Exclusionary Methods to Reduce Predation on Ground-nesting Birds and Their Nests

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Utah State University

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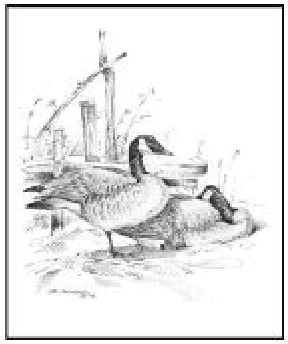

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Acknowledgments:

This publication was made possible by a Wildlife Restoration Grant from the U. S. Fish and Wildlife Service, Division of Federal Aid; the International Association of Fish and Wildlife Agencies; and the Jack Berryman Institute. Thanks go to A. D. Brown, J. Knisley, and R. D. Dueser for reviewing earlier drafts.

This publication may be cited as:

Jimenez, J. E., M. R. Conover, and T. A. Messmer. 2001. Exclusionary methods to reduce predation on ground-nesting birds and their nests. Berryman Institute Publication No. 20, Utah State University, Logan. 12pp.

This publication is also available online at www.BerrymanInstitute.org

Exclusionary Methods to Reduce Predation on Ground-nesting Birds and Their Nests

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2001

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Berryman Institute Publication No. 20

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INTRODUCTION

High predation rates on ground-nesting birds and their eggs are a serious problem in many parts of North America. The concern is that predation rates have increased as nesting habitat quality and quantity have declined (Cowardin et al. 1985, Wilcove 1985, Sargeant et al. 1993, Greenwood et al. 1995). In North America, the most serious nest predators are habitat and diet generalists which thrive in human-modified environments (Harris and Saunders 1993). Examples include the American crow (*Corvus brachyrhynchus*), red fox (*Vulpes vulpes*), striped skunk (*Mephitis mephitis*), and raccoon (*Procyon lotor*).

Increased nest predation can cause a decline in avian populations (Cowardin et al. 1985). In extreme cases, predation on breeding birds has resulted in extirpation of local populations, as documented by Bailey (1993) in the Aleutian Islands, where arctic fox (*Alopex lagopus*) and red fox are the main predators. More commonly, predation contributes to subtle long-term population declines, such as those experienced by dabbling duck populations nesting in the Prairie Pothole region (Cowardin et al. 1985, Greenwood et al. 1995, Beauchamp et al. 1996*a*). In this region, low nest success as a consequence of high rates of egg predation has resulted in recruitment rates well below those needed to sustain dabbling duck populations (Klett et al. 1988; Johnson et al. 1989; Clark and Nudds 1991; Sargeant et al. 1993; Greenwood et al. 1995; Beauchamp et al. 1996*a*,*b*).

Predation of hens and nests can be mediated by habitat variables such as nesting cover and the availability of alternative prey for predators (Crabtree and Wolfe 1988, Clark and Nudds 1991). When birds are nesting on farms, agricultural practices, such as plowing, mowing, and livestock management, also can influence nesting success (Greenwood et al. 1995, Kruse and Bowen 1996).

Wildlife managers can use a variety of direct and indirect management techniques to increase avian recruitment, such as conditioned food aversion, habitat improvement and restoration, and predator control (Conover 1990, Lokemoen 1984). However, many of these techniques are expensive, controversial, or inadequately tested (Trautman et al. 1974, Sargeant and Arnold 1984, Sargeant et al. 1995, Greenwood and Sovada 1996, Conover 1997).

In this publication, we review the literature on direct management techniques that have been used to exclude predators from gaining access to nests. We provide information on each technique's efficacy and cost so that landowners and wildlife managers can make better-informed decisions about how to protect nesting birds from predators.

We have emphasized studies conducted in the Prairie Pothole region of North America. This region has been exhibiting some of the most serious nest predation problems in North America and has been the focus of much research and management effort. Many studies have used artificial nests to assess nesting success. Although extrapolation of artificial nest studies to natural conditions has been criticized (Storaas 1988, Willebrand and Marcström 1988, Roper 1992, Major and Kendal 1996, Martin et al. 1996, Guyn and Clark 1997), these studies provide useful comparative data (Wilson et al. 1998).

Raccoon populations have been increasing in recent years and may have a severe impact on waterfowl recruitment in some areas.

Predator-Proof Fences

Fences of different sizes have been used to protect individual nests, colonies, and habitat patches. Structures used to exclude predators include wire mesh exclosures (Nol and Brooks 1982), electric fences (Sargeant et al. 1974, Foster 1975, Minsky 1980), and metal barriers (Post and Greenlaw 1989).

