LEAST TERN AND PIPING PLOVER UPDATE

I. *INTRODUCTION*

The Program's objective for interior least terns (*Sternula antillarum*) (hereafter least terns or terns) and piping plovers (*Charadrius melodus)* (hereafter piping plovers or plovers) were to improve production of both species along the central Platte River. Over the course of the First Increment, the indicators of success that were used included increasing the number of fledged tern and plover chicks by increasing breeding pairs and fledge ratios, and reducing mortality for both chicks and adults. Causes of mortality include losses to weather, flooding, and predation. One of causes of mortality that the Program has been concentrating on in recent years, is loss due to predation. This has become one of the areas of focus over the past few years and it is something that we can influence to some degree.

Monitoring was conducted by the Program staff, technicians, and Program partners to document and report least tern and piping plover activity and reproductive success during 2020.

II. *HABITAT AVAILABILITY AND SPECIES RESPONSE, 2007-2020*

Since 2007, the Program has restored or created approximately 83 acres of on-channel habitat and 109 acres of off-channel sand and water habitat (OCSW or off-channel habitat) (Table 1), and more OCSW habitat is expected to be added in future years. This, in addition to restored and created habitat by other organizations, resulted in 209 acres of total habitat being available for our target species in 2020.

Though some nesting has occurred on riverine sandbars in the past, OCSW sites have provided the most consistently available nesting habitat for both species (Tables 1). The limited amount of on-channel nesting observed at the beginning of the First Increment declined even further as on-channel habitat was lost during several high flow events. As a result, most of the nesting in the associated habitat reach (AHR) during the First Increment of the Program has occurred on managed off- channel habitats (Fig. 2-3). Overall, the Program has observed a positive species response to off-channel habitat construction and maintenance. The number of breeding pairs and nest counts have trended upward over the course of the First Increment as the Program has constructed additional OCSW habitats (Fig. 1). This is likely in part due to the increasing habitat availability. Because of this we have shifted our focus to OSCW habitat. This off-channel habitat provides a stable and predictable environment, but the price is increasing predation as the site ages. A more detailed explanation of on- vs off-channel productivity can be found in the Program's 2020 least tern and piping plover report (Mohlman 2021).

III. *METHODS*

Typically, we conduct 5 semi-monthly surveys (1 and 15 May, 1 June, 15 July, and 1 August) of the central Platte River between Chapman and Lexington, Nebraska (river surveys); and 7 semi-monthly sandpit surveys (1 and 15 of May, June, and July; and 1 August). Besides the surveys conducted along the river, we also surveyed 16 sandpits within Program Associated Habitats on

these dates to document adults, breeding pairs, nests, chicks, and fledglings during 2020.

In addition to semi-monthly surveys, we monitored all sites with active nests or broods on a semi-weekly basis throughout the nesting season. There were 16 sandpits monitored in 2020 using outside semi-weekly surveys. We attempted to observe nests and chicks twice per week until the nest or brood failed, or the chicks fledged. We conducted surveys of adults, nests, chicks, and fledglings from outside the nesting area. Program staff, technicians, and Program partners monitored nesting sites during 2020. Outside surveys were performed for at least 30 minutes during each site visit using binoculars and/or spotting scopes, at a distance that did not cause disturbance to nesting birds (usually >165 ft., but closer or farther as terrain dictated). Observations were conducted from multiple vantage points to allow observation of as much of the site as possible. Nests and chicks were often located by observing adult birds. We recorded date, 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. When chicks or fledglings were observed, we estimated the date of hatching or fledging based on current and previous nest and chick observations.

We derived least tern and piping plover breeding pair estimates (BPE) according to the methods described by Baasch et al. (2015). Briefly, we derived least tern and piping plover breeding pair estimates by adding the number of active, or recently failed nests (within the species-defined renest interval) to the number of active, or recently failed or fledged broods (within the species-defined renest or post fledge interval, respectively) observed on a given date. We obtained least tern breeding pair estimates by assuming: 1) least tern nests did not hatch within 21 days of being initiated; 2) least terns did not re-nest within 5 days of losing a nest or brood; 3) least tern chicks fledged at 21 days of age (fledging age 2010−2020); 4) least tern chicks that survived to 15 days of age (fledging age 2007−2009) also fledged; and 5) least terns did not re-nest after fledging chicks. We determined piping plover breeding pair counts by assuming: 1) piping plover nests did not hatch within 28 days of being initiated; 2) piping plovers did not re-nest within 5 days of losing a nest or brood or fledging chicks; 3) piping plover chicks fledged at 28 days of age (fledging age 2010−2020); 4) piping plover chicks that survived to 15 days of age (fledging age 2007−2009) also fledged; and 5) piping plovers did not re-nest within 5 days of fledging a brood. All counts of adults, breeding pairs, nests, chicks, and fledglings reported during semi-monthly surveys represent minimums present as they rely on direct observation.

The Program typically reports breeding pairs at their peak, when numbers of breeding pairs observed during a single observation period within the entire Program AHR first peaked. Thus, peak breeding pair estimates are associated with a specific peak date. AHR peak breeding pairs utilize the rules for calculated breeding pairs (BPE) as described above. Other methods used to be comparable to other programs that use other sampling intervals and methods that the Program reports can be found in more detail in the 2020 least tern and piping plover report. The Program's BPE was found to be the most appropriate estimator of breeding pairs based on our monitoring protocol and sampling effort (Baasch et al. 2015).

IV. *RESULTS*

A. *Least Tern Breeding Pairs and Productivity*

Least tern breeding pair counts peaked at 84 pairs (Table 2) on 19 June 2020. Breeding pair counts for this species have increased steadily since 2001 and the trend since 2007 can be seen in Fig. 4. As adult counts for the species were lower in 2020 than in 2019 (Table 2), we did observe a decrease in least tern and piping plover breeding pairs this year as well (Table 2; Fig. 4). However, tern numbers are still higher than counts observed during the years prior to the Program implementation. Adults observed in Table 2 represents the total across all the sites, of the largest count of adults observed at each site on any one survey. Program analyses indicated least tern breeding pair counts from 2001-2020 increased with habitat availability (Fig. 1). For every acre of habitat added 0.37 more least tern breeding pairs (bp) were present in the AHR (95% CI: 0.21 - 0.53 bp; $p < 0.001$).

