Piping Plover Management and Monitoring

Program Context: Under Maintenance Learning in the Extension Science Plan, Extension Big Questions (EBQ) #8 and #9 address the effect predation has on piping plover (*Charadrius melodus*, hereafter plover) productivity and how well the Program mitigates those losses.[1] The 2021 monitoring and management objectives were based on Extension Science Plan learning objectives:

EBQ #8:

1. Quantify the impact of predation on plover productivity.
2. Identify predator species responsible for losses.
3. Determine when losses are incurred, at the nest or during brood rearing.
4. Utilize population viability models to predict what effect decreases in fledge ratios due to predation may mean in terms of future plover breeding pairs on the central Platte River.

EBQ #9:

1. Evaluate the effectiveness of trapping, fencing, and/or predator deterrent lighting at reducing nest/brood failure due to predation.
2. Develop predator management alternatives based upon learning through remote camera/video monitoring.
3. Evaluate the necessity for additional predator management based upon plover response to predation over time.
4. Successful implementation of monitoring and management protocols in 2021 provided information to address these learning objectives.

Looking Back: An overall positive plover response to Program habitat creation, rehabilitation, and management has been observed across the Associated Habitat Reach (AHR) since 2001 and this trend continued in 2021, though reproductive success has varied by site (**Figure 1**). The decrease in the proportion of successful chicks over time and the decreases in fledge ratios in 2018 and 2019 for plovers prompted an investigation into possible causes and ways to improve reproductive success. Predation was identified as an important uncertainty linked to productivity. The Program began deploying additional monitoring in the form of track surveys and remote cameras on Program managed sites. This additional monitoring is being used to improve our overall monitoring accuracy, reduce the losses attributed to unknown causes, increase our understanding of the impacts of predation on our target species, as well as to measure potential predator and target species response to additional predator management actions that were deployed on three Program sites (BFS, Newark West, and Leaman). These management actions included predator exclusion fencing and predator deterrent lights.

For 2021, monitoring results and site-specific reproductive outputs for target species can be found in **Figure 1**. The additional monitoring that was conducted allowed us to gather more information:

- Plovers had the lowest proportion of failures assigned to an unknown cause since 2010 (**Figure 2**)
- Cameras documented 36 unique potential predator presence/predation events at the nest bowl

[1] Although the focus moving forward is on plovers, the reproductive success of the recently federally delisted interior least tern (*Sternula antillarum*, hereafter tern) was also monitored, providing additional information on the impacts of predation and effectiveness of predator monitoring and management.

    - 15 predation events captured on camera
        - 14 by great horned owls and 1 by an American crow
    - 2 additional predation events at camera-monitored nests not captured on camera
- 17 predation events at camera monitored nests resulted in the loss of:
    - Plovers= 12 nests, 42 eggs, and 5 chicks
    - Terns= 5 nests and 15 eggs
    - Great-horned owls accounted for 82% (14/17) of total predation events and were the most frequent predator captured by nest cameras (**Figure 3E and 3F**).

The additional monitoring deployed on Program managed sites used a combination of trapping results, track surveys, and remote cameras to gather information on the effectiveness of predator exclusion fencing and deterrent lighting. Evaluation of effectiveness was largely a qualitative assessment of how predator registers decreased when moving across barriers (trapping, moat, fencing) and deterrents (lighting) from the exterior to the interior of nesting peninsulas (**Figure 3 A-F**). When reviewing these predator monitoring results, we learned mammalian registers typically decreased as monitoring methods moved from the shorelines to individual nests. Other than Broadfoot – South Kearney, the nesting peninsulas that did have nest registers of mammalian species were those that did not receive additional management. However, the ubiquitous distribution of avian registers from shorelines to individual nests demonstrates the ineffectiveness of current predator deterrents for avian predators and the need to develop management tools that are specifically tailored to them.

Looking Forward: During the First Increment Extension the Program has prioritized gathering information on the impact of predation on plover productivity and the consequences of predation in terms of plover use of AHR habitat. At the same time, we need to develop a toolbox of management options that are effective and feasible over the long term if needed. This requires a management design over the next six years that allows us to gather information on both.

