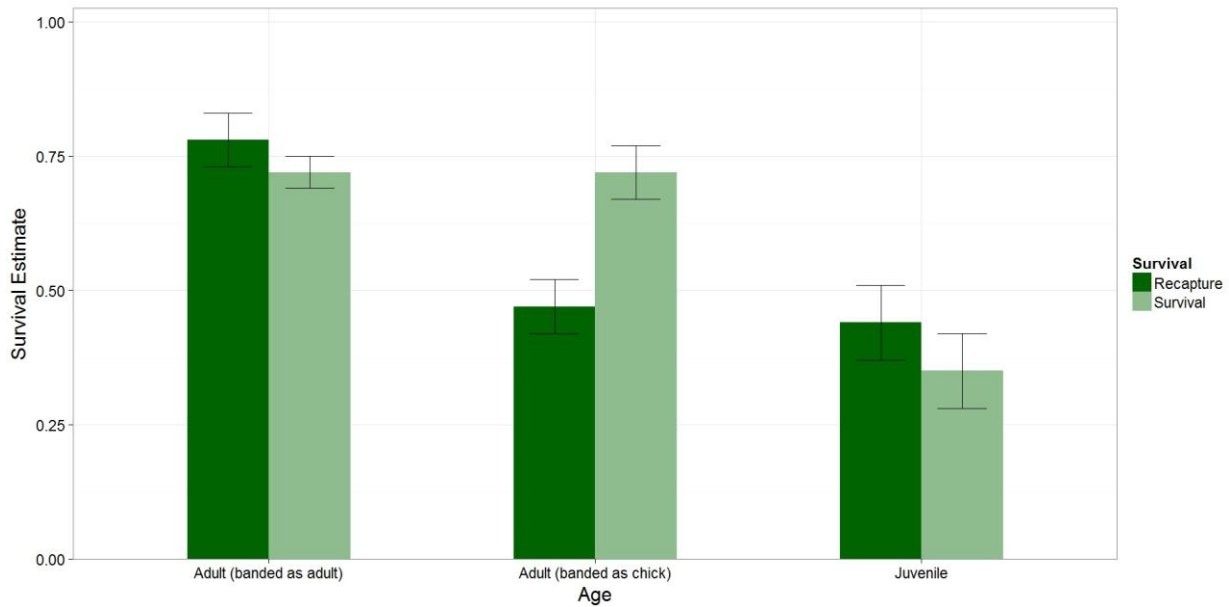


Figure 18. Annual survival and recapture probabilities for Piping Plovers originally banded as adults and chicks along the lower Platte River from 2008 to 2016.



Growth Scatterplots

We created scatterplots of Piping Plover and Interior Least Tern chick growth, based on body mass, from hatching to fledging. Scatterplots were created from 129 plover chicks and 121 tern chicks banded on off-river sites in 2017 (Figs. 19–20).