Least tern nests were observed and monitored at 10 of the 16 sandpits monitored during 2020. Nests are calculated as the total number of nests observed across all the sites over the nesting season. Similar to the breeding pair counts, nest counts have also increased steadily since 2007 (Table 2; Fig. 4). Chick and fledgling counts on Table 2 are the total of the highest number of chicks or fledglings in the appropriate age categories that are associated with each unique nest. In 2020, at least 1 egg from 70% (74/105) of least tern nests hatched resulting in 160 chicks and an overall nest-success rate of 1.52 chicks/nest and 1.90 chicks/breeding pair (160 chicks/84 breeding pairs) during 2020 (Table 2). Apparent fledge success at all sites monitored was 1.02 fledglings/nest (107 fledglings/105 nests) or 1.27 fledglings/breeding pair (107 fledglings/84 breeding pairs) (Table 2) with all nests occurring on sandpit sites during 2020.

The proportion of successful least tern nests and chicks for 2020 were higher than in 2019. There was an upward trend for the proportion of successful nests; however, there has been a downward trend in the proportion of successful chicks (Fig. 6) when looking at data from 2007-2020. That downward trend along with lower fledge ratios in 2019 (Fig. 8) for least terns, and similar trends in piping plovers, led to concern over productivity. Though least tern fledge ratios have held steady over the life of the Program, last year was the lowest they have been since before 2007. In the 2020 season, we did end up seeing an increase in fledge ratios from 2019 though.

B. *Piping Plover Breeding Pairs and Productivity*

Piping plover breeding pair counts peaked at 32 pairs (Table 3) on 12 June 2020. Piping plover breeding pair counts increased slightly from 2001−2007, declined during 2008 and 2009, and have since increased (Table 3; Fig. 5). Similar to least tern numbers, piping plover adult counts and breeding pairs were lower in 2020. However, also similar to observations for terns, plover numbers are still higher than counts observed during the years prior to the Program implementation. Adults observed in Table 3 represents the total across all the sites, of the largest

count of adults observed at each site on any one survey. Program analyses indicated piping plover breeding pair counts from 2001-2020 increased with habitat availability (Fig. 1). For piping plovers, every acre of habitat added led to 0.17 more breeding pairs present in the AHR (95% CI: 0.12 - 0.22 bp; $p<0.001$).

Piping plover nests were observed at 8 of 16 sandpits monitored during 2020. Nests are calculated as the total number of nests observed across all the sites over the nesting season. As with the breeding pairs, there was a dip in nest count numbers in 2008 and 2009, and those numbers have since increased, but with more variation than the breeding pairs had (Table 3; Fig. 5). Chick and fledgling counts are the total of the highest number of chicks or fledglings in the appropriate age categories that are associated with each unique nest. At least one egg from 57% (28/49) of piping plover nests hatched, which resulted in 98 chicks and an overall hatch ratio of 2.00 chicks/nest or 3.06 chicks/breeding pair (98 chicks/32 breeding pairs) during 2020 (Table 3). We observed an apparent nest-based fledging rate of 0.80 (39 fledglings/49 nests) and a pair-based fledging rate of 1.22 (39 fledglings/32 breeding pairs) at all sites monitored during 2020 (Table 3).

The proportion of successful nests and chicks for piping plovers increased from 2019 to 2020. When looking at the trends from 2007-2020, the proportion of successful nests has been slightly and gradually increasing, but the proportion of successful chicks is on a downward trend (Fig. 7). Piping plover fledge ratios peaked in 2012, which was around the time the Program stopped adding new nesting sites (though habitat has still been added to existing sites), but the 3-year running fledge ratios have seen a gradual decline since then. Fledge ratios in 2018 and 2019 were particularly low (Fig. 8), which as stated previously, was something that led to concern related to productivity. As with the least terns, the fledge ratios for 2020 did end up being higher than in 2019.

C. *Mortality*

We observed no research-related mortality during 2020. One least tern nest (1.0%) and two piping plover nests (4.1%) were determined abandoned. This is comparable to previous years. Predation was attributed as the cause of at least 5 least tern nests (4.8% of total tern nests) and 8 piping plover nests (16.3% of total plover nests), as well as 3 least tern broods (4.1% of total least tern broods) and 1 piping plover brood (3.6% of total piping plover broods) during 2020. Overall predation was lower than last year, and losses were spread out over time as well as over sites. In 2019, predation was concentrated over a few sites and large-scale losses of broods and chicks happened around the same time on those sites. No nests or broods from either species were recorded as being lost to weather or flooding during 2020. This was much lower than 2019, when 18 nests and broods were lost to significant flooding and cold rainy weather. In 2020, 22 least tern (21.0%) and 11 piping plover (22.4%) nest failures were attributed to unknown causes and these were fated as failed-unknown as there was not enough evidence to assign a specific fate. Sixteen least tern broods (21.6%) and nine piping plover broods (32.1%) were also assigned a

failed-unknown fate. These losses were also lower than the 87 failed unknown losses observed in 2019. One least tern nest was declared to have an unknown outcome as there was not enough evidence to determine if it hatched before failing. Because systematic inside monitoring has not been performed since 2016, determining nest fates has not been as precise as previous years when grid searching was performed. Predator cameras deployed on nests during the 2020 nesting season did assist in determining the fate of three nests. Overall, total losses of chicks and broods were lower than the previous season.