Killdeer nest.

Fences to protect individual nests

Wire mesh fences have successfully protected the nests of several species (Table 1). Estelle et al. (1996) improved daily survival rate of pectoral sandpiper (*Calidris melanotus*) nests using wire mesh fences to exclude arctic foxes in Alaska. Each fence could be constructed within 30 minutes at a cost of $4.00. Deblinger et al. (1992) examined the results of different studies to protect individual piping plover (*Charadrius melodus*) nests and concluded that fences were effective in reducing predation rates to below 10%. They reported that exclosure effectiveness was related to fence characteristics. Successful exclosures were triangular, covered, and had walls higher than 122 cm, built of 5x5-cm wire mesh, with the bottom of the fence buried deeper than 10 cm. One drawback of these fences was that they may have increased nest abandonment rates (Vaske et al. 1994).

Nol and Brooks (1982) used similar mesh exclosures to exclude gulls (*Larus* spp.) from killdeer (*Charadrius vociferus*) nests. However, raccoons were able to insert their forefeet through the holes, thus rendering the fences ineffective. In Florida, hardware cloth and metal barrier exclosures were used to protect seaside sparrow (*Ammodramus maritimus*) nests from garter snakes (*Thamnophis sirtalis*), Norway rats (*Rattus norvegicus*), rice rats (*Oryzomys palustris*), and fish crows (*Corvus ossifragus*, Post and Greenlaw 1989). These fences increased nesting success from 6% to 48%.

Electric fences also have been tested to determine their effectiveness in protecting individual nests. Sargeant et al. (1974) used electric fences to protect individual nests of sharp-tailed grouse (*Tympanuchus phasianellus*) and upland-nesting ducks (*Anas* spp.) in North Dakota and Manitoba. Overall, nest success increased from 21% to 67%.

Fences to protect colonies and habitat patches

Foster (1975) and Patterson (1977) used electrified fences to improve recruitment in sandwich tern (*Sterna sandvicensis*) and eider (*Somateria mollissima*) colonies by excluding foxes (Table 1). Foxes avoided the fences and rarely trespassed within them. Similar fences proved valuable when predator removal was impossible or undesirable. In North Dakota, Mayer and Ryan (1991) fenced out mammalian predators from 4 beaches where piping plovers nested semi-colonially. Birds nesting within the enclosures had 71% greater nest success than those nesting outside them (60% versus 35%, respectively), even though the exclosures did not restrict mink (*Mustela vison*) and gull access. The cost of fence material was $1.20/m and fence construction required 48 hours/fence in labor. Once built, the fences required little maintenance.

Several studies evaluated the use of electric fences to exclude mammalian predators from habitat patches where ducks nested (Table 1). Beauchamp et al. (1996*a*) analyzed 21 studies and concluded that nest success in fenced habitat patches was comparable to that on islands and higher than on unmanaged sites. Duck nest densities and the number of successful nests in habitat patches enclosed within an electrified fence in North Dakota increased from 0.83 to 2.61 nests/ha and 0.11 to 2.01 nests/ha, respectively (Arnold et al. 1988). In North Dakota and Minnesota, exclosures produced 7.8 and 6.9 more duckling/ha, respectively, than outside areas (Lokemoen et al. 1982). Greenwood et al. (1990) reported nest success improved from 7% outside exclosures to 36% within them. Seasonal predator control further increased nest success to 81%. The total cost of fence materials and herbicide for a 16-ha fence in 1989 was $4,500, excluding labor cost for construction, maintenance, and trapping. A fence that enclosed 19 ha of upland habitat and 2 ha of wetland in Iowa, and cost $7,240 (1985 dollars) for material and labor, improved nest success from 14 to 39% for mallards (*Anas platyrhynchos*) and from 14 to 30% for blue-winged teals (*Anas discors*). However, the fence delayed the exit of the broods, which increased duckling mortality (LaGrange et al. 1995). Pietz and Krapu (1994) and Howerter et al. (1996) subsequently demonstrated that the survival of ducklings could be improved by modifying the ground-level exits.

Research indicates that most fences are not completely predator proof. Despite improvements in the design, minks, weasels (*Mustela* spp.), rodents (Rodentia), foxes, coyotes (*Canis latrans*), badgers (*Taxidea taxus*), raccoons, and skunks may access exclosures (Lokemoen et al. 1982, Lokemoen and Messmer 1994, Howerter et al. 1996). Thus, some predator control within fenced areas may be needed to maximize nest success rates (Greenwood et al. 1990, LaGrange et al. 1995).