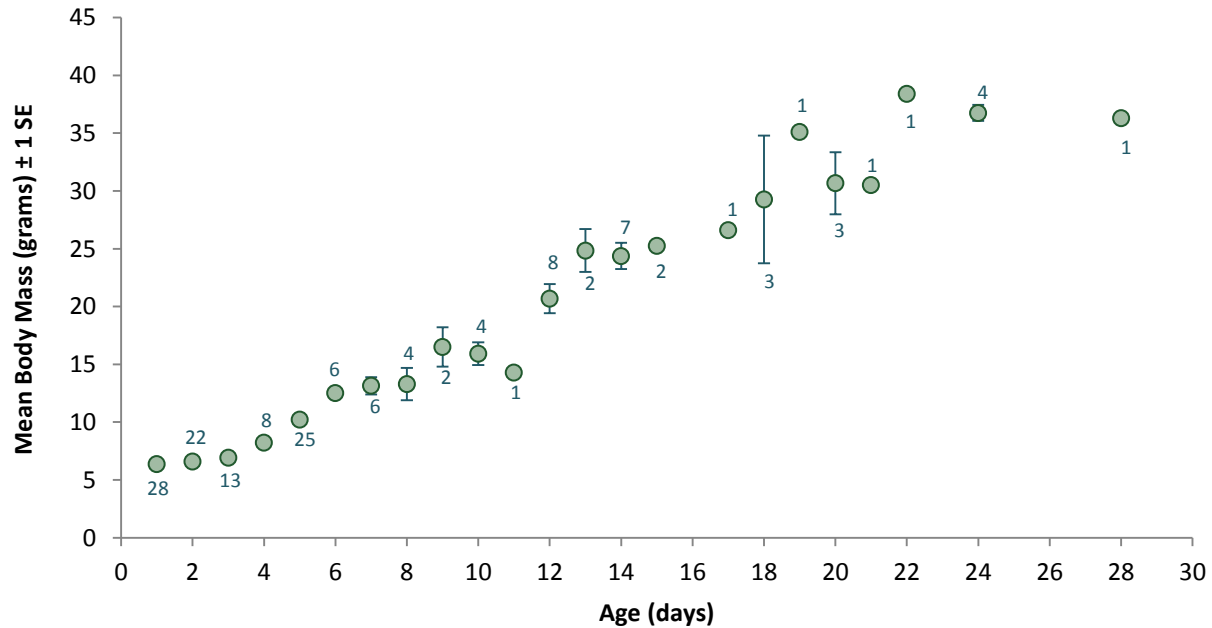


Figure 19. Scatterplot of Piping Plover chick growth from hatching to fledging at off-river sites in 2017. The graph shows the data represented as mean body mass, standard error, and sample size (number in each age class).

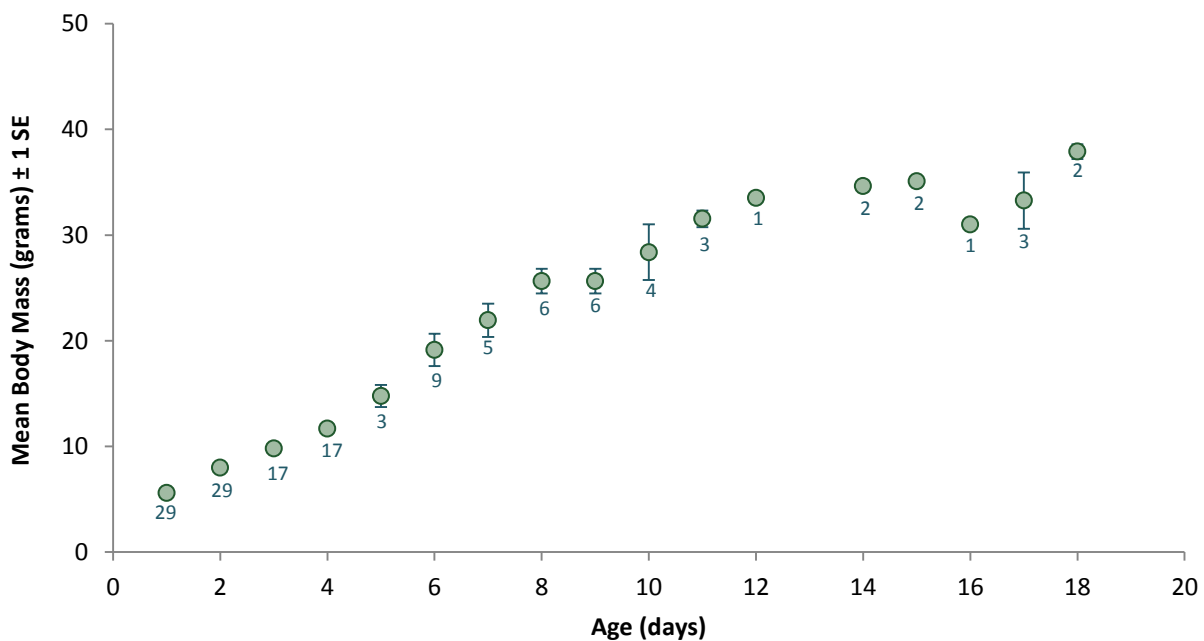


Figure 20. Scatterplot of Interior Least Tern chick growth from hatching to fledging at off-river sites in 2017. The graph shows the data represented as mean body mass, standard error, and sample size (number in each age class).

MANAGEMENT

The TPCP uses a voluntary, proactive approach to reduce human-bird conflicts and avoid the need for law enforcement actions in Interior Least Tern and Piping Plover management.

