EXCLOSURES: AN EXPERIMENTAL TECHNIQUE FOR PROTECTION OF NORTHERN BOBWHITE NESTS

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ABSTRACT

Nest predation has been implicated as a factor affecting northern bobwhite (*Colinus virginianus*) recruitment rates. Public stakeholders are increasingly questioning use of lethal methods to manage predation. We evaluated a nonlethal method consisting of single nest treatments using an exclosure to protect nests from potential predators. The exclosure treatment also included use of Amdro® (hydramethylnon) and Snake-a-way® repellents to deter red-imported fire ants (*Solenopsis invicta*) and snakes, respectively. We compared nest success of treated ($n = 8$) to untreated nests ($n = 18$). Treated nests were 88% successful which was a 2-fold increase over unprotected nests. We did not observe any difference in hen behavior between treatment and controls. This technique may be useful to study nest success of wild quail and is not intended to be a management technique to influence overall population growth.

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INTRODUCTION

Lethal and nonlethal predation management has been used by researchers and managers for decades in efforts to increase populations of ground-nesting birds (Chessness et al. 1968). However, removal of predators, primarily furbearers, has produced mixed results, especially for bird species other than waterfowl (Sargeant et al. 1995, Garretson et al. 1996). Concomitantly, public stakeholders are increasingly questioning use of lethal methods to manage predation (Messmer et al. 1999).

Data concerning efficacy of predator control for increasing northern bobwhite populations are limited and contradictory (Rollins and Carroll 2001). Beasom (1974) reported increased northern bobwhite population densities after 2 years of mesomammal control, but Guthery and Beasom (1977) did not. Lehmann (1984) reported slight annual increases in bobwhite numbers but no long-term trends, even though large numbers of coyotes (*Canis latrans*) were removed from the King Ranch. Frost (2000) suggested the effects of predator control were difficult to quantify. These mixed results may have occurred because lethal removal of species can change the importance of different predators rather than increasing nest success (Dion et al. 1999).

Public support for predator removal as a means of increasing nest success has been uncertain and use of taste aversion, screens, fences, or exclosures to reduce predation has been evaluated for several species. Electric fences and exclosures have been successfully used to protect duck (*Anas* spp.) nests from predation by mammals (Cowardin et al. 1998). Exclosures also have been useful in protecting nests of the endangered piping plover (*Charadrius melodus*) (Melvin et al. 1992). Plover nest success increased from 17 to 90% by excluding mammalian predators. Controlled taste aversion, lethal removal, and nest screens were compared as techniques to reduce northern raccoon (*Procyon lotor*) predation of loggerhead sea turtle (*Caretta caretta*) nests (Ratnaswamy et al. 1997). Only nest screens were effective at reducing the effect of raccoons and increasing nest success. Protected nests had predation rates of 7.6%, which was 20–50% of the rates of other treatments (Ratnaswamy et al. 1997).

Screens of sufficient size to allow passage of northern bobwhites likely will not restrict most reptilian and arthropod nest predators. Red-imported fire ants in some areas, including much of Texas, can depredate northern bobwhite nests causing chick mortality (Mueller et al.

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1999). These authors demonstrated the effectiveness of Amdro® (Ambrands, Atlanta, GA, USA) for protecting northern bobwhite nests from red-imported fire ants. Amdro® treatment eliminated the presence of red-imported fire ants in the nest area on the day of hatch and increased survival of chicks from nests treated by 38% compared to non-treated controls.

No studies of the effects of chemical treatments for prevention of reptilian nest predators are available. Snake-a-way® (Dr. T's Nature Product Inc., Pelham, GA, USA) is a commercially available snake repellent that contains naphthalene and sulfur, active ingredients that are registered as snake repellents by the Environmental Protection Agency (EPA Reg. No. 58630-1). We are not aware of any studies that used exclosures or Snake-a-way® to protect northern bobwhite nests.

The objectives of our research were to: (1) develop, and (2) evaluate a non-invasive nest exclosure technique designed to exclude mammalian predators from northern bobwhite nests. We also (3) evaluated if exclosures and snake repellent affected hen and chick movements and nest abandonment rates.

STUDY AREA

The project was conducted in Refugio County, Texas in the Texas Coastal Prairie (Gould 1975). The site (28° 28′ N, 97° 11′ W; elevation = 25 m) is a 10,040-ha working cattle ranch with oil wells and limited agricultural production. Grasslands were interspersed with live oak (*Quercus virginiana*) motts, honey mesquite (*Prosopis glandulosa*), and huisache (*Acacia smallii*). This area provides prime quail habitat with relatively dense populations. Potential nest predators included feral hogs (*Sus scrofa*), long-tailed weasels (*Mustela frenata*), coyotes, hispid cotton rats (*Sigmodon hispidus*), northern raccoons, bobcats (*Lynx rufus*), striped skunks (*Mephitis mephitis*), eastern spotted skunks (*Spilogale putorius*) (Davis and Schimdly 1994), and various snakes. No predator control was occurring on the ranch with the exception of periodic feral hog control.

