



Evaluation of Oyster Shell Enhancement on Western Snowy Plover Breeding Success



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Abstract:

This study evaluated the efficacy of oyster shell habitat enhancement on improving nesting density and nest success of federally threatened western snowy plovers. Breeding plover activity was monitored at Eden Landing Ecological Reserve, California from 2015-2016, and compared between enhanced and non-enhanced plots. Plovers selected to nest in enhanced plots, however, enhancement did not significantly impact survival rates. Daily nest survival over time decreased in enhanced plots and remained constant in non-enhanced plots. Predation by common raven substantially limited nest success during study years suggesting that enhancement may not effectively prevent nest predation without concurrent predator management.

Introduction:

The Pacific Coast population of the western snowy plover (*Charadrius nivosus nivosus*) is listed as a federally threatened species under the U.S. Endangered Species Act due to habitat loss and high predation pressure. Plovers breed on sandy beaches and in bays along the North American Pacific Coast. In order to reach recovery, this population must sustain 3,000 individuals for ten years throughout their range.

Currently, populations in the southern half of the range act as sources while those in the northern half act as sinks; San Francisco Bay in the central range supports a stable population.

Plovers in the South San Francisco Bay use dry salt evaporation ponds to breed and winter, however, the South Bay Salt Pond Restoration Project aims to restore some of this habitat back to native tidal marsh which will further their habitat loss. In order to reach recovery goals for this threatened species while meeting other ecological needs in the South Bay, remaining pond habitat was enhanced using oyster shells. Enhancement may provide camouflage for nests and birds, and may thereby decrease predation impacts. This study was designed in partnership with the San Francisco Bay Bird Observatory (SFBBO).

Hypotheses:

1. Nest site density or selection do not differ between enhanced and non-enhanced plots.
2. Daily nest survival rates do not differ between enhanced and non-enhanced plots.

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Method:

Study Site

This study was conducted within one salt evaporation pond, E14, in the Eden Landing Ecological Reserve, Hayward, California (37° 36' 31.23"N 122° 7' 30.54"W), owned by California Department of Fish and Wildlife (CDFW). Oyster shell enhancement plots were distributed in E14 by SFBBO, CDFW and Ducks Unlimited (Figure 2). Remaining areas were treated as Control plots.

- Plot New 1 (6.47 hectares) in 2014
- Plot New 2 (13.76 hectares) in 2014
- Pilot plots (3 1-hectare areas) in 2008

Sampling Design

All breeding plovers and nests in pond E14 were monitored weekly during the 2015 and 2016 breeding seasons (March 1 to September 15). Surveys were conducted using spotting scopes (Kowa Prominar TSN-664), binoculars, and physically walking through the habitat to check nests. The following nest data were collected: GPS location, enhancement type, adult presence, condition, fate, and egg float measurements to calculate egg age information. Wildlife trail cameras (Reconyx PC900) were deployed throughout pond E14 to document nest predation events.

Statistical Design

Apparent hatch rates were calculated as the percentage of hatched nests out of total nests laid. Since all nests were not active at the same time, nest densities were calculated by week and averaged by season. A nest survival analysis was conducted in program R to generate Daily Nest Survival Rates using multiple covariates.

Results:

A total of 186 plover nests were detected throughout pond E14 from 2015-16. Apparent hatch rates by enhancement area were:

- New 1: 55%
- New 2: 27%
- Control: 38%

Average weekly nest density was highest in New 1 (1.14 ± 0.56 and 0.70 ± 0.44 nests per hectare in 2015 and 2016, respectively), second highest in New 2, followed by Control during both study years (Figure 3). A chi-square analysis comparing the relationship between nest site selection and the proportion of enhanced habitat available showed significant results ($N=186$, $\chi^2=119.5$, $df=2$, $p<0.05$). Plovers selected to place their nests in New 1 over New 2, and New 2 over Control.