Before terns and plovers return to Nebraska in the spring and the field season begins, TPCP personnel meet with the production crews and property managers of the aggregate (sand and gravel) mines in our focus area. We discuss production plans for the upcoming season, safety regulations, and site access. We pay particular attention to concerns mine personnel have regarding on-site activities of the TPCP and changes to federal MSHA (Mine Safety and Health Administration) policy as it applies to non-mine personnel. We also meet with real estate developers and homeowners' associations at the lakeshore housing developments. At these meetings, we discuss the construction plans for the area and site access. We pay particular attention to property owners' concerns regarding on-site activities of the TPCP.

The result of these meetings is a set of site-specific management and monitoring plans; an equally valuable result is the TPCP becoming better acquainted with the people living and working at these sites. This makes our management efforts easier to implement and more effective as the nesting season progresses. We maintain close contact with these individuals throughout the season, so we can quickly respond to any on-site changes that develop.

Mine Safety and Health Administration (MSHA) and Institutional Animal Care and Use (IACUC)

Every year, all TPCP personnel receive MSHA training and certification for scientific (non-miner) workers. In 2017, our training was again provided by Tim Zuehlke, a MSHA certified trainer, and included mine safety, Red Cross First Aid, CPR and AED training. Copies of TPCP personnel certification cards are provided to the mining companies for their records. The Program Coordinator [MBB] completed University of Nebraska Institutional Animal Care and Use Committee (IACUC) training and maintains IACUC protocols and reporting.

Protecting Interior Least Tern and Piping Plover Nests

To protect tern and plover nesting areas, we erect "Keep Out" signs around the perimeter of all off-river nesting areas; these signs were designed in 2008 by the TPCP and have been widely adopted for use across Nebraska and other parts of the northern Great Plains. In areas where human foot or vehicle traffic is to be expected, 'psychological' barriers are added. These barriers consist of black or orange cord tied between the "Keep Out" sign posts with red-silver Mylar™ streamers attached to the cord to make it more visible.

Based on conversations with mine personnel and homeowners' associations before the nesting season begins, we mark off the areas where it would be safest for terns and plovers not to nest. At mines, these are areas that are going to be dredged during the nesting season or where heavy equipment will be operating. At housing developments, these are areas where buildings are to be constructed or utilities are to be installed. We know that terns and plovers avoid nesting in areas where the 1) substrate is disturbed by raking, 2) vegetation is present, 3) substrate particle size is unattractive to the birds or 4) areas are physically disturbed in some other way (J. Marcus, J. Dinan, R. Johnson, E. Blakenship, and J. Lackey 2007. *Waterbirds* 30: 251–258). In addition to planting vegetation, resurfacing the sand, and raking the substrate, we often opt for a physical method of discouraging birds from nesting in an area. Before the birds arrive, we put up grids of

three-foot-tall fiberglass poles with 16-foot-long streamers of red-silver Mylar™ flagging attached to them. The poles are set 16 feet apart. When the streamers blow in the wind, they make a crackling sound and sweep the ground, which discourages the birds from attempting to nest in the area.

We use protective wire mesh nest enclosures around plover nests, but not tern nests because of the birds' behavior around their nests—plovers walk up to their nests, while terns fly up to their nests. These enclosures help to protect plover nests from both human disturbance and natural predation. For terns, we place protective boundaries around tern nesting colonies that are in areas with human activity. We do this by placing a ring of 3-foot tall rebar poles around the nesting area; black cord with red-silver Mylar™ strips are tied between each of the poles. These marked off areas only help to protect tern nests from human disturbance; they do not reduce natural predation.



OUTREACH

Essential to our mission to protect Interior Least Terns and Piping Plovers is our outreach program. The TPCP is an important member of Nebraska’s conservation and environmental education community. We are frequently called upon to give presentations and lectures, assist with symposia, workshops and festivals, participate in workgroups, and serve on committees. While the majority of our outreach efforts are focused on terns and plovers nesting along Nebraska’s lower Platte River, we appreciate that we play a broader role in improving environmental literacy locally, regionally, and nationally. We take advantage of opportunities to reach as many different constituencies as possible with our message of common-sense conservation. The number of adults and children we are able to reach across the state has grown substantially over the past few years (Figs. 21-22). The TPCP continues to be one of the go-to programs in Nebraska’s environmental education community. We have evolved from being an organization that needed to seek out events to participate in to one that receives a stream of requests for participation. It is gratifying for us to meet people who know what the TPCP does and who commend us for our work.

