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Predator Management to Protect Endangered Avian Species

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There are about 275 species of birds on the U.S. Fish and Wildlife Service's (USFWS) list of threatened and endangered species (USFWS 1995). The International Union for the Conservation of Nature and Natural Resources (IUCN) noted that there is serious concern for the status of more than 2,000 species of birds, representing about 20 percent of the world's avifauna (Collar et al. 1995). These bird species include representatives of most taxonomic orders. Many of the species are endemic to islands or coastal areas and many are ground-nesting species. Most of the species on the IUCN list are associated with forests, scrub, and wetland or littoral habitats.

Many factors can threaten the continued existence of a species. Habitat loss and degradation are considered the main threats to most species of concern, followed by limited range or population size (Collar et al. 1995). Other factors include hunting, trapping, subsistence or commercial egg collecting, competition or predation by introduced species, natural causes, and unknown factors.

Efforts to restore endangered avian species have included: 1) legal protection from taking or harassment; 2) creation of reserves or refuges; 3) protection or restoration of habitats; 4) reduction of competition or predation; 5) provision of food or nest sites; 6) captive breeding or foster parenting; and 7) assessments of population size, recruitment, mortality, and habitat quantity and quality. Recovery plans have been developed for some endangered species. These usually are comprehensive, multiple agency/party plans or agreements that delineate specific threats, action items, designated areas, time lines, budgets and anticipated results. The plan may indicate a specific goal to be achieved, such as the number of breeding pairs in designated areas that could lead to a down-listing from endangered status. Unfortunately, only about 72 (26 percent) of the 275 listed avian species have recovery plans (USFWS 1995).

Predation

Predation is one of many mortality agents that influence populations, along with malnutrition, inclement weather, accidents, toxins, diseases and hunting by humans (deVos and Smith 1995). The significance of predation on prey populations has been widely argued. However, predators often play critical roles in the composition and function of ecosystems. The effects of predation on birds can be significant, especially with high predator densities or when predators gain access to areas they have not occupied historically. Non-native predators (feral cat [*Felis domesticus*], rats [*Rattus* spp.], red fox [*Vulpes vulpes*] and mongoose [*Herpestes auropunctatus*]) can have substantial effects on avian species, especially in localized situations or on islands (Bailey 1993, Burger and Gochfeld 1994, Welty and Baptista 1988).

Many species have been implicated in predation on endangered avian species. In addition to the species mentioned, other predators include coyote (*Canis latrans*), arctic fox (*Alopex lagopus*), feral dog (*Canis familiaris*), bobcat (*Lynx rufus*), skunk (*Mephitis mephitis*), raccoon (*Procyon lotor*), mustelids (*Mustela* spp.), ground squirrels (*Spermophilus* spp.), gulls (*Larus* spp.), ravens and crows (*Corvus* spp.), great-horned owl (*Bubo virginianus*), brown-headed cowbird (*Molothrus ater*), and brown tree snake (*Boiga irregularis*). Often, more than one species and taxonomic group of predators are involved. The egg, nestling and fledgling stages of avian development usually are most prone to predation (Burger and Gochfeld 1994). In general, ground nesters suffer highest predation levels, followed by cliff/burrow nesters, and lowest levels by tree nesters (deVos and Smith 1995). Predation may cause relatively slight to nearly complete loss of recruitment in avian species (Bailey 1993, Burger and Gochfeld 1994, Welty and Baptista 1988).

More than 30 avian species have been protected from predators as part of recovery efforts in the U.S. and its territories. These include large (Aleutian Canada goose [*Branta canadensis*], whooping crane [*Grus americana*], brown pelican [*Pelecanus occidentalis*]), intermediate-sized (light-footed clapper rail [*Rallus longirostris*], Attwater prairie chicken [*Tympanuchus cupido*], Hawaiian duck [*Anas wyvilliana*]) and small species (piping plover [*Charadrius melodus*], California least tern [*Sterna antillarum*], Kirtland's warbler [*Dendroica kirtlandii*]).

Predation Management

Many methods are available to reduce wildlife losses to predation, including physical, chemical, biological and other approaches (Fall 1990). Often, multiple methods are used to increase effectiveness and reduce hazards, in keeping with the principles of integrated pest management. Methods should be tailored to the specific situation, the target species, the locale and its laws and regulations, budget and personnel constraints, and the socio-political setting (Schmidt 1992, U.S. Department of Agriculture [USDA] 1994). Research continues to improve on existing methods and add new methods for managing predator impacts (Fall 1990).