Given that avian predators will not be excluded with top-open fences, the use of fences is recommended for regions where terrestrial nest predators predominate (Sargeant et al. 1993). Cover has been placed over single-nest fences to reduce avian predation (Pietz and Krapu 1994, LaGrange et al. 1995), but this procedure may not be practical for larger exclosures. One problem with fences is that in open grasslands, the fence infrastructure itself could serve as a perch and attract raptors. To further reduce avian predation, the removal of potential perches was suggested (Greenwood et al. 1990, see also Preston 1957).

Fences that exclude predators have generally proved successful in small areas where nest predation has been a consistent and significant limiting factor (Melvin et al. 1992, Goodrich and Buskirk 1995). Fences, although costly to construct, require low maintenance and endure for several years. When the costs are amortized over the expected life of the fence, this method often is more cost effective than other techniques (Lokemoen 1984, Goodrich and Buskirk 1995).

Fences used to protect solitary nesters tend to be more expensive per nest protected than those used for colonial species. Thus, single-nest fences are only justified when predation by terrestrial species is high and the bird needing protection has a high conservation value. As the size of a fenced area increases, the area it encompasses increases faster than its perimeter. Hence, it is more cost effective to fence a large area than a small one, in terms of cost per unit area. For this reason, the cost per additional young produced in fenced habitat patches or colonies generally is lowered if larger areas are protected. However, terrestrial predators are more likely to become a problem when large areas are enclosed, because longer fences provide more potential entry points. Additionally, the use of fencing on uneven terrain will increase construction costs and the risk of predator access to the exclosure.

Anti-predator fence to protect nesting waterfowl.

Use of Nesting Structures

Elevated artificial nesting structures (i.e., baskets, hay bales, floating platforms) have reduced mammalian predation on waterfowl nests (Losito et al. 1995), especially mallards (Doty and Lee 1974, Doty et al. 1975, Doty 1979). In Iowa, mallards used 33% of the structures and had an 87% nest success with densities up to 1.6 nests/ha (Bishop and Barratt 1970). In the Prairie Pothole region, mallards used 38% of the structures; 83% of the nests in baskets hatched (Doty et al. 1975). Open-top baskets received higher use than mailbox-type structures (Sidle and Arnold 1972), and "horizontal cones" were used the most (Doty 1979). Horizontal cones provided protection from mammals and reduced predation by gulls by concealing the eggs from above. Ducks were more likely to use baskets that were lined with barley (*Avena* spp.) straw or brome (*Bromus* spp.) hay or that were located in small openings in emergent vegetation (Doty et al. 1975, Doty 1988). Structures lasted beyond 7 years where they were not impacted by wind, waves or ice (Doty et al. 1975). Raccoons were the only mammalian predator that could reach the elevated nests, but they could be excluded by using "truncated metal cones" or metal sheet on the support poles (Doty et al. 1975, Doty 1979). Considering maintenance over 20 years, the cost per duckling produced in baskets was $1.48 (1974 prices, Doty et al. 1975, Table 1).

Artificial nesting structures used by waterfowl.

Use of Islands and Peninsulas

Gadwalls (*Anas strepera*), Canada geese, and mallards typically nest on islands that are isolated from mammalian predators (Vermeer 1970, Willms and Crawford 1989, Gosser and Conover 1998). Nest densities as high as 389 nests/ha have been reported on islands (Duebbert et al. 1983). However, predation by mink and raccoon, which may swim to the islands, can reduce duck nest success (Duebbert 1966, Willms and Crawford 1989, Fleskes and Klaas 1991, Beauchamp et al. 1996*a*).

Constructed islands have been used effectively to increase recruitment (Table 1, Lokemoen and Messmer 1993). Generally, both nest densities and nesting success rates are high on islands (Higgins 1986, 1988; Lokemoen and Messmer 1993, Gosser and Conover 1998). Gadwall nests densities of 62/ha with 65% nest success have been reported on constructed islands. This is much higher than in upland habitats (Hines and Mitchell 1983). Duebbert (1982) suggested an optimal island size of 0.5 - 5 ha, which is large enough to support numerous nests, but too small to support resident mammalian predators.