V. *DISCUSSION*

Even though our total nests and breeding pairs for both species were lower in 2020 than in 2019, fledge ratios and the proportions of successful nests and chicks were higher in 2020 than in 2019. Total losses, especially to weather, flooding, and predation, were lower in 2020 than in 2019. Numbers of adult counts are higher than when the Program started, and our long-term trend is still increasing for both terns and plovers. The upward trends in breeding pairs and nest counts over time, are likely in part due to the increasing habitat availability.

Decreasing proportional success of chicks and years with low fledge ratios could be related to weather, flooding, and predation losses. Predation in particular is being investigated as a major cause of loss and research is being conducted to answer questions the Program has in relation to predation; specifically, what impact does predation have on productivity and how can Program management reduce these impacts at OCSW sites. Recent downward trends in annual fledge ratios for piping plovers should take into account changes in habitat creation and availability over time. Fledge ratios for piping plovers peaked from 2010-2012, this was the period the Program added the majority of our nesting sites, but those ratios have since decreased. The current trends for proportion of successful chicks and piping plover fledge ratios are concerning and something we will continue to monitor.

Program data shows high annual variability in breeding pairs and fledges produced, something that has also been observed by other tern and plover monitoring programs (Hofer 2020, USACE 2019), and as a normal response by shorebirds to weather, flooding, and annual changes in habitat availability (Robinson *et al*. 2019). The Program is considering utilizing a suite of performance indicators and establishing acceptable ranges of variability for productivity parameters over longer periods of time that make sense based on Program learning, historical and recent literature, guidance from other programs, and guidance from the Service as to what is important re: the Biological Opinion. These ranges can help us determine when the variability we see is within normal limits versus when we should be concerned and respond with additional research and/or management actions.

We also need to keep in mind, that the Program and our breeding population in the AHR is only one part of a larger whole. There is higher connectivity amongst populations in the Great Plains

and Great Lakes than previously thought (Rose *et al*. 2020), and what happens each year in any of these areas can affect the others. Moving forward, we want to look at our results over larger temporal and spatial scales, the bigger picture, rather than just as isolated Program specific productivity. This can help us interpret our data to better understand observed trends in productivity and the degree to which Program management contributes to productivity.

Something else the Program will be taking into consideration for future management decisions, is the recent announcement of delisting of the interior least tern on January 12th. Up until this point, similar, but not identical, nesting habitat requirements for both species have been integrated into Program monitoring and management. Over the long term our least tern numbers have been increasing steadily in the AHR. Gains have been smaller for plovers, but their numbers have been increasing. The Program will continue to monitor and manage for both species as we communicate with and receive guidance from U.S. Fish and Wildlife Service to determine what delisting of the interior least tern means for the Program.

VI. TABLES

Table 1. On- and off-channel nesting habitat in the Associated Habitat Area by year, 2007−2020.

	On-Channel Habitat (ac)			Off-Channel Habitat (ac)		
Year	PRRIP	Others	Total	PRRIP	Others	Total
2007	0	24	24	0	48	48
2008	0	21	21	0	48	48
2009	0	15	15	0	48	48
2010	0	5	5	32	48	80
2011	0	5	5	60	48	108
2012	0	0	0	72	48	120
2013	55	0	55	72	48	120
2014	19	0	19	80	48	128
2015	47	0	47	90	48	138
2016	4	0	4	87	51	138
2017	0	0	0	99	61	160
2018	0	0	0	109	83	192
2019	0	0	0	94	84	178
2020	0	0	0	109	100	209

Table 2. Summary of least tern reproductive success at sandpits and river-island sites on the central Platte River in Nebraska, 2007–2020. Site- specific details on numbers of adults, nest, chicks, and fledglings observed during 2020 are provided in PRRIP's 2020 LTPP Report (Mohlman 2021). Site-specific details of daily, incubation- and brooding-period survival rates (RMark estimates) for 2020 are provided in the report as well.

	Least Tern													
Reproductive Parameter	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Adults Observed	132	80	97	123	125	116	136	166	224	157	118	174	169	158
Peak Breeding Pairs	39	37	42	53	60	64	58	94	141	88	77	88	95	84
Total Nests Observed	53	64	60	76	90	88	95	146	188	119	118	113	132	105
Successful Nests (≥1 egg hatched)	22	27	37	43	52	63	51	82	116	74	63	79	67	74
Apparent Nest Success	0.42	0.42	0.62	0.57	0.58	0.72	0.54	0.56	0.62	0.62	0.53	0.67	0.51	0.70
Daily Nest Survival Rate	0.97	0.98	0.99	0.98	0.97	0.99	0.97	0.97	0.98	0.98	0.98	0.98	0.98	0.98
Incubation-period Survival Rate	0.55	0.61	0.73	0.64	0.58	0.76	0.56	0.52	0.63	0.71	0.61	0.65	0.61	0.72
Chicks Observed (<15D)	50	54	71	105	124	144	118	180	258	170	129	168	137	160
Hatch Ratio (<15D Chicks/Total Nests)	0.94	0.84	1.18	1.38	1.38	1.64	1.24	1.23	1.37	1.43	1.09	1.49	2.04	1.52
Hatch Ratio (<15D Chicks/Breeding Pair)	1.28	1.46	1.69	1.98	2.07	2.25	2.03	1.91	1.83	1.93	1.68	1.91	1.44	1.90
Chicks (≥15D)	40	44	48	67	98	95	70	104	158	91	78	117	74	107
Fledglings (21D)	----[A]	-----	----	64	89	84	64	91	146	80	76	117	71	107
Historic Fledge Ratio (≥15D Chicks/Total Nests)	0.75	0.69	0.80	0.88	1.09	1.08	0.74	0.71	0.84	0.76	0.66	1.04	0.56	1.02
Fledge ratio (21D Chicks/Nest)	-----	-----	----	0.84	0.99	0.95	0.67	0.63	0.78	0.67	0.64	1.04	0.54	1.02
Historic Fledge Ratio (≥15D Chicks/Breeding Pair)	1.03	1.19	1.14	1.26	1.63	1.48	1.21	1.11	1.12	1.03	1.01	1.33	0.78	1.27
Fledge Ratio (21D Chicks/Breeding Pair)	-----	-----	----	1.21	1.48	1.31	1.10	0.62	1.04	0.91	0.99	1.33	0.75	1.27
Daily Brood Survival Rate [B]	-----	0.98	0.98	0.98	0.99	0.99	0.97	0.98	0.98	0.98	0.97	0.98	0.97	0.98
Brooding-period Survival Rate [B]	-----	0.75	0.79	0.72	0.89	0.81	0.59	0.69	0.68	0.61	0.56	0.69	0.57	0.70

[A] "-----" years for which indicated data were not collected.