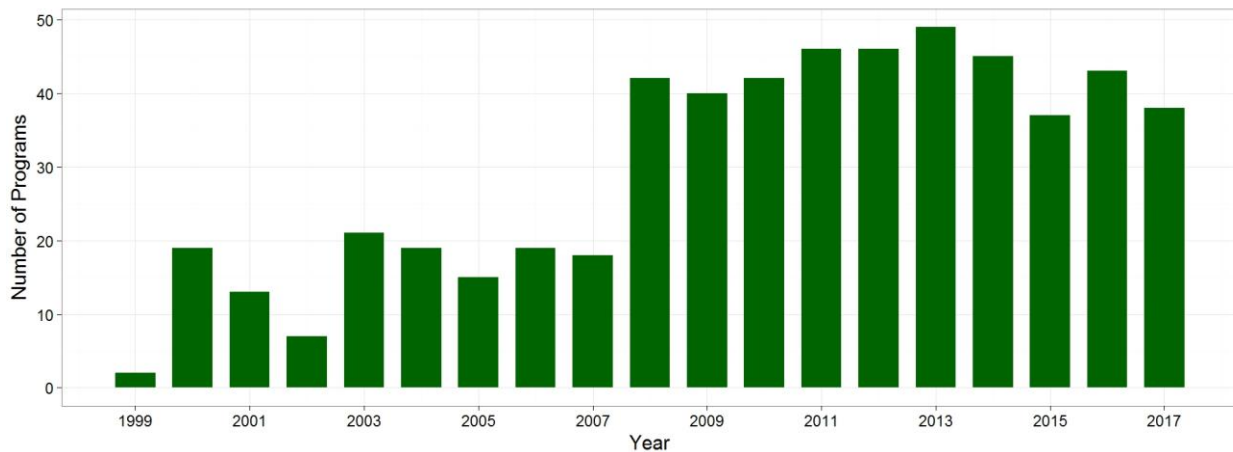


Figure 21. Number of programs delivered by the TPCP from 1999 through 2017 (this only includes scheduled programs; we frequently deliver impromptu presentations).

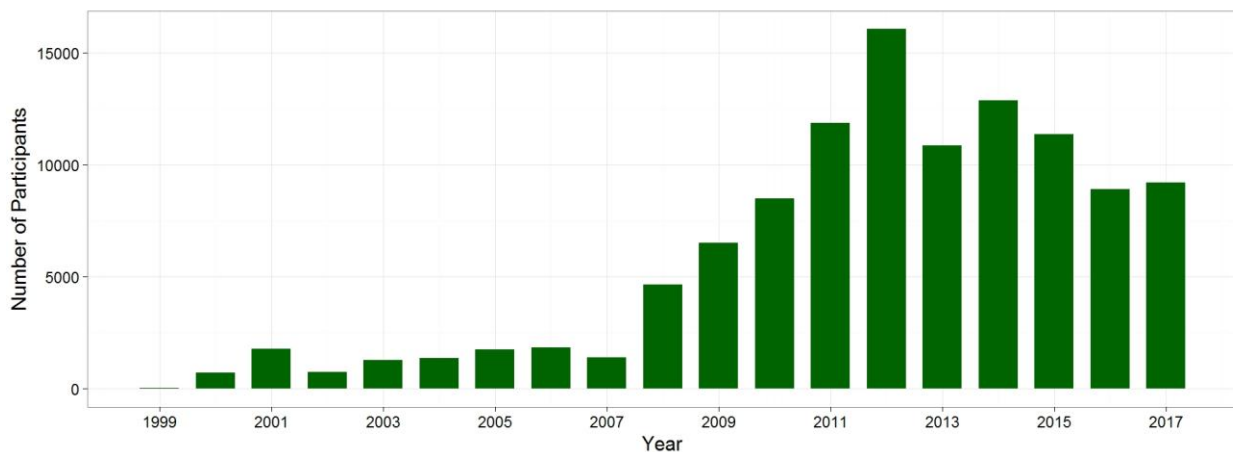


Figure 22. Number of participants in TPCP programs from 1999 through 2017 (this only includes scheduled programs; we frequently deliver impromptu presentations).