Unfortunately, in the case of endangered avian species, many of the methods for predation management are not appropriate. For example, frightening devices and guard animals probably would be as threatening to a nesting colony as the predators themselves. The methods used most commonly include exclusion (nest or area barriers made of wire mesh and/or electric wires) or predator removal (box and leg-hold traps, snares, shooting, and toxicants). Details on the use of these methods can be found in Hygnstrom et al. (1994), Lokemoen and Messmer (1994), Robinson et al. (1993) and USDA (1994).

A plan to protect an endangered avian species must address many factors to help assure success, including: 1) identifying the problem species; 2) assessing the extent of the problem and other contributing factors; 3) stating objectives and measures of success; 4) gaining agency and landowner cooperation; 5) allowing public input; 6) defining the control area, including buffer zones; 7) defining time frames for control; 8) using integrated, diverse methods, as appropriate; 9) obeying related laws and regulations; and 10) monitoring and documenting results. Implementing predator management programs may be costly and require several years to achieve objectives; however, the use of volunteers may help to reduce costs. Publication of results may help to improve future programs.

Predator management, or the reduction of any overabundant wildlife species, is controversial even among professional biologists (Goodrich and Buskirk 1995, Robinson et al. 1993). The reintroduction of endangered species often has met with resistance because of costs and/or conflicts with other resources or land uses. Wildlife managers must take into consideration many, often conflicting, laws, policies and resource demands.

Case Histories

Multiple Predator Species Management in California

Along coastal California, numerous avian species are threatened or endangered by loss of habitat and coastal development, including the California least tern, light-footed clapper rail and western snowy plover (*Charadrius alexandrinus*). Predation on eggs, chicks and fledglings has been identified as a factor limiting the recovery of these species. In the early 1980s, biologists and nest monitors documented predation and attempted, with fencing and occasional shooting, to exclude and remove predators. When these early efforts met with limited success, the USDA Animal Damage Control (ADC) Program was consulted, then contracted, to provide predator management. By direction of the USFWS, mitigation funding from a number of sources was used to establish predator management programs. In southern California, ADC has active programs at 19 of 29 least tern nesting sites (Caffrey 1994) and 7 of 10 marshes where light-footed clapper rails occur (Zembal 1991).

The efforts have been directed at numerous species of avian and mammalian predators, including crow, raven, kestrel (*Falco sparverius*), burrowing owl (*Athene cunicularia*), barn owl (*Tyto alba*), great horned owl, loggerhead shrike (*Lanius ludovicianus*), northern harrier (*Circus cyaneus*), peregrine falcon (*Falco peregrinus*), red-tailed hawk (*Buteo jamaicensis*), bobcat (Felis *rufus*), feral cat, California ground squirrel (*Spermophilus beecheyi*), coyote, feral dog, gray fox (*Urocyon cinereoargenteus*), red fox, long-tailed weasel (*Mustela frenata*), striped skunk, raccoon and opossum (*Didelphis virginiana*). All of these species are known to prey on the California least tern and western snowy plover, whereas the coyote and red fox are primary predators of the light-footed clapper rail.

Because of this large array of predators, a strategy was developed with a goal of maintaining each nesting colony free of predators (Butchko and Small 1992). This strategy involved timing of control efforts, use of diverse methods, and communication between nest monitors and ADC personnel to assure that predation was curtailed. The principal equipment used to remove mammalian predators was cage, leghold and Conibear traps, and gas cartridges. These were used at all sites prior to the arrival of the protected species and throughout the nesting period (April 1 to August 15). In some cases, shooting was used when other methods failed. Equipment used to trap and relocate avian predators included bal-chatri, channing and pole traps. An avian toxicant, DRC-1339, was used in some cases, under a state permit, to control crows and ravens.

The results of these programs have been positive, with increased fledgling production rates documented in several cases. At Batiquitos Lagoon, predator management was begun in April, 1994. Predators identified were kestrels, owls, ravens, raccoons and long-tailed weasels. The 68 fledglings produced in 1994 represented a 100-percent increase over the previous year.

At Camp Pendleton, about 550 California least tern eggs were laid and only 56 chicks were fledged in 1987. In 1993, after six years of predator management, 522 fledglings were produced from 604 eggs—a 900-percent increase. The predators included kestrels, owls, northern harriers, coyotes, striped skunks and ground squirrels.

At the Seal Beach Naval Weapons Station and National Wildlife Refuge, the light-footed clapper rail population increased from 5 to 28 pairs from 1986 to 1991. In 1986, a predator management program was begun, directed at removal of the non-native red fox. Numbers of foxes trapped and removed increased from 60 per year (1986 and 1987) to a high of 128 (1988), then declined to 22 (1989). The reduction in foxes taken and the increase in the rail population illustrates the importance of proper identification and persistent control of the primary predator species.