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

Table 3. Summary of piping plover reproductive success at sandpit and river island sites along the central Platte River in Nebraska, 2007–2020. Site-specific details on numbers of adults, nest, chicks, and fledglings observed during 2020 are provided in PRRIP's 2020 LTPP Report (Mohlman 2021). Site-specific details of daily, incubation- and brooding-period survival rates (RMark estimates) for 2020 are provided in the report as well.

	Piping Plover													
Reproductive Parameter	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Maximum Adults Observed	52	23	31	46	55	60	68	69	74	64	65	74	88	71
Peak Breeding Pairs	19	13	12	20	27	30	27	30	39	43	40	37	45	32
Total Nests Observed	27	21	15	33	34	46	31	43	54	60	51	47	60	49
Successful Nests (≥1 egg hatched)	15	8	9	21	27	32	23	34	34	40	30	35	31	28
Apparent Nest Success	0.56	0.38	0.60	0.64	0.79	0.70	0.74	0.79	0.63	0.68	0.59	0.74	0.52	0.57
Daily Nest Survival Rate	0.99	0.98	0.99	0.98	0.99	0.99	0.99	0.99	0.98	0.99	0.98	0.99	0.98	0.98
Incubation-period Survival Rate	0.71	0.58	0.67	0.54	0.77	0.69	0.73	0.77	0.64	0.69	0.61	0.68	0.51	0.51
Chicks Observed (<15D)	44	26	27	76	87	99	80	116	119	120	92	95	94	98
Hatch Ratio (<15D Chicks/Nest)	1.63	1.24	1.80	2.30	2.56	2.15	2.58	2.70	2.2	2.00	1.80	2.02	1.57	2.00
Hatch Ratio (<15D Chicks/Breeding Pair)	2.32	1.24	2.25	3.80	3.22	3.30	2.96	3.87	3.05	2.79	2.30	2.57	2.09	3.06
Chicks (≥15D)	27	10	18	53	61	68	43	67	73	70	53	36	42	52
Fledglings (28D)	-----[A]	-----	-----	42	45	59	28	55	52	55	47	23	30	39
Historic Fledge Ratio (≥15D Chicks/Nest)	1.00	0.48	1.20	1.61	1.79	1.48	1.39	1.56	1.35	1.17	1.04	0.77	0.70	1.06
Fledge ratio (28D Chicks/Nest)	-----	-----	-----	1.27	1.32	1.28	0.90	1.28	0.96	0.92	0.92	0.49	0.50	0.80
Historic Fledge Ratio (≥15D Chicks/Breeding Pair)	1.42	0.77	1.50	2.65	2.26	2.27	1.59	2.23	1.87	1.63	1.33	0.97	0.93	1.63
Fledge Ratio (28D Chicks/Breeding Pair)	-----	-----	-----	2.01	1.67	1.97	1.04	1.83	1.33	1.28	1.18	0.62	0.67	1.22
Daily Brood Survival Rate[B]	-----	0.94	0.98	0.99	0.99	0.99	0.98	0.99	0.99	0.98	0.98	0.96	0.97	0.98
Brooding-period Survival Rate[B]	-----	0.42	0.79	0.70	0.73	0.78	0.62	0.69	0.68	0.55	0.63	0.29	0.44	0.58

[A] "-----" years for which indicated data were not collected.

