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EFFECTIVENESS OF PREDATOR EXCLOSURES FOR PECTORAL SANDPIPER NESTS IN ALASKA

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Abstract.—During the summer of 1992 we placed wire-mesh exclosures around 13 of 52 Pectoral Sandpiper (*Calidris melanotos*) nests near Oliktok Point on the North Slope of Alaska. Exclosures were 66–69 cm in diameter, 31-cm tall, and were made of 5 × 10-cm mesh weld-wire with 3-cm mesh chicken wire tops. The 5 × 10-cm mesh size allowed females to enter and exit an exclosure easily, and design of the exclosure provided sufficient anchoring to prevent Arctic fox (*Alopex lagopus*) from digging under or raising exclosures. Daily survival rate of protected nests (0.982) was significantly greater than that of unprotected nests (0.717). In considering the daily survival rates of protected and unprotected nests, the behavioral responses of Pectoral Sandpipers to exclosures, and the fact that no protected nests were depredated, we conclude that this exclosure was effective under our study conditions. We offer specific considerations for designing exclosures and suggest that exclosures similar to the one we descibe may be used to protect other shorebird species.

PROTECTORES EFECTIVOS CONTRA DEPREDADORES PARA NIDOS DE *CALIDRIS MELANOTOS* EN ALASKA

Sinopsis.—Durante el verano de 1992 colocamos, en los alrededores de 13 de 52 nidos del playerito *Calidris melanotos*, protectores de tela metálica, para excluir depredadores. El trabajo se llevó a cabo en Oliktok Point en el norte de Alaska. Los protectores fueron de 66–69 cm en diámetro, 31 cm de alto y fueron construidos en tela metálica de 5 × 10 cm con una cubierta de tela metálica de 3 cm. La tela metálica de 5 × 10 cm. permitió que las hembras entraran y salieran del exclusor de depredadores sin problemas a la vez que evitó que individuos de la Zorra Artica (*Alopex lagopus*) pudieran tener acceso al nido. La tasa de supervivencia de nidos protegidos (0.982) fue significativamente mayor que la de nidos sin protección (0.717). Tomando en consideración la tasa de supervivencia de aves protegidas, la respuesta en conducta de los playeritos y el hecho de que ningún nido protegido fue depredado, concluimos que los protectores fueron efectivo bajo las condiciones del estudio. Ofrecemos alternativas para el diseño de protectores contra depredadores y sugerimos que protectores similares al descrito pueden ser utilizados para proteger otras especies de playeros.

In summer of 1992, we studied energetics and reproductive success of Pectoral Sandpipers (*Calidris melanotos*) on the North Slope of Alaska west of Prudhoe Bay. Annual rate of nest success (percentage of nests in which at least one egg hatches) for Pectoral Sandpipers may vary considerably from year to year due to nest-site availability, abundance of predators, and availability and abundance of alternate prey for predators (Wayne Hanson, pers. comm., Summers and Underhill 1987). Regarding variation in nest success, two studies near Prudhoe Bay report apparent nest success of 32% ($n = 37$) during 1972–1980 (W. Hanson, unpublished

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data), 23% (n = 210) during 1988–1991, and 15% (n = 72) in 1992 (Declan Troy, pers. comm.).

Early in our field season, we observed a low rate of nest success among unprotected Pectoral Sandpiper nests. Potential predators in our study area included Parasitic Jaeger (*Stercorarius parasiticus*), Long-tailed Jaeger (*S. longicaudus*), Pomarine Jaeger (*S. pomarinus*), Glaucous Gull (*Larus hyperboreus*), Common Raven (*Corvus corax*), and Arctic fox (*Alopex lagopus*). Because our research required that we follow females through incubation and into chick rearing, we developed a wire-mesh exclosure to protect nests from potential predators. Our objectives here are to describe the exclosure we developed and to evaluate its effectiveness from the perspective of daily survival rates, behavior, and a nest's vunerability to predation.