At San Elijo Lagoon, where no ADC predator management program exists, production of California least terns is poor and declining. In 1992, 35 nests produced only two fledglings. In 1993 and 1994, 9 and 12 nests, respectively, produced no fledglings. The limited production in 1992 and zero production in 1993 and 1994 were attributed to predation from ravens, kestrels, coyotes and raccoons (Caffrey 1992, 1993, 1994).

After numerous years of protecting these endangered species, it appears that effective programs will have several key elements. They require adequate numbers of qualified personnel; a persistent effort, often seven days per week from sunup to sundown; and preventive control, rather than reactive control. Finally, they require that proper and diverse methods of control be available to remove specific predators once identifed (Butchko and Small 1992).

Brown Tree Snake Management in Guam

The need to control the introduced brown tree snake on Guam is highlighted by the disappearance of 9 of 11 forest bird species from the island, continued declines of both remaining species of forest birds, cessation of breeding by seabirds formerly present and significant reductions in the abundance of introduced birds (Engbring and Fritts 1988). Selection of the methods and strategies to employ in control of snakes on Guam required determination of predator population levels (Rodda et. al 1992a), assessment of sampling and control techniques (Rodda and Fritts 1992), and, ultimately, evaluation of control efforts at scales relevant to preservation of endangered species and other native vertebrate fauna (Rodda et al. 1992b).

Programs to control snake populations are not well-developed anywhere in the world. Much original research is needed to develop the control techniques taken for granted for other vertebrate groups. Important factors include the high densities of this snake (15-50 per ha), its secretive and cryptic nature, the extremely low numbers remaining of some bird species, and the movement and dispersal abilities of both birds and the snake.

High snake densities require the control or removal of large numbers of individuals to achieve measurable benefits. For example, the Mariana crow (*Corvus kubaryi*) has persisted in low numbers even after the disappearance of smaller native birds, perhaps due to special behaviors and a larger egg and body size. The discovery of a snake approximately 785 millimeters in snout-to-vent length in the process of swallowing an egg from a Mariana crow nest in March 1993 suggests that at least 76 percent of all male and 65 percent of all female snakes were of sufficient size to prey on crow eggs. Assuming a 1:1 sex ratio in a snake population of about 35 to 50 per hectare, about 25 to 36 snakes per hectare are capable of preying on crow eggs, threatening the reproduction of the species. With hand-capture rates of one to two snakes per hectare for experienced snake biologists in forest situations (Rodda and Fritts 1992) and the limitations of hand capture in high forest, other methods clearly were needed (Rodda et al. 1992c).

Control efforts relying on hand capture of snakes or capture by trapping are limited in scale and difficult to apply to areas large enough to accommodate mobile prey. Trapping experiments in 1 to 1.4 hectare experimental plots revealed that 5 to 7 percent of the snake population moved in or out of a plot per night (Rodda et al. 1992b). Thus, it is probable that large numbers of snakes will move into control sites over a period of weeks or months, and trapping efforts necessarily would be nearly continuous and extend over long time periods. The numbers of snakes that must be removed to achieve adequate protection of endangered species will be much larger than the the snake density at a point in time (e.g., 15-50 per ha). For example, 584 individual snakes were recorded in a 4-hectare plot over a 36-month interval, while the density of snakes never exceeded 60 per hectare at any point in time (E. Campbell unpublished data).

Preliminary work on snake trap efficacy suggests that the nature of the bait and trap spacing are both important. At least 30 to 40 traps per hectare are needed to assure adequate trapping rates (e.g., 6-26 percent of the population per night). Thus, a 1-square kilometer area would require 3,000 to 4,000 traps to achieve adequate control and offset re-entry and reproduction by snakes. Placing, checking, rebaiting and maintaining access to this many traps would require considerable funds and personnel, even in the relatively small area of Guam.

Snake removal and exclusion from selected control areas could produce snake-free islands of habitat where endangered species could survive and reproduce without the continual need to capture large numbers of snakes for long periods of time (Rodda et al. 1992b). In two 1-hectare plots bounded by snake barriers, snake densities were lowered essentially to zero. Once snakes were removed, an effectively snake-free environment was maintained. In two 1-hectare, unfenced plots, snakes remained abundant, plots were constantly invaded by additional snakes and snake predation rates remained high (E. Campbell unpublished data).

