



**Extension AMP Table.** Questions, actions, and decisions for exploration of relationship between predator management and least tern and piping plover productivity as defined by the Program.

<b>Management Objective:</b> <i>Improve production of the interior least tern and piping plover from the central Platte River.</i> <b>Broad Uncertainty:</b> Relationship between predation and tern and plover productivity.				
<b>Big Question:</b> Can the Program improve chick survival through additional predator management activities (turtle exclusion, deterrent lights, tree removal, etc.) enough to meet the tern and plover management objective?				
Priority Management Hypothesis	AM Management Action/Study Components	Key Metrics	IF-THEN Decision Criteria	Alternative Hypotheses and/or Issues to be Resolved
<b>TP1a</b> – Additional nocturnal predator deterrents (lights) are necessary to increase chick survival to meet three-year running average fledge ratios and sustain sufficient long-term tern and plover productivity within the AHR.  <b>TP1b</b> – Turtle trapping/exclusion are necessary to increase chick survival to meet three-year running average fledge ratios and sustain sufficient long-term tern and plover productivity within the AHR.	<b>TP1a</b> – Trapping mammalian predators at all sites* and installing deterrent lights at a subset of off-channel sand and water (OCSW) sites.  <b>TP1b</b> – Trapping mammalian predators at all sites* and turtle trapping and/or fencing at a subset of off-channel sand and water (OCSW) sites.	<b>TP1a,b</b> –  Tern and plover nest survival rate  Tern and plover chick survival rate  Tern and plover fledge ratio		<b>TP1<sub>Alt1</sub></b> – Additional nocturnal predator deterrents are not necessary to increase nest and chick survival to meet three-year running average fledge ratios and sustain sufficient long-term tern and plover productivity within the AHR. <b>TP1<sub>Alt2</sub></b> – Turtle trapping/fencing is not necessary to increase nest and chick survival to meet three-year running average fledge ratios and sustain sufficient long-term tern and plover productivity within the AHR.

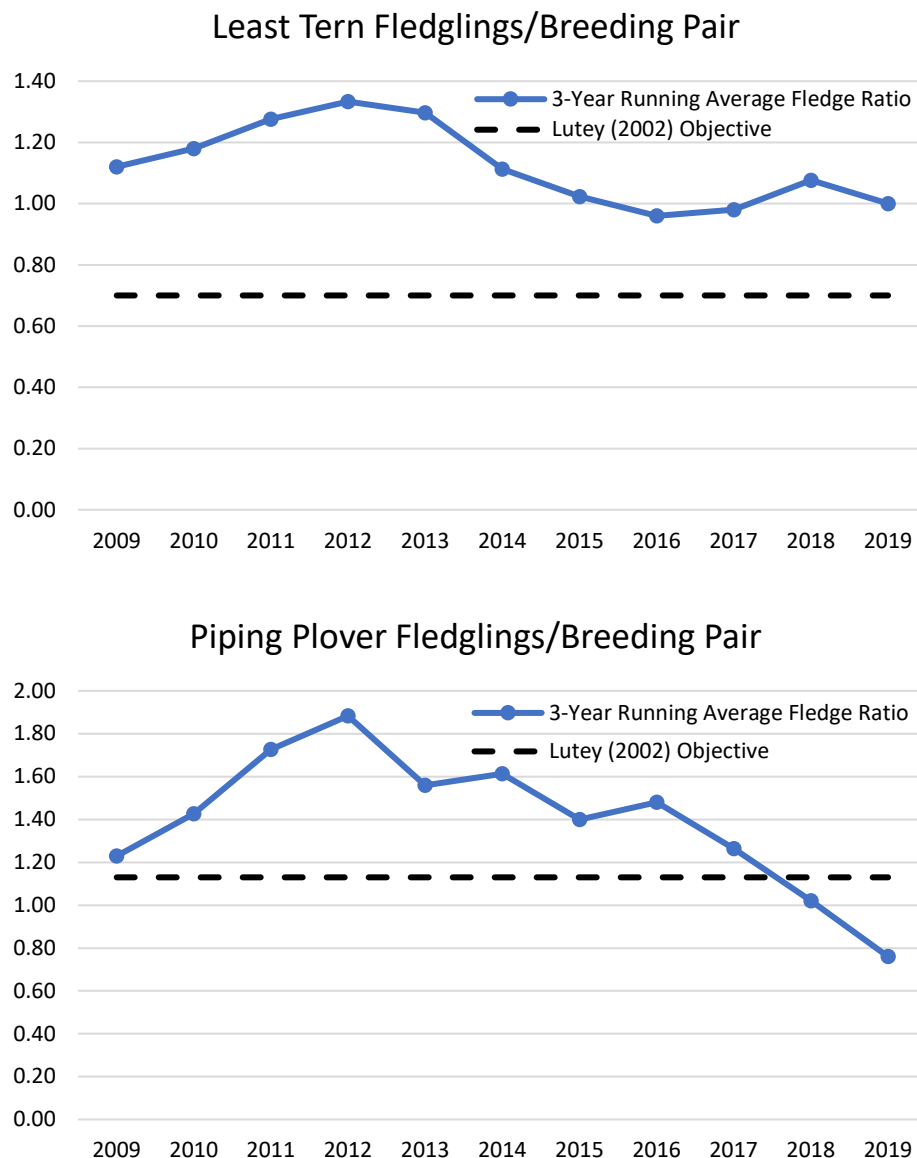
\*Continuing OCSW management action regardless of effectiveness of deterrent lights or turtle trapping/exclusion.