STUDY AREA AND METHODS

This study was conducted near Oliktok Point, Alaska, about 63 km west of Prudhoe Bay (70°30′N, 149°50′W) from 9 Jun.–18 Jul. 1992. Landscape features in this area of the Arctic Coastal Plain include rolling thaw-lake plains, shallow (1–2 m) elliptical lakes, drained lake basins, and patterned ground forms such as low- and high-center polygons. Vegetation in the area is dominated by sedges, mosses, lichens, and low woody shrubs (Walker and Acevedo 1987).

We searched for nests by observing and flushing female Pectoral Sandpipers. Upon finding a nest, we trapped and individually color-banded each female and floated eggs to determine incubation stage. Nests were at various stages of incubation when we found them. We checked nests on a schedule that ranged from weekly to daily. We decreased the interval of nest checks as eggs approached hatch.

Because we suspected that predation was the cause of a low rate of nest success during 9–21 June, we developed a predator exclosure to protect nests. Nests not depredated during 9–21 June (n = 5) received exclosures as quickly as we could make and install them, and nests we found after 21 June (n = 8) received exclosures within 1–4 d after finding them.

Exclosures were 66–69 cm in diameter, 31-cm tall, and were made of 5 × 10-cm mesh weld-wire. We covered exclosures with tops fashioned from 3-cm mesh chicken wire. The exclosures were anchored to the substrate by a row of 10-cm spikes, which were part of the fencing wire and were pushed into the tundra (Fig. 1). Two pieces of wood lath were positioned on opposite sides of the exclosure, and were pounded into permafrost so that the top edge of the wood lath was flush with the top rim of the exclosure. Each exclosure took 30 min to construct, <10 min to install by 1–2 people, and cost approximately US $4.00 for materials. All exclosures were constructed at our base camp, away from nest sites.

A female's acceptance of an exclosure was monitored by noting active incubation 1–4 d after an exclosure was installed. After exclosures were installed, we checked nests for continued incubation, signs of predator visitation, and hatching or failure of eggs.

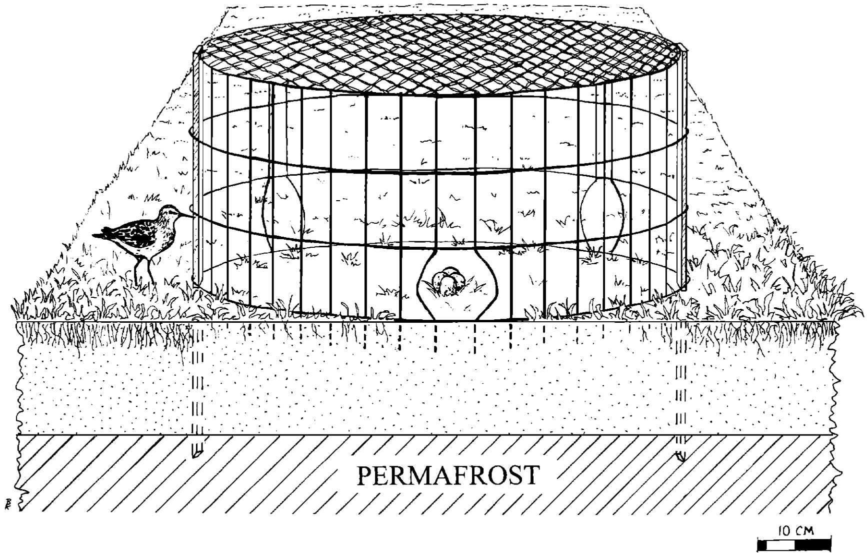

FIGURE 1. A scaled illustration of the predator exclosure described in this study. The exclosure was 66–69 cm in diameter, 31-cm tall, and was made of 5 × 10-cm mesh weld-wire with a chicken wire top.

We classified a nest as failed when (1) we found eggs missing from the nest and had determined previously by flotation that the eggs could not yet have hatched or (2) it was obvious that a female had abandoned her nest (non-developing eggs and continued absence of a female). We classified a nest as successful when (1) we noted chicks either in the scrape or with their individually color-banded mother or (2) we determined in the previous nest visit that the float angles of the eggs were indicative of hatch, the female of the nest exhibited brood-like behavior, and there was no evidence of predation. Using these criteria, we had no nests of unknown fate.