The current management design calls for maintenance of 2021 predator management actions through 2023, providing 3 years of data for evaluation before adjusting management if necessary. However, in response to documented high piping plover nest losses to predation by great horned owls in 2020-2021, there have been questions about the severity of avian predation and if we need to intervene sooner rather than later. Currently, the only management tool available to the Program for which we have some information on effectiveness from use at other locations is nest caging. Results for nest caging have been mixed and point to this option as being effective at increasing nest survival, but with less clear effects on survival to fledging and adult survival (Anteau et al. 2022). Experience by managers along the central Platte point to nest cages as beneficial if used as a targeted, short-term strategy. Implementation of nest caging may be warranted if predation at nests remains consistently high and significantly decreases overall AHR productivity over multiple years (are not compensated for by high productivity at other OCSW sites). Nest caging may also be more effective over the long term if we can apply this technique in a targeted manner by adapting cage design, implementation design, and timing to known predator communities at specific sites. However, if we interrupt current management now we lose information on the spatial and temporal impact of predation without nest caging (thus the ability to quantify benefit of nest caging if implemented in the future) and the ability to quantify the effectiveness of current, lower effort fences and lights as potential long-term strategies. Implementing nest cages now would also prevent us from learning how plovers respond to predation over the longer term (**Table 1**).

Though other options exist for managing avian predators (e.g., chemical deterrents (Avery et al. 1995) or dummy nests), each of those options are subject to the same types of tradeoffs and would require time to develop and test. As we likely move from a maintenance learning phase into a Second Increment of basic maintenance, we need to use the time we have during the Extension to determine what level of predator management is necessary and develop low investment, long-term options to meet that need.

Table 1. Potential benefits and tradeoffs to continuing or interrupting current management

Continuing	Interrupting
Benefit: Quantify effectiveness of management, predation losses, and plover response over 3-6 years. Continue same level of disturbance and effort.	**Benefit:** Possibly reduce losses due to predation and test other potentially effective techniques.
Tradeoff: If management ineffective, potentially suffer high reproductive losses and lose time for testing other management techniques.	**Tradeoff:** Cannot evaluate effectiveness of current management or impact of site-specific predation. Alternative management may be ineffective, high effort, and/or pose significant risks to target species.

Discussion Questions

1) What other information could we gather that may help decision-making on how to deal with avian predators?
2) Any suggestions for improving implementation of predator management and monitoring of predator and target species response?
3) How do we better evaluate effectiveness of our predator management actions? How to best present for decision-making

References Cited

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Avery ML, Pavelka MA, Bergman DL, Decker DG, C. Knittle CE, and Linz GM. 1995. Aversive Conditioning to Reduce Raven Predation on California Least Tern Eggs. *Colonial Waterbirds.* 18(2):131-138. http://www.jstor.org/stable/1521474