DSR did not significantly vary by enhancement areas (New 1, New 2, Control), by nest age, distance to nearest levee, or camera presence. The distance to nearest levee was nearly significant for survival. DSR did significantly vary by year and by time over each season in enhancement plots (Figure 4 and 5):

- Decreased in New 1 (99-83%)
- Decreased in New 2 (98-71%)
- Remained constant in Control (95%)

The majority of predation events documented by nest camera were by common raven. Forty plover nests were depredated by common raven (New 1: 15 New 2: 15, Control: 9), and only one by peregrine falcon.

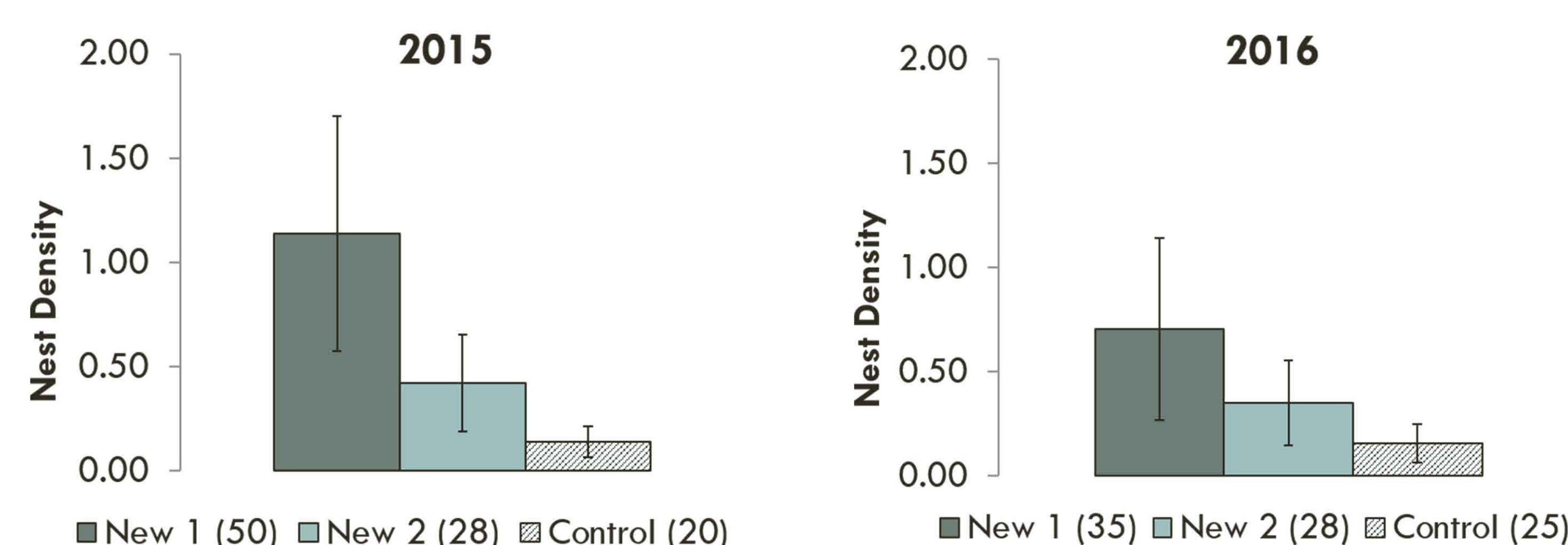
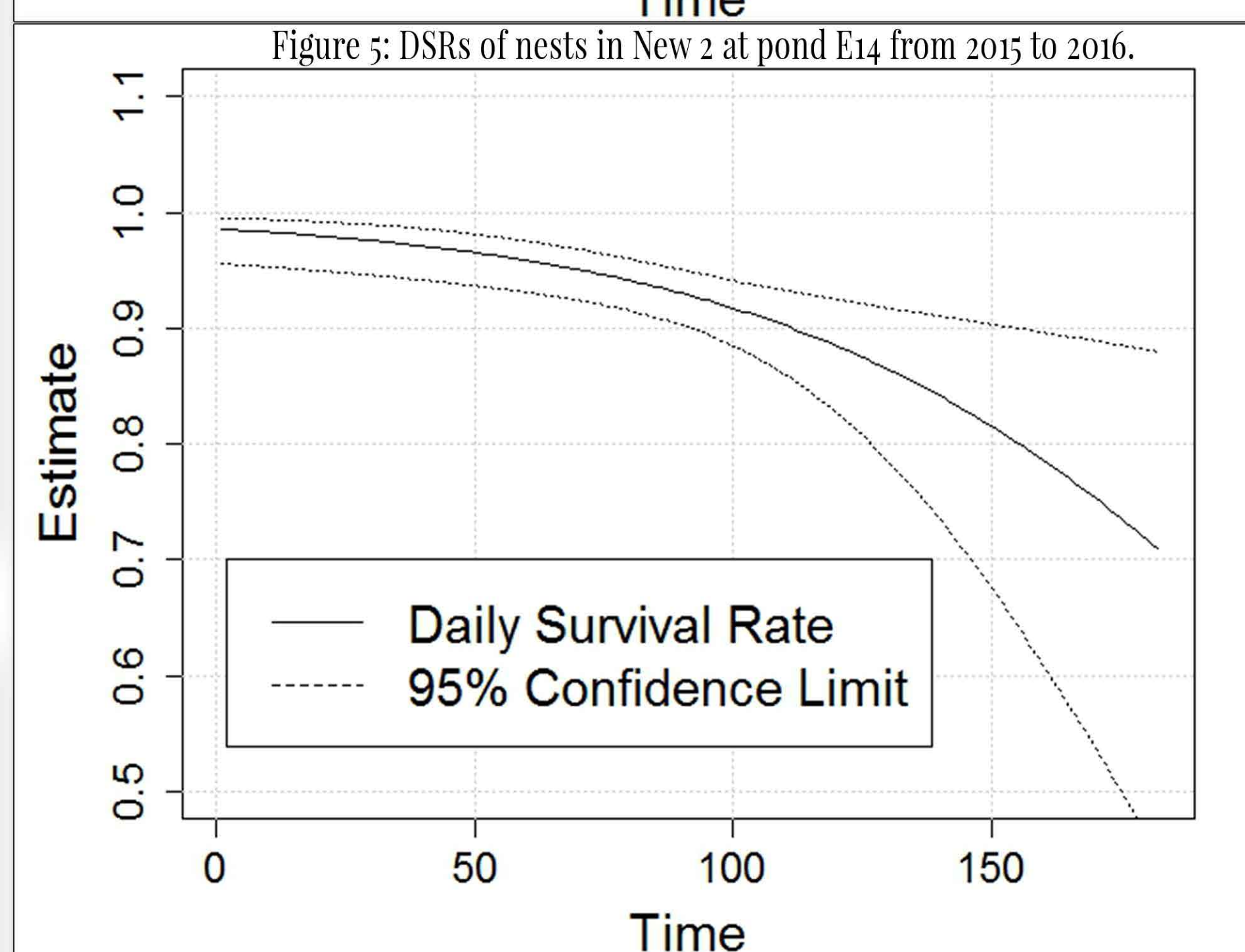
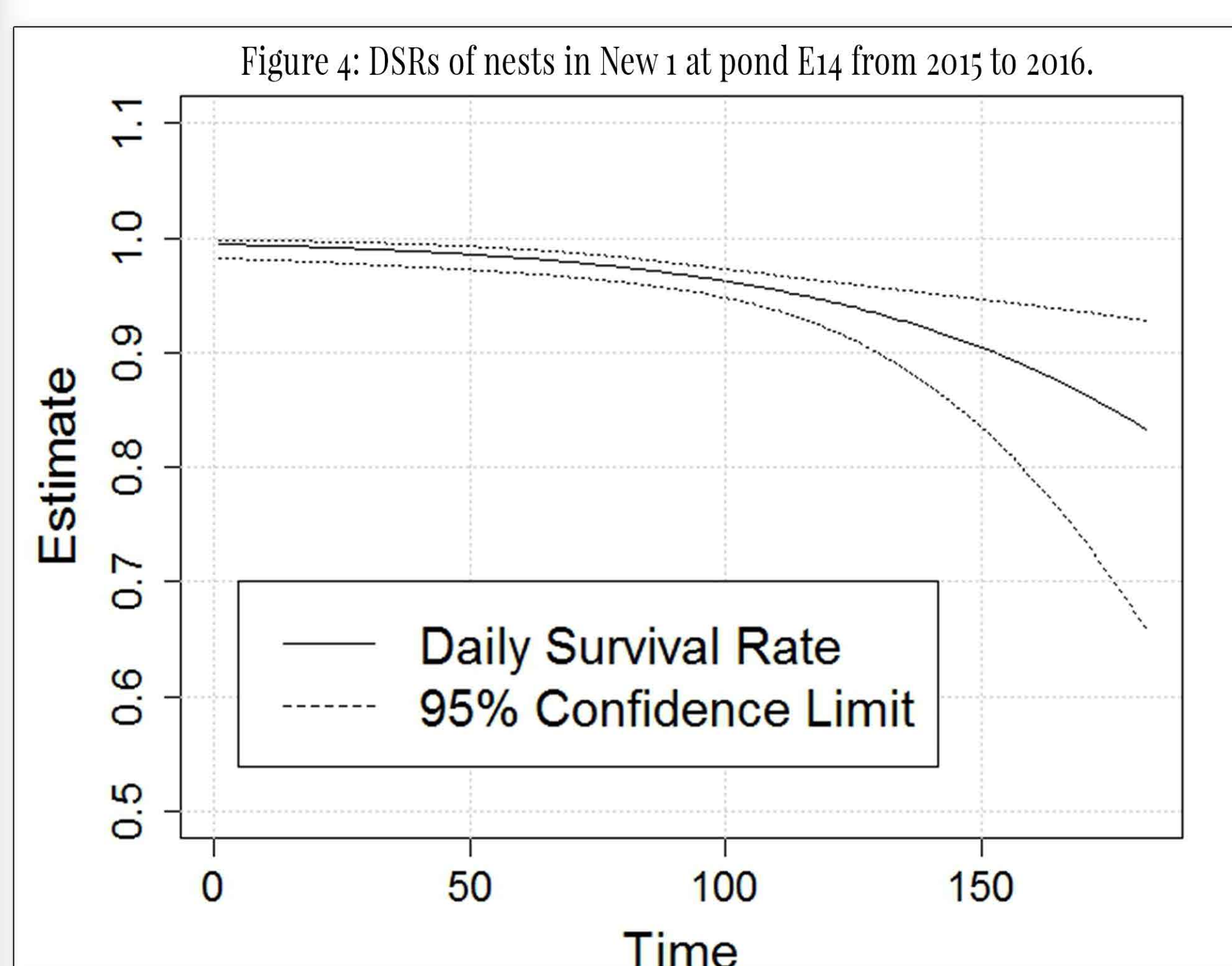