Programs for the General Public

An Evening with Heather Henson, Conservation Biologists, and Birds, Lincoln, NE

Campbell School Family Nature Night, Lincoln, NE

Dimensions School Family Nature Night, Lincoln, NE

Durham-Smithsonian Museum Teacher's Night Out, Omaha, NE

EarthWellness Festival, Lincoln, NE

Florida Audubon Society Shorebird Beach Monitors, Ft. Myers, FL

Fremont Eco-Fair, Fremont, NE

Iowa Western Community College, Council Bluffs, IA

Irving Middle School Chimney Swift Club, Lincoln, NE

Nebraska Ornithologists' Union, Ogallala, NE

Sandhills Discovery, Ainsworth, NE

The Messengers documentary film, Hastings, NE

Wahoo Bird Club, Wahoo, NE

Homeowners' Associations

Lake Socorro, Sandy Pointe, Bluewater, Ritz Lake, and Lake Allure

University of Nebraska-based Programs

Sunday with a Scientist, Morrill Hall

UNL Career Fair

UNL Graduate Student Welcome

UNL Women's Club

Education-Curriculum Development Activities

Informal Educators of Lincoln Network

Iowa Western Community College Environmental Studies

Lincoln Public Schools STEM

Nebraska Association of Teachers of Science

University of Nebraska School of Natural Resources

Professional presentations

Acoustical Society of America, Omaha, NE

Ecological Society of America, Portland, OR

Iowa Western Community College, Council Bluffs, IA

Midwest Fish and Wildlife Conference, Lincoln, NE

Nebraska Master Naturalist, Ogallala, NE

Nebraska Natural Legacy Conference, Broken Bow, NE

NGPC/USFWS/Congressional Delegation Coordination Meeting, Grand Island, NE

The Wildlife Society, Albuquerque, NM

Water Leaders Academy, Kearney, NE

Wilson Ornithological Society, Ft. Myers, FL

Professional Committees and Workgroups

Lower Platte River Weed Management Area

Nebraska Bird Partnership Steering Committee and Conservation and Science Advisory

Nebraska Environmental Trust Technical Advisory Committee

Nebraska Land Trust Lower Platte River Advisory Committee

PACE (Planning, Aggregate, Community, Environment)

North American Bird Conservation Initiative (NABCI)

We were recognized by the North American Bird Conservation Initiative (NABCI) as a human dimensions-bird conservation success story

(<http://ternandplover.unl.edu/monitor/birdhumaninteraction.asp>)

Platte River Time-Lapse Project (<http://plattebasintimelapse.com>)

We were pleased work with the Platte River Time-Lapse Project as they developed a tern and plover educational curriculum suitable for upper level elementary-middle school students and teachers. The material is currently available at: <http://plattebasintimelapse.com/learn/terns-and-plovers>

On-Line Activities: The internet and social media continue to be important tools in expanding our outreach program. Our website (<http://ternandplover.unl.edu>) is frequently updated with information about the Partnership. Our YouTube videos, "Respect the Signs, Respect the Birds", "Plover at Nest" and "Points about Plovers" continue to generate interest in the TPCP.

Featured in the Media

To be featured in forthcoming textbook, "Urban Evolution" by Menno Schilthuizen (Naturalis Biodiversity Center, Leiden University)

Featured in April 2017 issue New Territory magazine, "Building a Better Swallow" by Conor Gearin (MIT Science Writing MS student)

Featured in 18 August 2017, The Wildlife Society online newsletter, "Greater Prairie Chicken nests unaffected by wind energy development"

Featured in 29 November 2016, "Making a more perfect penguin", Hakai magazine, 29 November

Grants and Funding

- Brown, M. B. (Principal Investigator), "At-Risk Bird Surveys", Nebraska Game & Parks Commission, \$20,000.00, Awarded. (start: April 1, 2016, end: February 28, 2018).
- Brown, M. B. (Principal Investigator), "At-Risk Bird Surveys", Nebraska Game & Parks Commission, \$30,596.00, Awarded. (start: April 1, 2016, end: February 28, 2018).
- Brown, M. B. (Principal Investigator), "Non-Game Bird Research Assistance", Nebraska Game & Parks Commission, \$40,208.00, Awarded. (start: December 2, 2016, end: February 20, 2017).