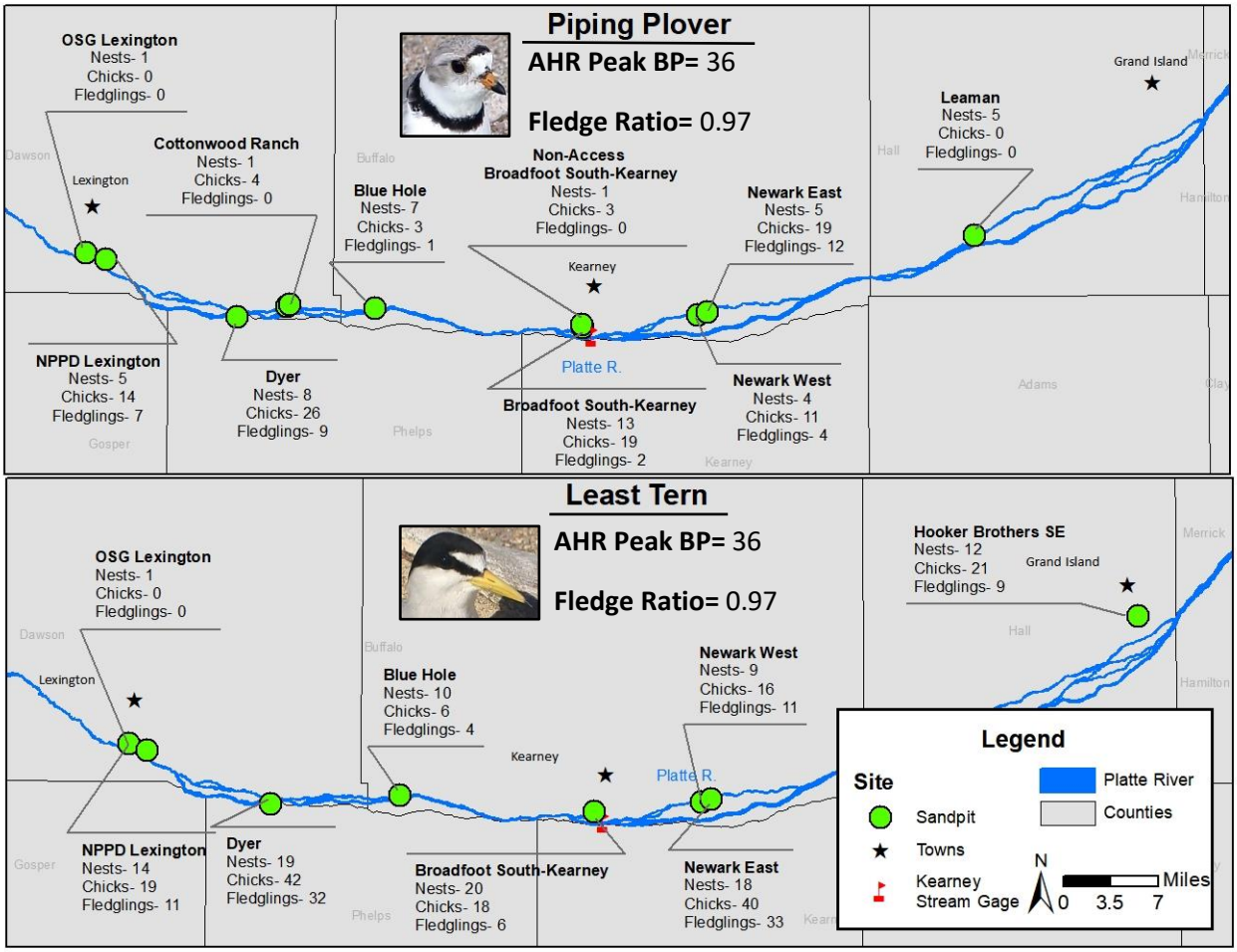

Figure 1. Distribution and numbers of piping plover and least tern nests, chicks, and fledglings observed within Program associated habitats during 2021 surveys of off-channel sand and water (OCSW) sites. Piping plover nests and chicks were observed and monitored at 10 of the 17 sites monitored during 2021, and tern nests and/or chicks were observed and monitored at 8 of the 17 sites.