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

VII. FIGURES

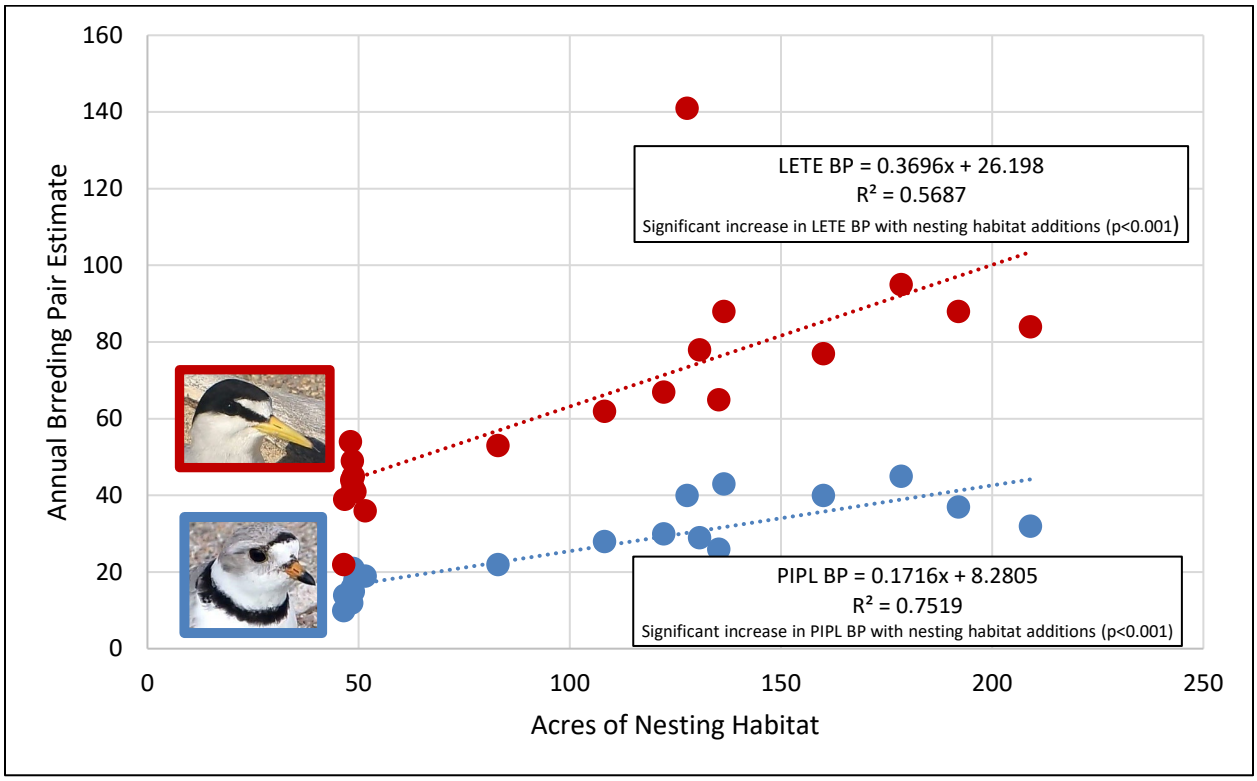

Figure 1. Relationship between numbers of least tern (red) and piping plover (blue) breeding pairs and availability of off-channel habitat within the Program Associated Habitat Reach, 2001-2020.

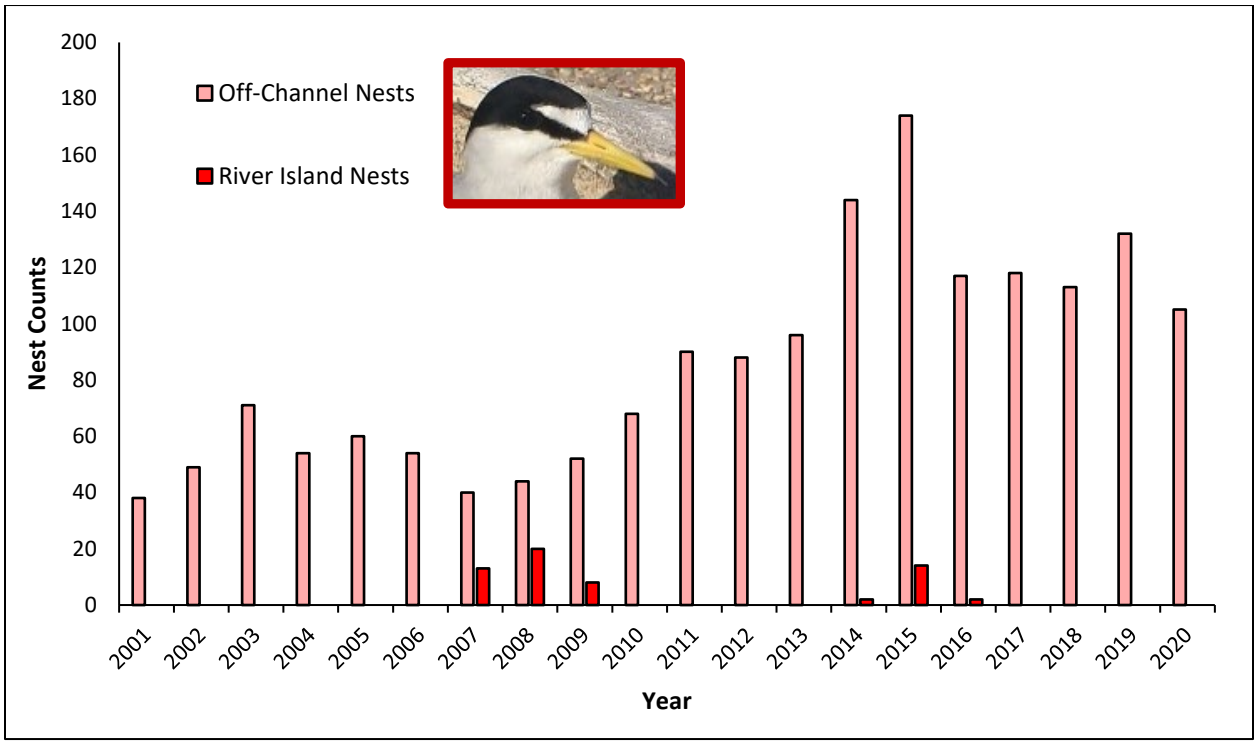

Figure 2 Comparison of least tern off-channel (light red bars) and on-channel (dark red bars) nests within the Program Associated Habitat Reach, 2001-2020.