Publications

- Jorgensen, J. G., Brown, M. B. (2017). Evaluating persuasive messages to influence dog leash law compliance at a public use recreation area in Nebraska, USA. *Great Plains Research* 27: 131-142.
- Zeigler, S. L., Catlin, D. H., Brown, M. B., Fraser, J. D., Dinan, L. R., Hunt, K. L., Jorgensen, J. G., Karpanty, S. M. (2017). Effects of climate change and anthropogenic modification on a disturbance-dependent species in a large riverine system. *Ecosphere* DOI: 10.1002/ecs2.1653 (with cover photo).
- Brown, M.B., J.G. Jorgensen and L. R. Dinan. (2016). 2016 Interior Least Tern and Piping Plover monitoring, research, management, and outreach report for the lower Platte River, Nebraska. Joint report of the Tern and Plover Conservation Partnership and the Nebraska Game and Parks Commission Non-game Bird Program, Lincoln, NE.
- Jorgensen, J. G., Brown, M. B. (2017). Temporal migration shifts in the Aransas-Wood Buffalo Population of Whooping Cranes (*Grus americana*) across North America. *Waterbirds* (with frontispiece) 40:195-206.
- Harrison, J. O., Brown, M. B., Powell, L. A., Schacht, W. H., Smith, J. A. (2017). Nest site selection and nest survival of Greater Prairie-Chickens near a wind energy facility. *Condor* 119:659-672.
- Hoppe, I. R., Harrison, J. O., Raynor, E. J., Brown, M. B., Powell, L. A., Tyre, A. J. (in review) Time and Environment Influence Incubation by Greater Prairie-Chickens in the Nebraska Sandhills. *Ibis*.
- Powell, L. A., Brown, M. B., Smith, J. A., Harrison, J. O., Whalen, C. E. (2017). Modeling the spatial effects of disturbance: a constructive critique to provide evidence of ecological thresholds. *Wildlife Biology* doi: 10.2981/wlb.00245.
- Raynor, E. J., Whalen, C. E., Brown, M. B., Powell, L. A. (in review). Location matters: evaluating Greater Prairie-Chicken (*Tympanuchus cupido*) boom chorus propagation from leks located along an anthropogenic disturbance gradient. *Avian Conservation and Ecology*.
- Raynor, E. J., Whalen, C. E., Brown, M. B., Powell, L. A. (2017). Grassland bird community and acoustic complexity appear unaffected by proximity to a wind energy facility in the Nebraska Sandhills. *Condor* 119:484-496.

- Smith, J. A., Brown, M. B., Harrison, J. O., Powell, L. A. (2017). Predation risk: a potential mechanism for effects of a wind energy facility on Greater Prairie-Chicken survival. *Ecosphere*. 8:e01835. 10.1002/ecs2.1835.
- Whalen, C. E., Brown, M. B., McGee, J., Powell, L. A., Walsh, E. J. (2017). Quantitative analysis of the acoustic characteristics of lekking male Greater Prairie-Chicken vocalizations. *Great Plains Research* 27: 93-108.
- Whalen, C. E., Brown, M. B., McGee, J., Powell, L. A., Walsh, E. J. (in review). Male Greater Prairie-Chickens adjust aspects of their vocalizations in the presence of wind turbine noise. *Condor*.
- Johnson, A. E., Mitchell, J. S., Brown, M. B. (2017). Evolution of social behavior drives morphology in the Hirundinidae (Class Aves). *Ecology and Evolution* (with cover photo), 7:550-560.
- McCollum, K. R., Powell, L. A., Snyman, A., Brown, M. B., Carroll, J. P. (in review). Occupancy analysis and density estimation of Kori Bustards (*Ardeotis kori*) in the Northern Tuli Game Reserve, Botswana. *Avian Conservation and Ecology*.
- McGregor, C., E. Bruster, M.B. Brown, L.R.Dinan, L. R., J.G. Jorgensen. (2016). Evidence of occurrence of Black Rail (*Laterallus jamaicensis*) in the Nebraska Rainwater Basin. *Nebraska Bird Review* 84:132-137.
- Brown, C. R., Brown, M. B., Pyle, P., Patten, M. A. (2017). Cliff Swallow (*Petrochelidon pyrrhonota*). *Birds of North America Online* (bna.birds.cornell.edu).
- Brown, C. R., Roche, E. A., Brown, M. B. (2017). Why come back home? Breeding-site fidelity varies with group size and parasite load in a colonial bird. *Animal Behavior*, 132, 167-180.
- Brown, C. R., Brown, M. B. (in review). Parasites drive stabilizing survival selection on nestling mass and brood size in Cliff Swallows. *Journal of Evolutionary Biology*.
- Brown, M. B., Brown, C. R., Pyle, P., Patten, M. A. (in press). Barn Swallow (*Hirundo rustica*). *Birds of North America Online* (bna.birds.cornell.edu).
- Burnett, J.L., Roberts, C.P., Allen, C.R., Brown, M.B., and Moulton, M.P. (2016). Eurasian Tree Sparrow (*Passer montanus*) range expansion in North America. *Biological Invasions* 19:5-9 DOI 10.1007/s10530-016-1273-4.