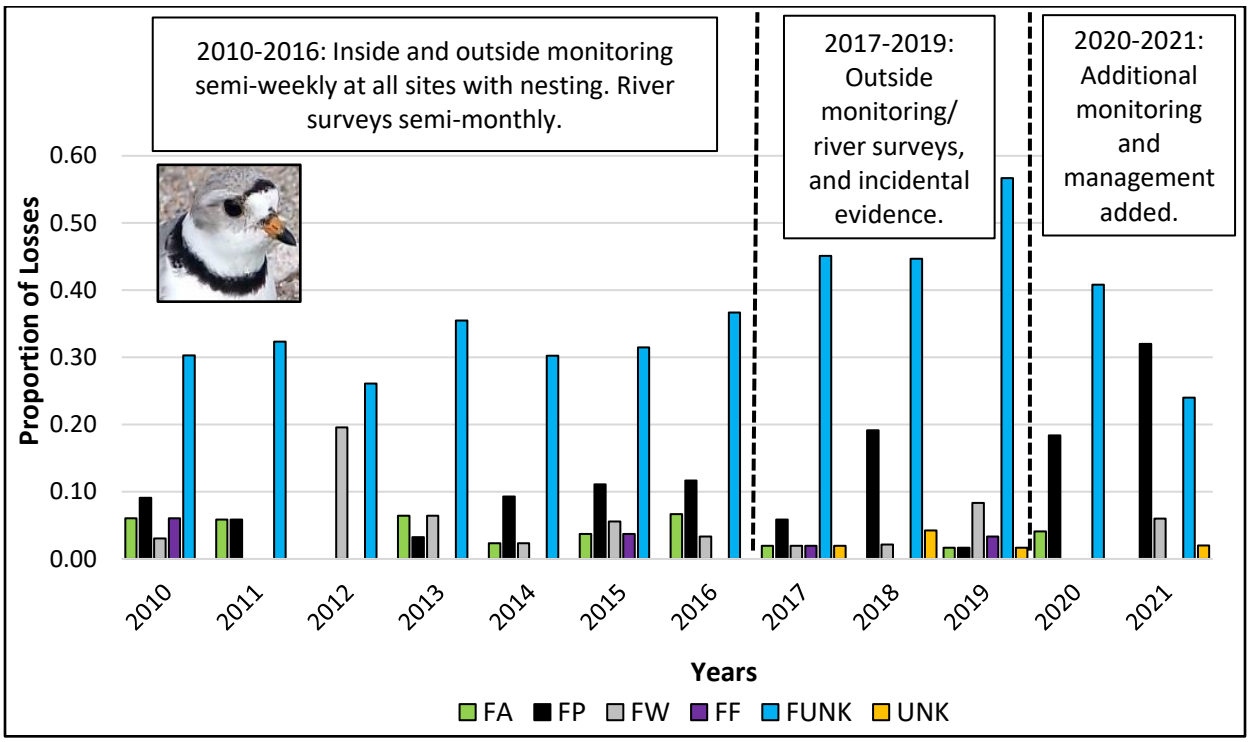

Figure 2. Proportion of combined nest and brood losses in each category for piping plovers from 2010-2021 across the AHR. Each loss represents a unique reproductive attempt. The assigned causes of loss include failed-abandoned (FA)(green), failed-predated (FP)(black), failed-weather (FW)(grey), failed-flooded (FF)(purple), failed-unknown (FUNK)(blue), and unknown (UNK)(orange). The dotted black lines represent changes in monitoring protocol. Protocols for the fating of nests and broods have evolved and have gradually become more accurate and consistent. For the purpose of this figure, all unknown nests from 2010-2021 were re-fated according to current protocol and definitions so they were directly comparable.