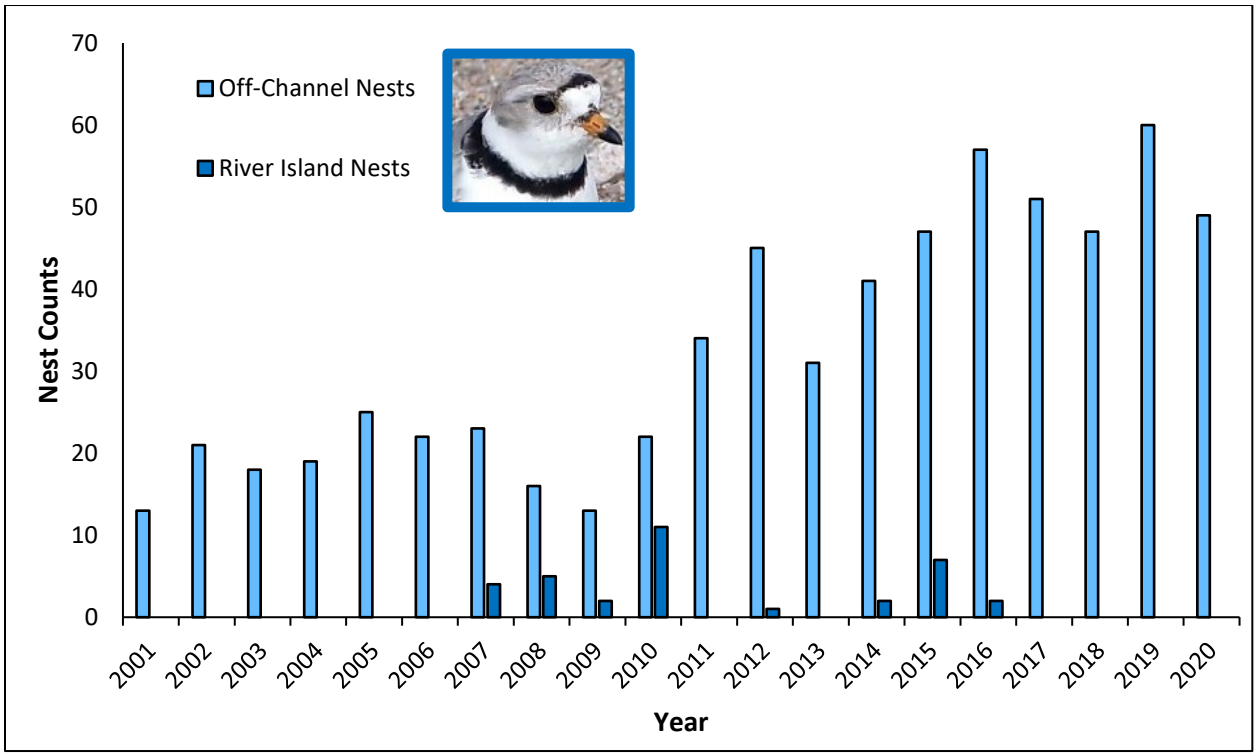

Figure 3. Comparison of piping plover off-channel (light blue bars) and on-channel (dark blue bars) nests within the Program Associated Habitat Reach, 2001-2020.

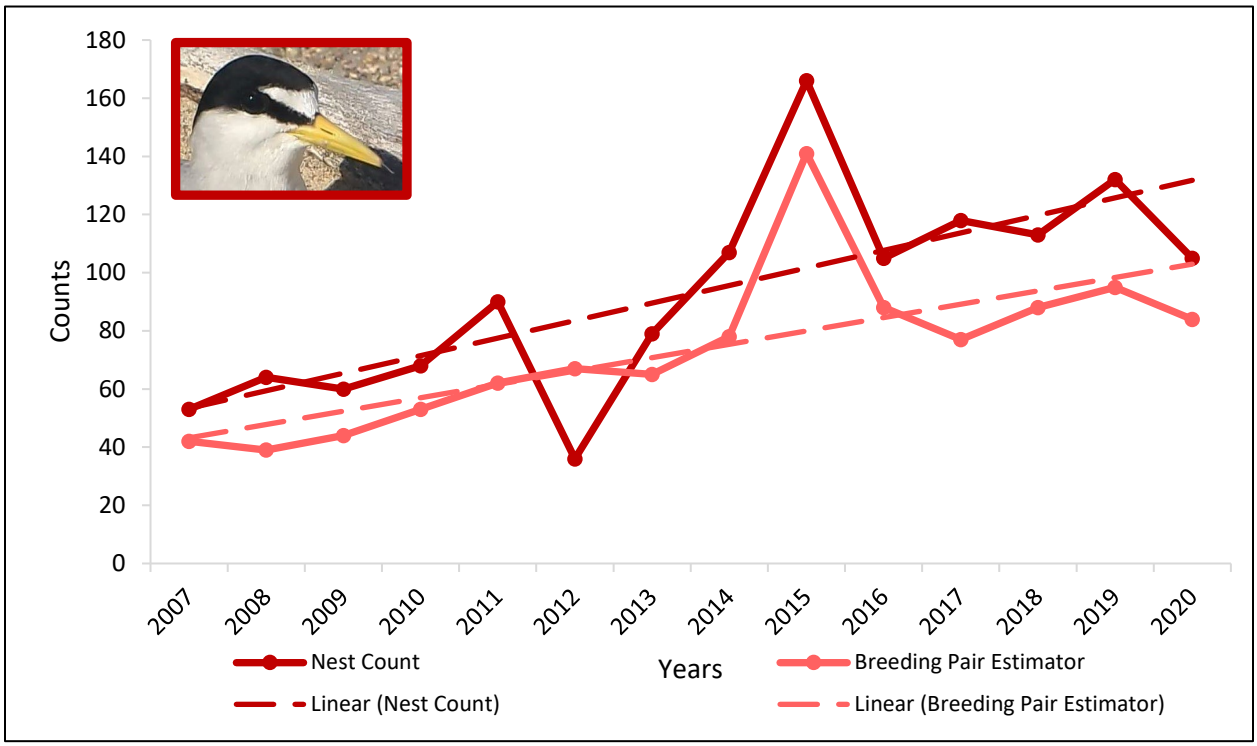

Figure 4. Least tern nest and breeding pair counts at sandpits and river-island sites on the central Platte River in Nebraska, 2007–2020.