Reviewers for Professional Publications and Organizations

Human Dimensions of Wildlife
 Nebraska Environmental Trust
 Nebraska Game and Parks Commission
 Oregon State University Extension (eOrganic)
 Tropical Conservation Science
 United States Fish and Wildlife Service
 Wilson Journal of Ornithology

Miscellaneous

Hold UNL IACUC#1261 research approval certificate

Hold UNL IRB#20130213371EX research approval certificate

Hold NGPC Scientific and Educational permit # 905. Authorized to trap, net, band, release, and salvage endangered Least Tern, threatened Piping Plover, and incidental species

Hold USFWS Master Bander permit # 23545, with authorization to trap, use mist nets, and band all species except waterfowl, eagles and all endangered/threatened species except Interior Least Terns and Piping Plovers

Hold USFWS Threatened and Endangered Species permit # TE070027-0. Authorized to handle endangered Interior Least Terns and threatened Piping Plovers; reauthorized through 2018

Advisor, Friends of Ash Hollow Watchable Wildlife [Lake McConaughy state historical park and WMA] citizen science project

Advisor, Nebraska Ornithologists' Union (NOU) Louisiana Waterthrush citizen science project

Mentor, Lincoln Public Schools job shadowing program, Lincoln, NE

University of Nebraska Teaching and Mentoring

Mentor, Association for Women in Science (AWIS), University of Nebraska, Lincoln, NE

Mentor, Big Red Summer Camp for high school students

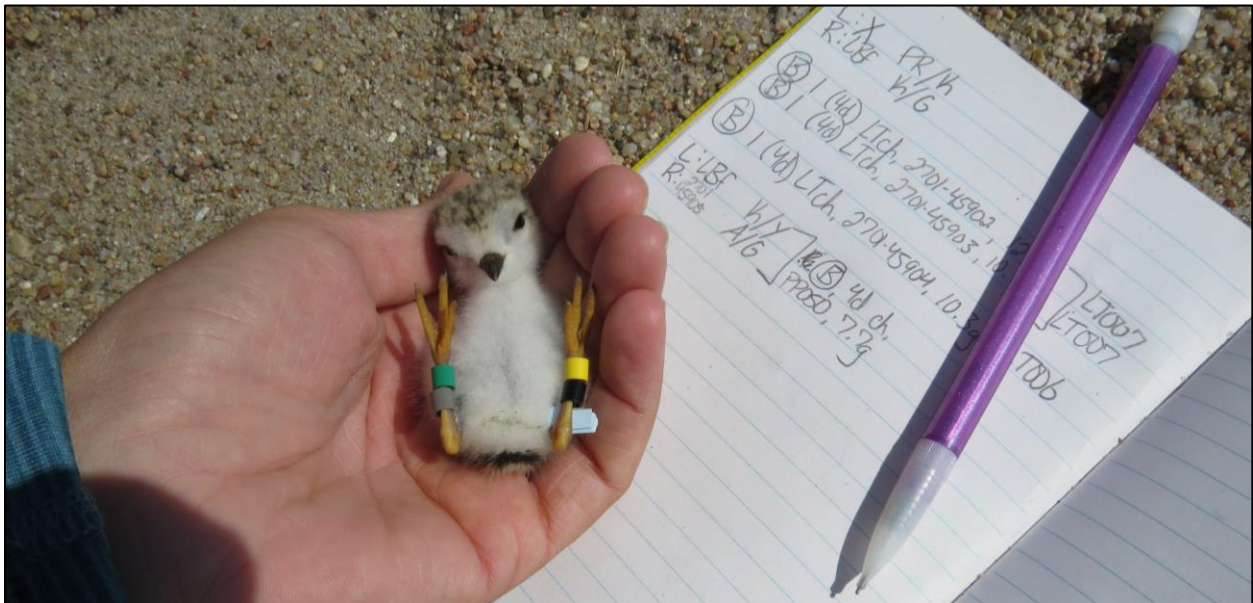
Mentor, 2 M.S. students and 1 post-doctoral student, University of Nebraska, Lincoln, NE