Figure 3: Average weekly nest density (number of nests per area in hectares) in pond E14, Eden Landing Ecological Reserve, Ca. from 2015 to 2016.

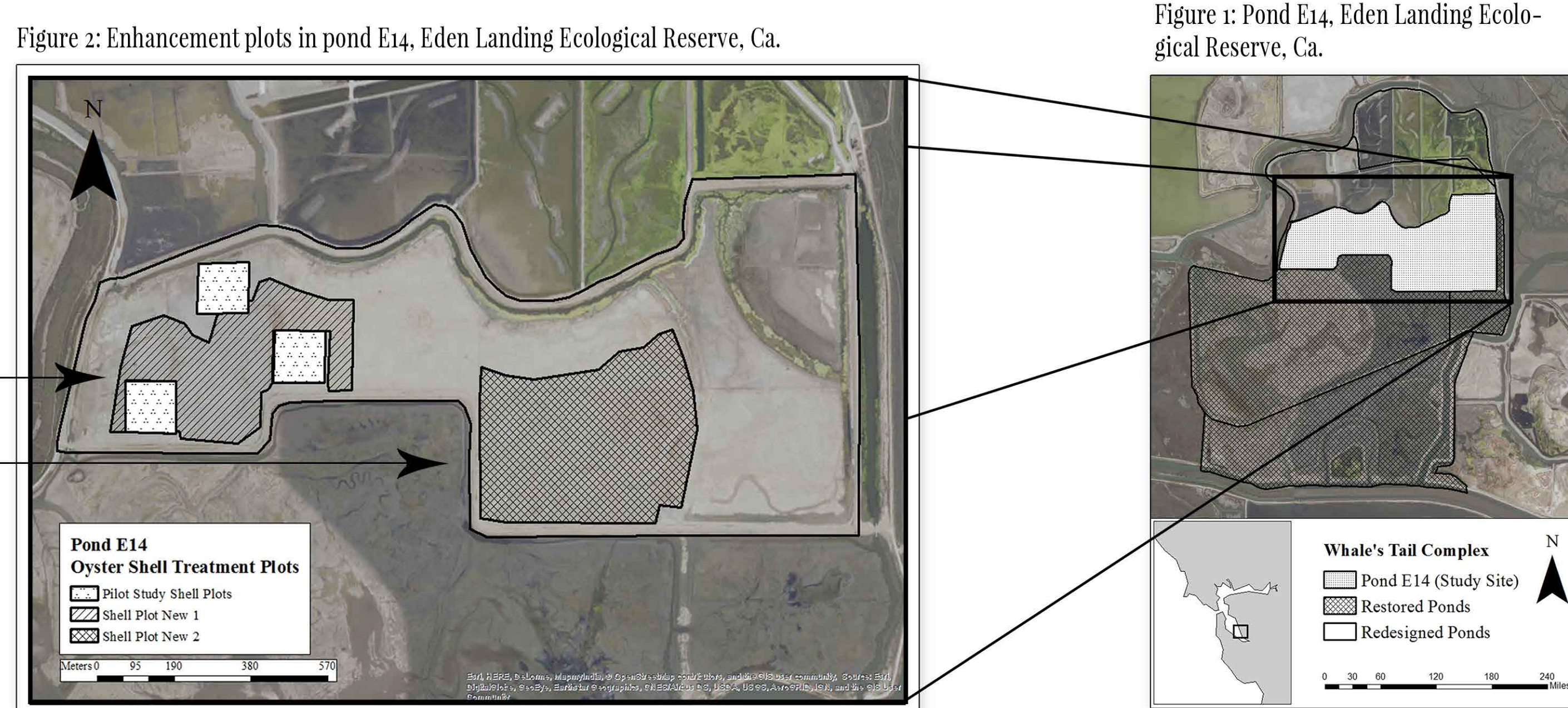


Figure 1: Pond E14, Eden Landing Ecological Reserve, Ca.

Discussion:

1. Oyster shell enhancement increases nesting density and positively influences nest site selection.
2. Oyster shell enhancement itself did not impact DSR but the passing of time over the season did; rates changed in each plot.
3. Common ravens limited nesting success during this study and are known predators throughout the breeding plover range. It is possible that ravens were attracted to high nesting densities may have equated oyster shells with a food source.

Future Implications:

Plovers may benefit from oyster shell enhancement as it attracts nesting effort and may be strategically used by resource managers to encourage nesting as specific locations. However, it is unlikely that enhancement will improve nesting success unless predator populations are concurrently controlled. Raven populations in the Western United States have increased by 166% over the last 40 years and these generalists thrive in urban areas like the San Francisco Bay. Enhancement should not be applied without further researching its influence on nest predation by ravens, otherwise the stability that the South Bay plover population holds across the range could be disrupted.