Rather than calculate nest success based on an apparent rate (number of successful nests/total number of nests found), we have used the Mayfield method (Mayfield 1961, Mayfield 1975) to calculate an estimate of daily survival rates for 39 unprotected and 13 protected Pectoral Sandpiper nests. Use of the Mayfield method is appropriate in our case because it is likely that failed nests were not located in equal proportion to successful nests (Pectoral Sandpipers are a cryptic, ground-nesting species), we located nests in various stages of incubation, and nest-check intervals were not greater than 1 wk (Johnson 1979). We used the methods of Johnson (1979) to calculate the standard error of daily survival rates and to compare daily survival rates of unprotected and protected nests.

RESULTS

Daily survival rate of protected nests (0.982, n = 13, SE = 0.010) was significantly greater than the daily survival rate of unprotected nests (0.717, n = 39, SE = 0.039; $P < 0.0001$). On average, a protected nest experienced 12.8 (SE = 1.9) exposure days before hatching or failing, but an unprotected nest experienced only 3.5 (SE = 0.3) exposure days. Because protected nests were exposed to potential predation longer than unprotected nests, it is unlikely we have overestimated protection provided by exclosures.

Exclosures were effective also from a behavioral perspective because they did not appear to inhibit female attendance of a nest. Females generally returned to their nests within 15 min after exclosure installation. All 13 females were incubating their nests when we checked them 1–4 d after installing exclosures.

Although Arctic fox attempted to enter exclosures, none of the protected nests failed due to predation. We found evidence of digging by Arctic fox at 9 of 13 exclosures. They dug at 6 of 9 exclosures at least once, and at 3 of 9 exclosures more than once, but they did not manage to penetrate the exclosures. Unfortunately, we did not see foxes digging at any of the exclosures and cannot comment on behavior of female Pectoral Sandpipers during such events.

Of the 3 protected nests that failed, 2 failed due to abandonment and one to death of a female (unknown cause). One of the abandoned nests was a late, renesting attempt, and it experienced multiple fox visits. In the other case, we found no evidence of fox visitation, and examination of one abandoned egg showed that the egg was fertile.

Of the 38 unprotected nests that failed, we believe the primary reason for failure was predation rather than abandonment or infertility. Predation appears to have been the primary cause of failure because all eggs typically had disappeared from a nest before they could have hatched (as determined by previously floating the eggs) and nests were undisturbed. Neither infertility nor abandonment played a significant role in nest failure because all eggs we floated showed signs of development, and as far as far as we could tell, females had been in attendance of their nests in our previous visits.

We believe the Arctic fox was the primary predator because we never found eggshell remains near empty nests (punctured eggshell remains are a common sign of avian predation, Byrkjedal 1980, W. Hanson, pers. comm.), occasionally we detected a musky fox odor in nest cups, and once we found a fox scat near an empty nest. Finally, the digging marks at protected nests indicate foxes were attempting to depredate nests.

DISCUSSION

We believe our exclosure was effective in protecting Pectoral Sandpiper nests. We designed the exclosure to protect against what we thought were the most likely predators in the study area, Arctic fox and other birds.

We made exclosures large enough so that foxes could not reach a nest, and covered exclosures so that neither avian nor mammalian predators could enter through the top. We also used the smallest wire mesh that would allow Pectoral Sandpipers access to their nests, yet exclude most known predators in the study site. We anchored exclosures securely to the permafrost so that predators could not pull up or dig under them. These design features appeared effective against potential predators. This is true especially in the case of foxes because they did not enter the exclosures even after repeated digging attempts at individual exclosures.