NRES 208 Introduction to Applied Climate Science (presentation; E. Walter-Shea)

NRES 399 Independent Research (supervisor)

NRES 233L/433L/833L Wildlife Management Techniques (with Larkin Powell)

TEAC 890 Master Naturalist (training for teachers)



LITERATURE CITED

- American Ornithologists' Union. 1998. Check-list of North American Birds, 7th edition. American Ornithologists' Union, Washington, DC.
- Annear, T., I. Chisholm, H. Beecher, A. Locke, P. Aarrestad, C. Coomer, C. Estes, J. Hunt, R. Jacobson, G. Jobsis, J. Kauffman, J. Marshall, K. Mayes, G. Smith, R. Wentworth, and C. Stalnaker. 2004. Instream Flows for Riverine Resource Stewardship. Revised edition. The Instream Flow Council, Cheyenne, WY.
- Brown, M.B. and J.G. Jorgensen. 2010. 2010 Interior Least Tern and Piping Plover monitoring, research, management, and outreach report for the lower Platte River, Nebraska. Joint report of the Tern and Plover Conservation Partnership and the Nebraska Game and Parks Commission.
- Burnham, K.P. and D.R. Anderson. 2002. Model selection and multimodel inference: a practical information-theoretic approach. 2nd edition. Springer, New York, NY.
- Dinsmore, S.J. and J.J. Dinsmore. 2007. Modeling avian nest survival in program MARK. *Studies in Avian Biology* 34: 73–83.
- Hays, H. and M. LeCroy. 1972. Field criteria for determining incubation stage in eggs of the Common Tern. *Wilson Bulletin* 83: 425–429.
- Lebreton, J.D., K.P. Burnham, J. Clobert, and D.R. Anderson. 1992. Modeling survival and testing biological hypotheses using marked animals: a unified approach with case studies. *Ecological Monographs* 62: 67–118.
- Lettink, M. and D.P. Armstrong. 2003. An introduction to using mark-recapture analysis for monitoring threatened species. Department of Conservation Technical Series 28A: 5–32.
- Marcus, J.F., J.J. Dinan, R.J. Johnson, E.E. Blankenship, and J.L. Lackey. 2007. Directing nest site selection of Least Terns and Piping Plovers. *Waterbirds* 30: 251–258.
- Pyle, P. 1997. Identification guide to North American Birds. Slate Creek Press, Bolinas, CA.
- Rabbe, M. 2014. USFWS Interior Least Tern and Piping Plover nesting survey results from 2014 for the Lower Platte River, Leshara to Columbus, Nebraska. U.S. Fish and Wildlife Service Grand Island Field Office Report.
- R Development Core Team. 2014. R: A language and environment for statistical computing. R Foundation for Statistical Computing. Vienna, Austria. Accessed at: <http://www.R-project.org>
- White, G.C. and K.P. Burnham. 1999. Program MARK: survival estimates from populations of marked animals. *Bird Study* 46: S120–S139.
- Van der Toorn. 1997. A survival guide to survival rates. *Marine Mammals: Public Display and Research* 3: 27–28.