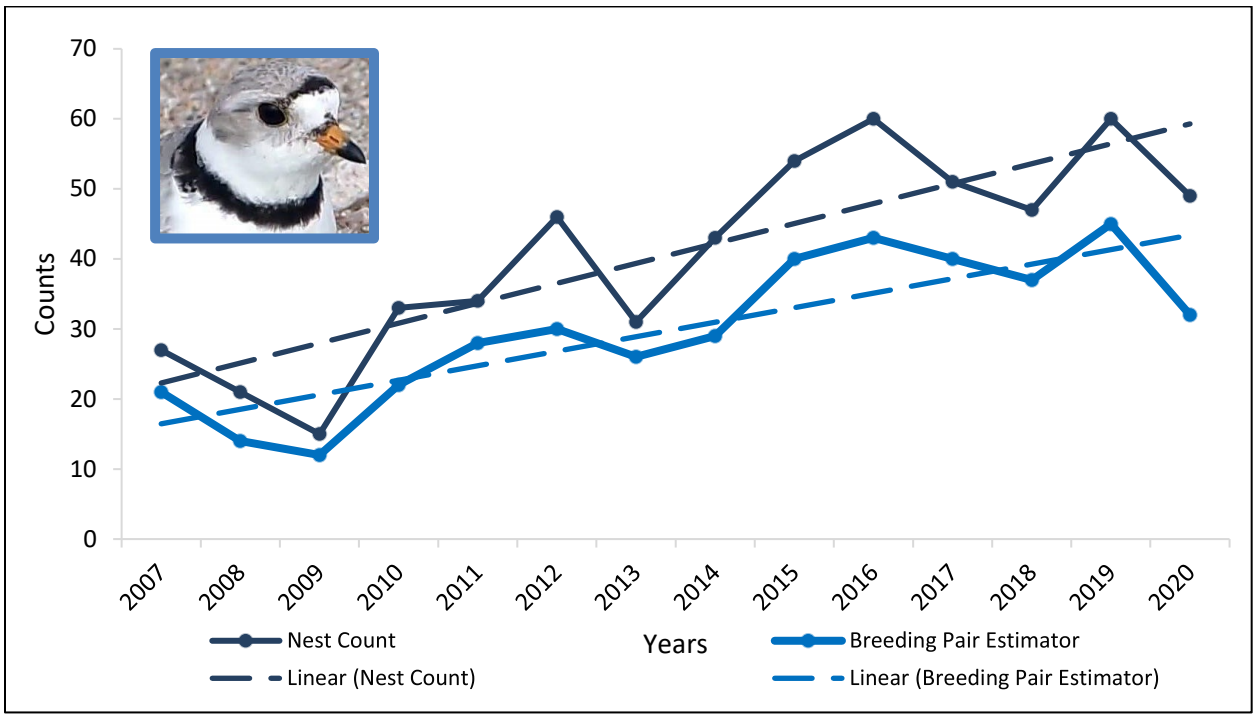

Figure 5. Piping plover nest and breeding pair counts at sandpits and river-island sites on the central Platte River in Nebraska, 2007–2020.

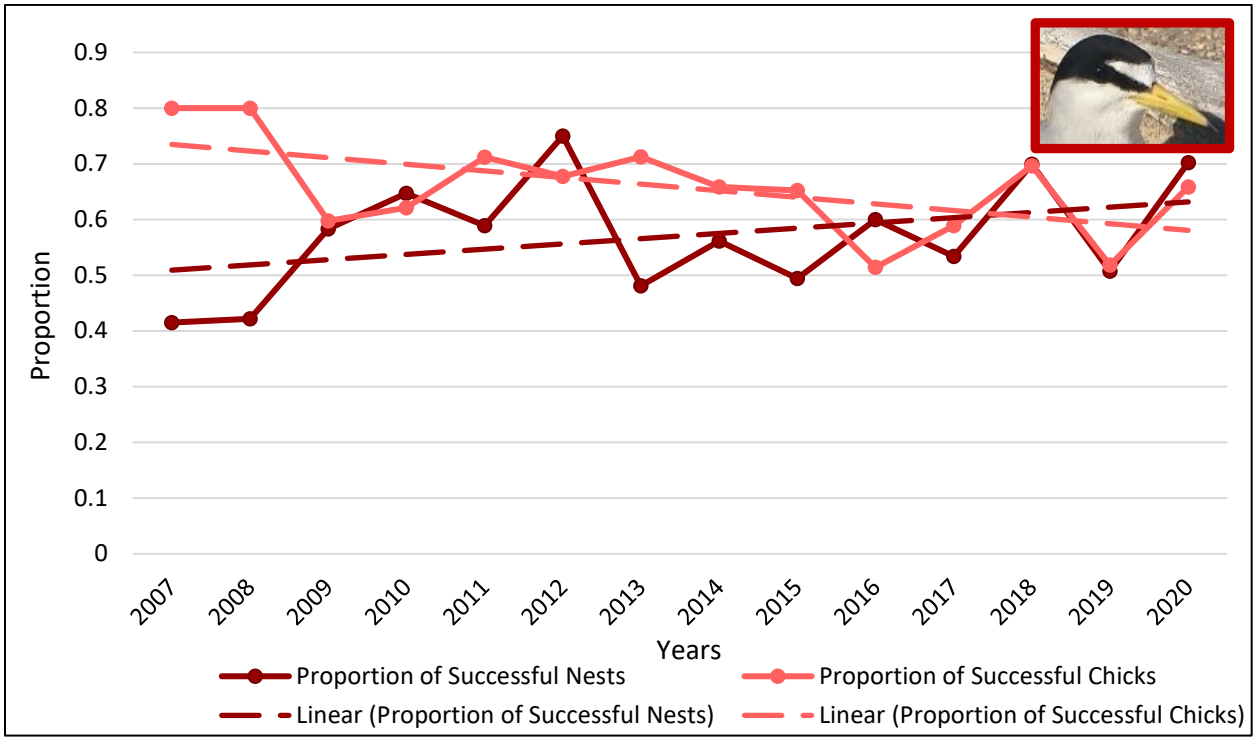

Figure 6. Proportion of successful nests and chicks (and linear trendline for each) for least terns from at sandpits and river-island sites on the central Platte River in Nebraska, 2007–2020.