Additional considerations in designing exclosures should include the response of a ground-nesting species to disturbance, whether the species of interest nests in dense vegetation, and whether avian predators present a significant threat. For example, exclosures used around Piping Plover nests (*Charadrius melodus*; Melvin et al. 1992) were left uncovered because a few birds nesting in dense vegetation (n = 4) left their nests by flying up and out of exclosures when disturbed. Melvin et al. (1992) did not note any significant threat by avian predators at their study site and so left their exclosures uncovered. In contrast, Pectoral Sandpipers, nesting on the open tundra, tended to sneak off their nests by running for a short distance and then flying, or they flew through the side of an exclosure. We did not observe birds trying to leave their nests by flying directly upward. Because of the behavior of Pectoral Sandpipers and the possible threat of either avian or mammalian predators entering an exclosure from the top, we covered exclosures.

Another difference between the exclosure we developed and those used in other studies is the smaller size of the one we describe (Deblinger et al. 1992, Melvin et al. 1992, Rimmer and Deblinger 1990). We chose the dimensions for this exclosure after considering the difficulty of acquiring fencing materials on the North Slope, transporting exclosures, and the limited personnel and time to make and install exclosures. We think it is noteworthy that despite their small size, our exclosures were not penetrated by predators. We would recommend, however, that the dimensions of this exclosure be enlarged in future studies in order to create a larger buffer between predators and nesting birds.

Although protected nests had a greater daily survival rate than unprotected nests in our study, we did not monitor unprotected and protected nests at the same time. An alternative explanation as to why the daily survival rate increased between unprotected and protected nests is that predation pressure decreased over the season. We do not believe this to be the case, however, because foxes visited and attempted to enter exclosures, which generally were installed later in the season. To remove the confounding factor of possible changes in predation pressure over time, one would need to install exclosures at random to nests throughout the breeding season and to monitor protected and unprotected nests simultaneously.

Although the exclosure described here was developed so that we could protect nests for other research purposes, another valuable and current application for exclosures is to protect nests of endangered or threatened species (Deblinger et al. 1992, Melvin et al. 1992, Rimmer and Deblinger 1990). For example, exclosures similar to but larger than the one described here have been used to protect Piping Plover nests (Melvin et al. 1992) in Massachusetts, producing a daily survival rate of 0.994. Whether exclosures are to be used for manipulative studies or for protecting threatened species, their use should include consideration of potential predators, behavior of predator and prey, and potential effects an exclosure may have on the nesting species under study. If these considerations have been addressed for a given species and they yield conditions similar to what we have described, we would recommend an exclosure design similar to ours for protecting nests of other shorebird species.

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LITERATURE CITED

BYRKJEDAL, I. 1980. Nest predation in relation to snow-cover: a possible factor influencing the start of breeding in shorebirds. Ornis Scand. 11:249–252.

DEBLINGER, R. D., J. J. VASKE, AND D. W. RIMMER. 1992. An evaluation of different predator exclosures used to protect Atlantic coast piping plover nests. Wildl. Soc. Bull. 20:274–279.

JOHNSON, D. H. 1979. Estimating nest success: the Mayfield method and an alternative. Auk 96:651–661.

MAYFIELD, H. 1961. Nesting success calculated from exposure. Wilson Bull. 73:255–261.

———. 1975. Suggestions for calculating nest success. Wilson Bull. 87:456–466.

MELVIN, S. M., L. H. MACIVOR, AND C. R. GRIFFIN. 1992. Predator exclosures: a technique to reduce predation at piping plover nests. Wildl. Soc. Bull. 20:143–148.

RIMMER, D. W., AND R. D. DEBLINGER. 1990. Use of predator exclosures to protect Piping Plover nests. J. Field Ornithol. 61:217–223.

SUMMERS, R. W., AND L. G. UNDERHILL. 1987. Factors related to breeding production of Brent Geese (*Branta b. bernicla*) and waders (Charadrii) on the Taimyr Peninsula. Bird Study 34:161–171.

WALKER, D. A., AND W. ACEVEDO. 1987. Vegetation and a Landsat-derived land cover map of the Beechey Point Quadrangle, Arctic Coastal Plain, Alaska. Cold Regions Research and Engineering Laboratory Report 87–95.

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