Avian use of constructed islands for nesting may decline if soil and vegetation are eroded due to wave action (Higgins 1986). To construct more durable islands, Higgins (1986, 1988) and Lokemoen and Messmer (1993) suggested building them higher and in smaller wetlands. However, wetlands must be large enough to impede immigration of predators from the mainland. This condition is met by large (>5 ha) permanent wetlands with water depths >1 m. After the winter ice melts, predators may have to be removed from islands (Lokemoen and Messmer 1993). The construction costs of artificial islands ranged from $23 to $31 per duckling produced (Lokemoen 1984, Higgins 1986).

The cheapest way to create an island is to make one out of an existing peninsula by cutting it off from the mainland by a moat or fence. Lokemoen and Woodward (1993) compared duck breeding on 20 peninsulas in North Dakota, eight of them isolated from mainland by electric fences and two by water-filled moats. Isolated peninsulas exhibited 3 times the nest success and produced 9 times more ducklings/ha than peninsulas that were still attached to the mainland (Table 1). The cost per duckling produced was lower on fenced ($6.6) than on moated peninsulas ($33.6, Lokemoen and Woodward 1993). Problems with raccoons crossing moats were detected.   Lokemoen and Messmer (1994) provide comprehensive guidelines and cost estimates for constructing fences and moats to reduce predator access to peninsulas. Duckling production on fenced peninsulas costs less than on man-made earthen islands or small rock islands (Lokemoen and Messmer 1993). Costs per duckling produced were similar to those obtained using nest baskets, but higher than when using electrified fences in upland nesting habitat (Lokemoen 1984). Although production of ducklings on islands and moated peninsulas was high, construction costs resulted in higher costs per individual bird produced than other practices (Table 1, Lokemoen 1984).

Considering the effectiveness and cost per additional duckling produced, fenced peninsulas are more efficient than moated peninsulas or man-made islands. However, peninsulas often are absent, in which case, the construction of islands may be the only option available. Predator problems caused by swimming (i.e., raccoon and mink) and avian predators will not be solved by fencing peninsulas and constructing islands. Thus, seasonal predator management may still be required.

Conclusions

Productivity of ground-nesting birds can be increased through several non-lethal management techniques that attempt to exclude or obstruct predator access to hens and their nests. Our review indicates a wide range in the quality and quantity of data accumulated, the success of different methods, and the spatio-temporal applicability of the techniques. To fill the gaps, much research is still needed. Most studies evaluating the effectiveness of techniques did not quantify costs per additional young produced (Table 1). This is the common currency that wildlife managers will need when choosing between competing techniques.

Moated peninsula.

Currently, no management practice is uniformly better than another to reduce predation on nesting birds. Instead, different techniques will show various degrees of success, depending on circumstances and species involved. For instance, individual nests of shorebirds scattered on sandy beaches were successfully protected with a simple fence around each nest, colonial-nesting terns were protected with electrified fences, prairie-nesting dabbling ducks were protected with electrified fences enclosing large upland areas with dense cover, mallards responded well to nesting baskets installed in wetlands, and artificial islands worked best for mallards and gadwalls (Table 1).

There is no panacea for boosting bird recruitment. Managers need to select the most appropriate technique based on the species that needs protection, the local predator community, local topography, and management goals. Ideally, the decisions should be based on a cost/benefit analysis of producing additional young (Lokemoen 1984). We believe that with well-designed experiments and by adjusting the techniques available to other scenarios and different species, exclusionary techniques could be used to protect a large array of species from nest predators.

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Table 1. Summary of Results

This table contains information about the efficacy and cost-effectiveness of fences, nesting baskets, artificial islands, fenced peninsulas, and moated peninsulas in improving reproductive success of ground-nesting birds.