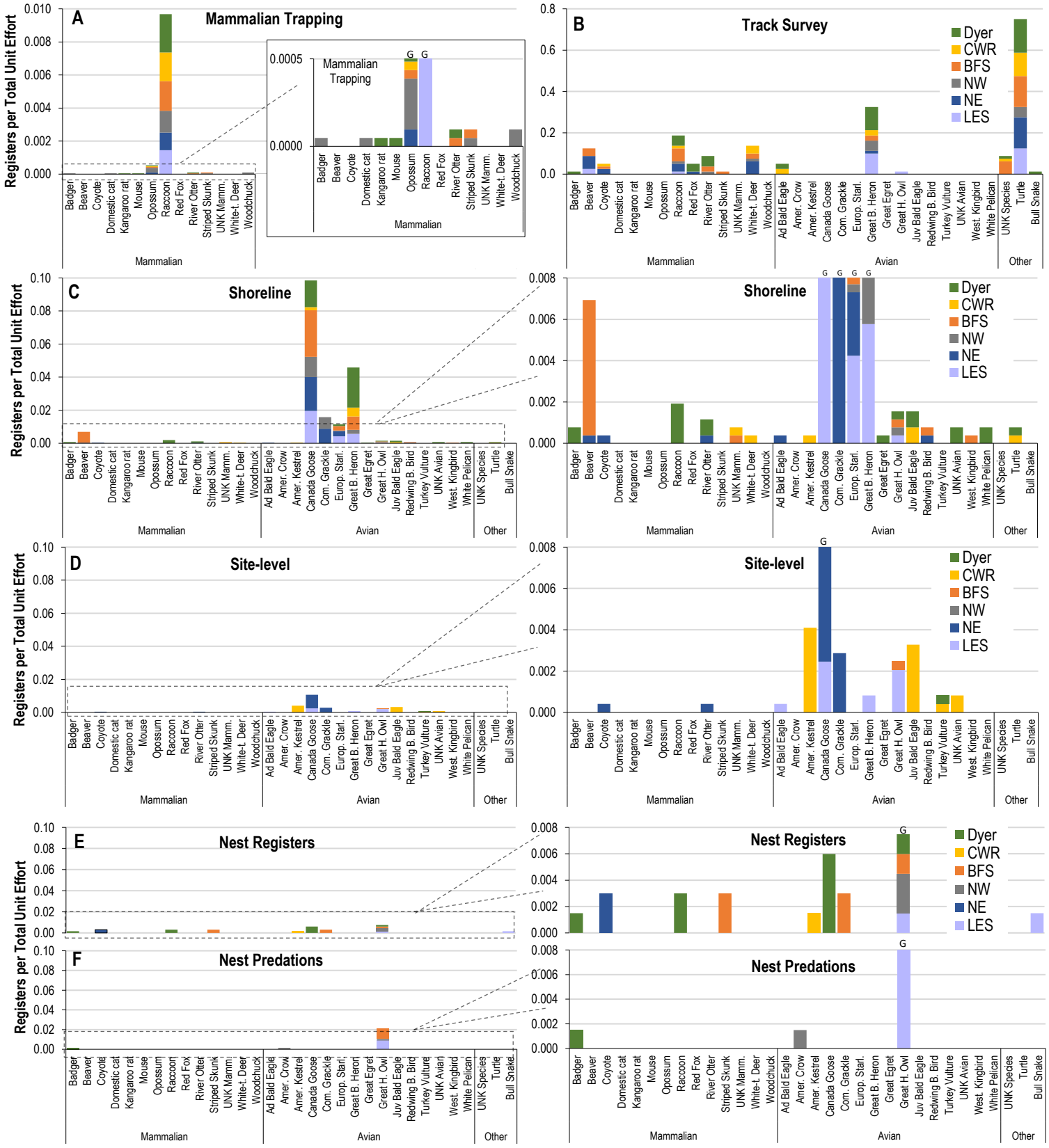
A
Mammalian Trapping
Registers per Total Unit Effort
Mammalian
B
Track Survey
Dyer
CWR
BFS
NW
NE
LES
Mammalian
Avian
Other
C
Shoreline
D
Site-level
E
Nest Registers
F
Nest Predations

Figure 3 (A-F). Potential predators registered per total unit effort at off-channel nesting sites as registered by (**A**) mammalian trapping, (**B**) weekly track surveys, (**C**) shoreline cameras, (**D**) site-level cameras, and (**E**) registers and (**F**) predation events at nest-level cameras. For Figures A and C-F, panels on the right are enlarged to show detail at a smaller scale. Nesting sites include Dyer, Cottonwood Ranch (CWR), Broadfoot-South Kearney (BFS), Newark West (NW), Newark East (NE), and Leaman East (LES). Registers per total unit effort was calculated by taking the total unique registers for each potential predator species at each nesting site obtained through the specified monitoring method divided by the sum of total effort dedicated to that type of monitoring (camera days, trap days, or track surveys) across all sites.

[G] Registers surpass y-axis scale. Refer to figure on the left for full scale.