## Definition and Purpose

The Platte River Recovery Implementation Program (Program) and Nebraska Public Power District (NPPD) manage nine off-channel sand and water sites for interior least tern (tern) and piping plover (plover) nesting. Since 2007, the Program and NPPD have implemented terrestrial predator trapping at all managed nesting sites. In 2019, the Program underwent a process to revise an adaptive management plan (AMP) to be implemented during the Program's First Increment Extension. During this process, the Program identified a Big Question and associated hypotheses related to the necessity of additional predator control at off-channel nesting sites. This decision was related to the fact that plover three-year running average fledge ratios increased as new sites were added from 2009-2012, reached an all-time high in 2012, and declined annually since the Program ceased creating new habitat in 2013 and the sites subsequently aged (Figure 1).

**Figure 1.** Observed three-year, running average fledge ratios for interior least tern (top) and piping plover (bottom) on off-channel nesting sites along the central Platte River, 2007-2019.





The Program invested substantial resources in increasing the amount of available off-channel nesting habitat by removing vegetation from existing sandpits and constructing new off-channel sand and water nesting habitat. This habitat has attracted high numbers of breeding terns and plovers annually. However, the high concentration of nests and chicks on this permanent off-channel habitat may make them more vulnerable to predation. Predation impacts the productivity and adult survival of terns and plovers and predation management is an important strategy to aid in the recovery and conservation of these listed species. Furthermore, predator management is identified in species recovery plans for terns and plovers as a recovery and conservation action that must be considered if recovery of these species is to be achieved.

Predators are known to key in on permanent nesting sites of terns and plovers. Similar to the central Platte River, predation has been identified as a factor that limited the productivity of terns and plovers on older nesting sites on the Missouri River. Similar to the central Platte River off-channel sites, apparent nest success for these older sandbars remained high with 68% of plover nests and 70% of tern nests hatching out at least one egg; however, productivity on the older bars on the Missouri River was low due to high chick mortality. In the absence of evidence of chick losses due to weather events, the most likely cause of the recorded high chick mortality was reported to be predation.

In 2008, United States Department of Agriculture personnel erected modified pole traps on a sandbar complex on Lewis and Clark Lake and on six constructed sandbar complexes on the Gavins Point River Segment on the Missouri River. Plover chicks on these sites had significantly higher survival rates than sandbars where no avian predators were removed during this year. The three older constructed sandbars saw an increase in productivity over the 2004-2007 time period with a combined fledge ratio of 1.36 for piping plovers and 0.59 for least terns. Similarly, strobe light systems have been used to deter nocturnal predators on four sites on the Gavins Point River segment. For the four sites on the Gavins Point Segment with strobe lights, tern nest success was 69% and plover nest success was 100% while the tern success rate for sites without strobe lights on the Gavins Point River Segment was only 19% and piping plover nest success was 61%.

Program monitoring data and observations suggest avian and terrestrial predators have learned to hunt on off-channel nesting sites as they age and that current piping plover productivity levels are insufficient for maintaining a long-term population along the central Platte River (Figure 1). Program predator monitoring data indicates mammalian predators are the most prevalent predator within the nesting sites during the night while avian predators are the most prevalent predator during the day. As such, the Program will test the effectiveness nocturnal predator deterrent lights and turtle management techniques to decrease predator presence and increase tern and plover productivity on nesting sites. Turtle management will include turtle trapping and turtle exclusion fences to discourage turtle egg-laying on nesting sites to decrease nesting site attractiveness to predators. Based on research findings, ongoing predation management efforts will focus on implementing a combination of management actions in a manner that will, at a minimum, sustain current populations of the terns and plover and ideally improve productivity and increase the central Platte River populations of these species.