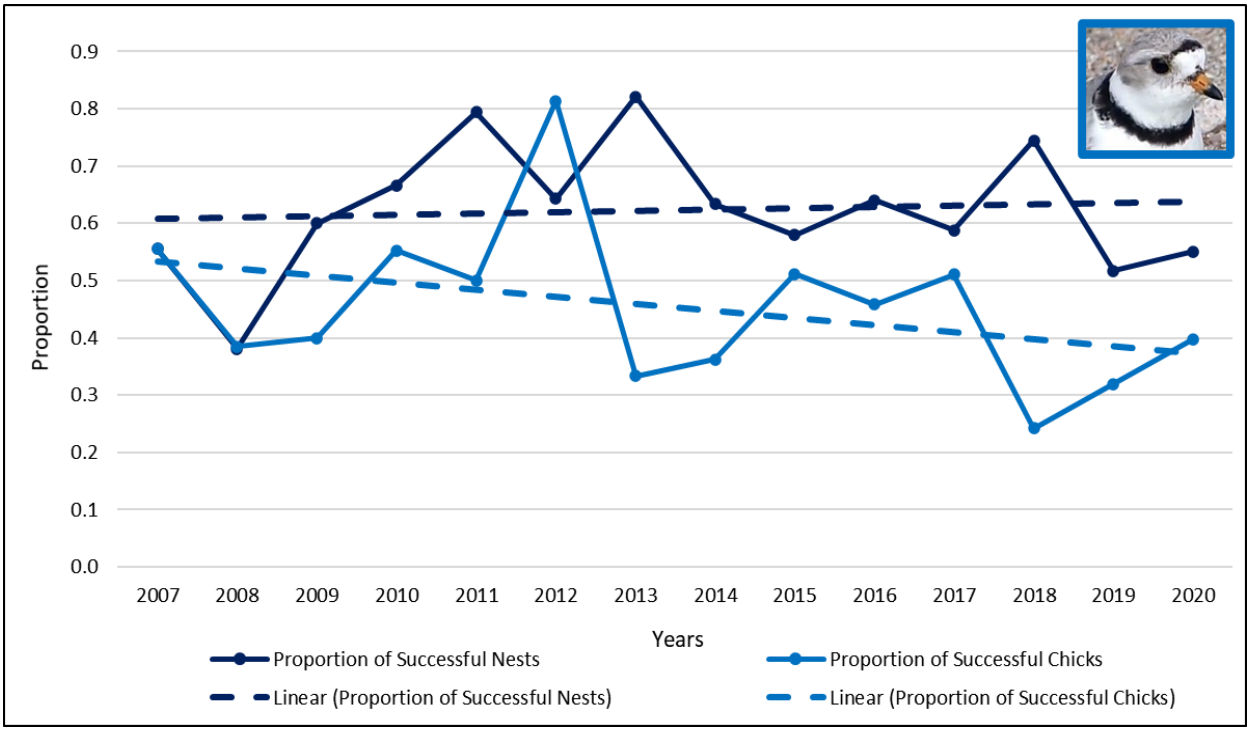

Figure 7. Proportion of successful nests and chicks (and linear trendline for each) for piping plovers at sandpits and river-island sites on the central Platte River in Nebraska, 2007–2020.

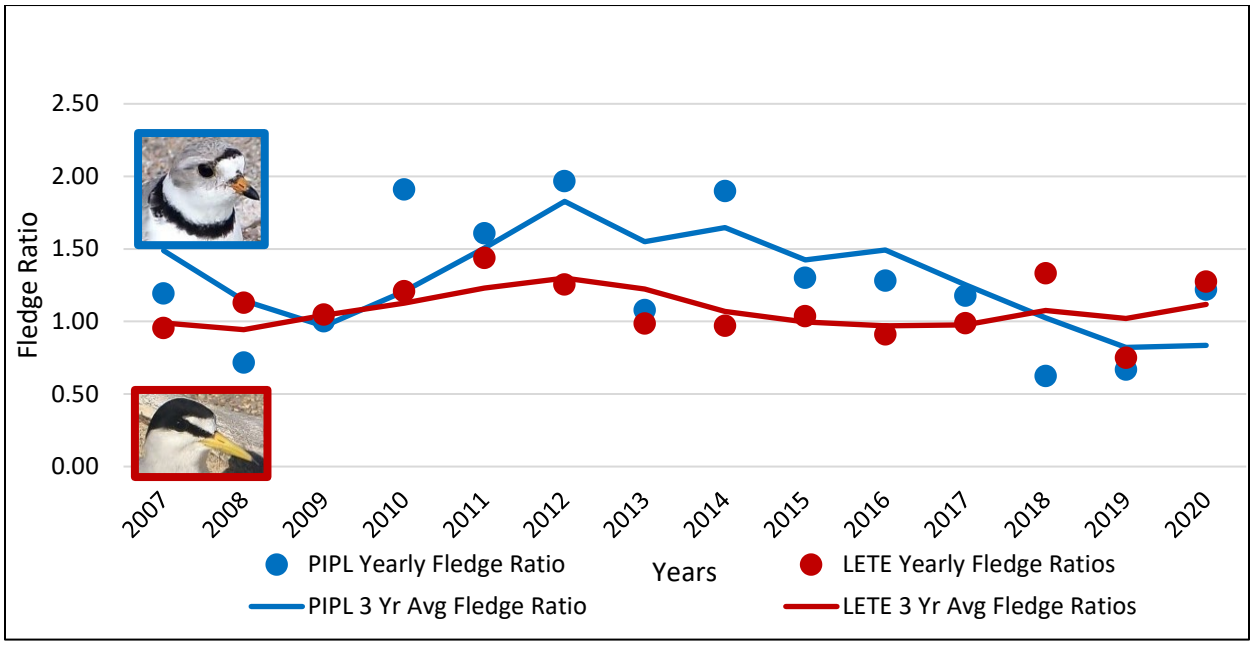

Figure 8. Annual fledge ratios (points) and 3-year running average fledge ratios (lines) for least terns (blue) and piping plovers (red) at sandpits and river-island sites on the central Platte River in Nebraska, 2007–2020.

VIII. REFERENCES

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