Species	Location	Protected Unit	Cost/unit ($)	Effectiveness (treated vs. untreated)	Life Expectancy	Authors
SIMPLE FENCES						
Pectoral sandpiper	Alas.	1 nest	4.00	Daily survival rate 0.98 vs. 0.72	1 season	Estelle et al. 1996
Piping plover	Mass.	1 nest	15.00	Chicks fledged/pair 2.0 vs. 0.1	1 season	Melvin et al. 1992
Piping plover	Mass.	1 nest	50.00	Nest success 0.92 vs. 0.25	1 season	Rimmer and Deblinger 1990
Killdeer	Ont.	1 nest	Not provided	Nest success 0.71 vs. 0.33	1 season	Nol and Brooks 1982
Seaside sparrow	Fla.	1 nest	Not provided	Nest success 0.48 vs. 0.06	1 season	Post and Greenlaw 1989
ELECTRIFIED FENCES						
Sandwich tern	U.K.	1 colony	Not provided	No. nesting pairs 450 vs. 80	1 season	Foster 1975
Terns and eiders	U.K.	1 colony	Not provided	Kept foxes out	1 season	Patterson 1977
Piping plover	N.D.	95 nests (7 ha)	810.00 (materials)	Nest success 0.60 vs. 0.35 Chicks fledged/pair 1.00 vs. 0.66	3 seasons	Mayer and Ryan 1991
Dabbling ducks	N.D.	1 nest	Not provided	Nest success 0.73 vs. 0. 21	1 season	Sargeant et al. 1974
Dabbling ducks	N.D.	45 ha	Not provided	Nests/ha 2.61 vs. 0.83 Successful nests/ha 2.01 vs. 0.11	3 seasons	Arnold et al. 1988
Dabbling ducks	N.D.	9 ha	1.44/m (incl. labor)	Nest success 0.65 vs. 0.45 7.8 additional chicks/ha	20 years	Lokemoen et al. 1982[1]
Dabbling ducks	Minn.	17 ha	1.84/m (incl. labor)	Nest success 0.54 vs. 0.17 6.9 additional chicks/ha	20 years	Lokemoen et al. 1982[1]
Dabbling ducks	N.D.	40 ha	4,500 (for 1 16-ha fence)	Nest success 0.36 vs. 0.07 (0.81 with predator control)	Not provided	Greenwood et al. 1990[1]
Mallard	Ia.	21 ha	7,240 (incl. labor)	Nest success 0.39 vs. 0.14	Not provided	LaGrange et al. 1995[1]
Blue-winged teal	Ia.	21 ha	7,240 (incl.labor)	Nest success 0.30 vs. 0.14	Not provided	LaGrange et al. 1995[1]
NESTING BASKETS						
Mallard	Prairie Potholes	NA	1.48/duckling	Nest success 0.83 Production 2.6 ducklings/basket/yr	20 years	Doty et al. 1975
ARTIFICIAL ISLANDS						
Gadwall	Sask.	0.03 ha	Not provided	Nest density 62/ha Nest success 0.65	Not provided	Hines and Mitchell 1983
Mallard	N.D.	0.0025 ha	31.25/duckling	Nest success 0.48 Ducklings/island 0.8	20 years	Higgins 1986

TABLE 1. SUMMARY OF RESULTS (CONTINUED)

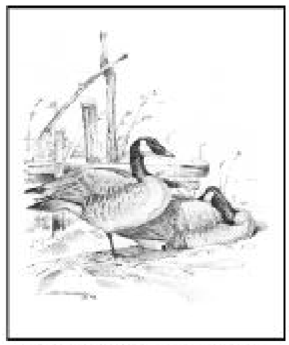
Species	Location	Protected Unit	Cost/unit ($)	Effectiveness (treated vs. untreated)	Life Expectancy	Authors
PENINSULAS WITH ELECTRIC FENCES						
Dabbling ducks	N.D.	Not provided	6.63/duckling	Nest success 0.54 vs. 0.17 Ducklings/ha 21.8 vs. 1.9	20 years	Lokemoen and Woodward 1993[1]
PENINSULAS WITH MOATS						
Dabbling ducks	N.D.	Not provided	33.59/duckling	Nest success 0.75 vs. 0.14 Ducklings/ha 21.8 vs. 1.2	50 years	Lokemoen and Woodward 1993[1]

[1]Lokemoen et al. (1982), Greenwood et al. (1990), Lokemoen and Woodward (1993), and LaGrange et al. (1995) controlled predators inside their fences or isolated peninsulas.

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Robert L. Gilliland, Vice-President and Director, Cooperative Extension Service, Utah State University, Logan, Utah.

About The Jack H. Berryman Institute

The Jack H. Berryman Institute is part of the College of Natural Resources and Cooperative Extension Service of Utah State University. The Institute has the mission of trying to improve human-wildlife relationships by resolving human-wildlife conflicts. The Institute fulfills its mission through research, extension, and education.



Berryman Institute

About This Publication

High levels of predation on ground-nesting birds and their eggs are a serious concern in North America. This publication reviews various exclusion techniques that can be used to prevent predator access to the nests of ground-nesting birds and provides information on the efficacy and cost of those techniques. It is meant to help wildlife managers and private landowners who wish to protect nesting birds from predators.

This publication is also available online at www.BerrymanInstitute.org

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