### **Implementation Criteria**

Beginning in 2020, we propose to maintain current levels of terrestrial predator trapping at all off-channel nesting sites while implementing combinations of nocturnal predator deterrents lights, turtle trapping, and turtle exclusion fences to determine the efficacy of these methods for increasing productivity at off-channel nesting areas (Table 1). We hypothesize these additional predator management actions will decrease terrestrial and avian nocturnal predator activities at nesting sites and lead to increased tern and plover productivity. The study will begin with a pilot year in 2020 where turtle trapping will be deployed at two sites, turtle exclusion fence at one site, and deterrent lights at two sites. In the absence of major experimental design revisions following 2020, the study will proceed at full capacity from 2021-2027 where two sites



will be fenced, three sites turtle trapped, and 4-5 sites outfitted with deterrent lights each year and treatments will be assigned at random annually. Upon conclusion of the study data will be evaluated to determine the efficacy of turtle management and deterrent lights to increase productivity on off-channel nesting areas.

In 2020, turtle trapping will be executed with baited sinking turtle traps (sinking turtle traps - [www.texasstates.com](http://www.texasstates.com)) at Dyer (3 traps) and Blue Hole (5 traps) at a density of one trap per 2500 ft of suitable nesting habitat shoreline at a site. Sinking traps were specifically chosen to target softshell turtles, as these are most frequently observed at nesting sites. Turtle exclusion fencing (Redbrand Woven wire 39") will be implemented at Broadfoot South (~5,500 linear ft) with steel six-foot t-posts fitted with avian spike deterrents. Deterrent lights (Foxlights Solar Night Predator Deterrent) will be set on 8 ft t-posts and placed at Blue Hole and Newark West at a density of one light per five acres of suitable nesting habitat. These lights have a top mounted light source with four colors that randomly varies in timing and pattern.

**Table 1.** Experimental design for predator trapping and installation of deterrent lights at off-channel nesting sites within the AHR. The design for year 1 (2020) is shown below and treatments will be rotated annually so that all sites will be exposed to turtle management and deterrent lights during this study.

Site Name	Turtle Management	Deterrent Lights	Terrestrial Predator Trapping
Lexington Sandpit	No	No	Yes
Dyer	Trapping	No	Yes
Cottonwood Ranch	No	No	Yes
Blue Hole	Trapping	Yes	Yes
Johnson Pit	No	No	Yes
Broadfoot South	Fencing	No	Yes
Newark West	No	Yes	Yes
Newark East	No	No	Yes
Leaman	No	No	Yes

### Constraints

Given the year-to-year variability in productivity at each site, the primary constraint for this experimental design is the number of replicates needed to have sufficient statistical power to detect a difference in productivity rates at experimental and control sites. Based on assumptions to estimate statistical power, at least eight years of study duration would be required to achieve high statistical power and indicate a positive influence of avian predator control measures. As such, we will use statistical modeling and a weight of evidence approach to assess this hypothesis.

### Performance Metrics

We will calculate daily nest and brood survival rate (DSR) to obtain incubation and brooding period survival rates (DSR<sup>n</sup>) separately for each species where n is 21 days for least tern nests and broods and 28 days for piping plover nests and broods. Proportion of chicks fledged and fledglings per breeding pair and nest will also be calculated at each site within a given year.

### Modeling and Output

Nest or brood fate logistic regression models will be developed, with a logit link function, using the nest survival models in package RMARK in Program R for both nest and brood survival analyses. Evaluation of nest and brood survival will occur to test for statistically significant differences between tern and plover productivity rates when turtle trapping, turtle enclosure fencing, and/or deterrent lights, are included as additional predator management compared to when they are absent. To test for statistical significance of management techniques, chi-square tests will be performed to compare the null model and models including trapping variables within the nest survival modeling framework in Program MARK. The proportion of



chicks fledged and fledglings per breeding pair will also be compared using generalized linear mixed models to evaluate if statistically significant differences occur between sites with and without turtle trapping or turtle enclosure fencing as well as sites with and without deterrent lights.

### **Uncertainties**

Efficacy of turtle trapping, turtle enclosure fencing, and deterrent lights for improving tern and plover productivity.

### **Criteria for Adjusting Actions**

This experimental design will be implemented for the pilot year plus seven years (2020, 2021-2027) at which point productivity rates will be evaluated to determine the efficacy of turtle trapping, turtle enclosure fencing, and deterrent lights for improving productivity of terns and plovers. A 0.20 increase in nesting or brooding period survival rates and fledge ratios would be indications of an effective means of controlling predation and improving production of terns and/or plovers within the AHR.

### **Decision/Activity Level**

EDO – design, oversee monitoring and data collection, data analysis and synthesis

AMWG and TAC – input on design and learning approach

GC – decisions on use of Program resources for predator control and consideration of tradeoffs (learning and otherwise) in prioritizing predator management activities