METHODS

We followed guidelines of the Texas Tech University Institutional Animal Care and Use Committee (IACUC #99885) during this study. Northern bobwhite hens were trapped from February until May 2000 ($n = 35$) and 2001 ($n = 24$) using walk-in funnel traps (Smith et al. 1981) baited with milo, corn, or a mixture of both. Hens were fitted with a 6-g necklace style radio transmitter (American Wildlife Enterprises, Monticello, FL, USA) and released. Radiotelemetry was used to monitor hens and locate their nests following Mueller et al. (1999). We randomly assigned each nest located to be a treatment or control by flipping a coin. This sampling scheme resulted in nests being scattered across the 10,040-ha landscape with all nests at least 75 m apart. We assumed that all were subject to similar pressure from vertebrate predators. Nests of hens that renested were also randomly assigned as a treatment or control. This approach ensured that both treatment and control nests would be exposed from the beginning to end of the nesting season.

The treatment consisted of exclosures that were $1.22 \times 1.22 \times 0.4$ m in size constructed of welded wire with 5×10 cm openings. Each exclosure had 4 sides, a wire mesh top, and an open bottom. Exclosures were centered on the nest and staked to the ground with 1.27-cm diameter rebar. Two pieces of rebar were threaded through the top of the exclosure to prevent any impact from an aerial attack or from large birds using it as a roost site. We attempted to build the exclosures when the hen was off the nest, but 4 of the 8 exclosures were installed while the hen was on the nest. Exclosures were installed within the first week a hen was incubating. The exclosure treatment also included Amdro® and Snake-a-way® to deter red-imported fire ants and snakes, respectively. Amdro® was spread at the rate of 1.7 kg/ha over 60-m^2 centered on the nest to reduce red-imported fire ants in the immediate area and to negate the impacts of individuals foraging outside the treated area (Mueller et al. 1999). Eighty-five grams of Snake-a-way® were applied in a 10 to 12-cm band encircling the exclosure.

Radio-marked hens were checked every 2 to 3 days early in the nesting cycle and daily as the expected hatch date approached. Nests were classified after hatch as either successful or not. A nest was considered successful if at least 1 egg hatched. Nest predators were differentiated as red-imported fire ants or other. We used the adjusted-Wald normal test for small sample sizes to examine differences in nest success between treatments (Agresti and Coull 1998).

RESULTS

Only 14 and 11 hens were alive at the onset of nesting season during 2000 and 2001, respectively. Success was arithmetically greater for exclosure nests (75%, $n = 4$ during 2000; 100%, $n = 4$ during 2001) than for control nests (25%, $n = 12$ during 2000; 67%, $n = 6$ during 2001) within years. We pooled the data by year for analysis because small sample sizes (< 5 per treatment) precluded analysis between years. Exclosure nest success (88%, $n = 8$) was greater ($Z = 2.07$, $P = 0.019$) than control nest success (39%, $n = 18$) when data were pooled for both years. Only 1 control nest and no exclosure nests were predated by red-imported fire ants. We did not identify individual vertebrate nest predators and do not have an evaluation of the effectiveness of Snake-a-way® alone for repelling snakes from nests.

DISCUSSION

Naphthalene and sulfur, the active ingredients in Snake-a-way®, are registered as snake repellents by the Environmental Protection Agency, but the effectiveness of Snake-a-way® in the field is unclear (Marsh 1993, Ferraro 1995). Our sample size did not allow examination of the individual components of the exclosure study, but the exclosure treatment as a whole.

Our results were similar to those of Melvin et al. (1992) and Ratnaswamy et al. (1997), who used nest exclosures to achieve nest success rates of 90 and 92% for piping plover and sea turtle nests, respectively. Nest success for northern bobwhites typically varies from 28 to 46% (Rosene 1969) and averages 45% in South Texas counties (Lehmann 1984). A 38% nest success rate for northern bobwhites has been previously reported for our study area; thus, the success rate for control nests in our study is typical for the area (Mueller et al. 1999).

Only 1 of the exclosure nests was destroyed during either year, by an unidentified predator. Long-tailed weasels, hispid cotton rats, and eastern spotted skunks occur in the area and are known predators of quail eggs (Davis and Schimdly 1994). These species are the most likely suspects because of their size and the fact the exclosure was left intact; only the nest and eggs were destroyed. We ruled out other mesomammals and anything larger, such as coyotes, because the exclosure itself was completely intact. Larger animals could not enter through the 5×10-cm opening, and could not enter from underneath without digging. No sign of digging under the exclosure was present and the predator had to have entered through the welded wire mesh. We do not believe the nest was predated by a snake because egg fragments were present in the nest and snakes typically consume the eggs whole (Hernández et al. 1997).

Installation of the exclosures did not cause nest abandonment even when the hen was present while we drove stakes to secure the enclosure. Occasionally, the hen when present during exclosure installation, would run or fly through the mesh openings but usually remained close to the nest. We monitored hen movements later the same day or early the next day to make sure hens were still incubating and they returned in every case.

We do not believe brood movements were affected. Chicks moved freely with their parent upon hatch as expected. Use of exclosures did not appear to have any negative effects on hen or chick behavior. Many studies have not achieved an increase in nest success through predator control, whereas we increased nest success by reducing the impacts of predation rather than predators themselves. Thus, exclosures may be a non-lethal technique that could be used to protect ground-nesting birds from mammalian predators. This technique warrants further investigation regarding its potential for contributing to increased nest success.

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