The necessity of combining snake exclosures with other control measures was illustrated by a trapping effort on Orote Peninsula, Guam, in 1991. About 37 snakes per hectare were present and a 26-percent chance existed of capturing any snake present each night (i.e., 26-percent snake capture success). With no snake movements, a decline of the snake population to zero would be expected after about 14 to 15 days of capture and removal effort. In practice, snake captures at the site did not decline appreciably. Remarkably, 151 snakes were removed from a 1.4-hectare plot predicted to have a population of about 52 snakes. Capture success did not even decline significantly during the last days of the study. Had the plot been isolated by barriers or major habitat features, the number of captures necessary to achieve control would have been much less.

Clearly, a variety of tools and strategies are needed to protect endangered birds adequately from brown tree snakes. Hand capture, traps, barriers and yet-to-be-developed methods (such as toxicants and repellents, modification of prey bases and habitats supporting snake populations, and biological controls) must be considered together to achieve efficient and effective control of this voracious predator.

Gull Management in New York

The piping plover is listed as a threatened species on the U.S. Atlantic Coast and as an endangered species in the State of New York, with about 1,150 nesting pairs on the U.S. Atlantic Coast in 1995. At the Breezy Point Unit of the National Park Service's (NPS) Gateway National Recreation Area in New York, herring (*Larus argentatus*) and great black-backed gulls (*L. marinus*) may affect piping plover nesting by disrupting courtship, territory establishment, chick feeding activities, and by direct predation on adult plovers and chicks (USDA 1993). In a Biological Opinion issued in 1989, USFWS identified the control of gull nesting in plover nesting areas as one of several recommended procedures for the recovery of piping plovers. Also in 1989, the NPS completed an Environmental Assessment that concurred with the USFWS finding. Beginning in 1993, ADC and NPS have conducted a cooperative gull management program at Breezy Point to reduce gull impacts (USDA 1993).

Two-phase gull management programs have been conducted at Breezy Point each spring and summer, from 1993 through 1995. Intensive harassment of gulls during the period of nest establishment (March-April) is directed at deterring gulls away from the site to reduce nesting and, ultimately, cause the site to be abandoned as a gull nesting colony. Eliminating gull reproduction through physical destruction of nests and eggs (June-July) is directed at reducing gull numbers on the site throughout the summer and, eventually, eliminating the site as a gull nesting colony. During both phases of the gull management program, ADC and NPS personnel coordinated all work activities to reduce or eliminate potential negative impacts of gull management activities on piping plovers, terns and other wildlife species of special concern.

Gull harassment activities were conducted by ADC and NPS biologists from about mid-March through mid-May during all daylight hours. Pyrotechnics and distress calls were used to deter gulls from landing on the site. A total of 27,832 rounds of pyrotechnics (screamers, bangers, 12-gauge cracker shells) were expended during the three field seasons.

Gull nest and egg treatment activities were conducted by ADC and NPS biologists from early May through mid-July. In 1993, gull eggs were punctured and physically destroyed. In 1994 and 1995, puncturing was not used because it was more time consuming and did not reduce the amount of time gulls spent loafing on beaches near plovers (relative to physical destruction). A total of 4,243 eggs (4,112 herring gull eggs and 131 great black-backed gull eggs) were destroyed.

It is difficult to determine the effectiveness of the gull management program. After three years of harassment and egg/nest treatment, the Breezy Point gull colony continues to exist. Piping plover productivity (number of fledged chicks per adult pair) has declined dramatically since the early 1990s, although the number of pairs (15-18) has remained relatively constant. Plover nest distribution has changed, with more plover nests occurring farther from the gull colony site, but closer to areas of high human use. Impacts from gulls are only one type of factor affecting piping plover success on Breezy Point. Because the degree to which gulls impact plovers and the effectiveness of gull control on improving plover productivity are unknown, NPS is initiating a research project to quantify the impact of gull predation on nesting plovers. If it is determined by NPS and USFWS that gulls are having unacceptable effects on plovers and that elimination of the gull colony is desirable, ADC would recommend that the gull colony be reduced or eliminated with the toxicant DRC-1339.

Conclusions

Comprehensive and expensive efforts usually are needed to assist recovery of endangered avian species, but often are accompanied by substantial controversy. Predators are important components of ecosystems, and control programs justifiably receive careful scrutiny by the public, concerned parties, tribes and agencies. Each predator control effort must include a careful consideration of legal mandates and regulations, the situation and species involved, the various parties with vested interests, the resources available, and the likelihood and economic cost of success. Only substantial efforts to protect or restore habitats and predator management, where appropriate, likely will stem the listing and extinction rates for avian species in North America and worldwide.

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