Evolving Bird Management Research at the USDA Wildlife Service's National Wildlife Research Center

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ABSTRACT As the methods-development arm of the U.S. Department of Agriculture's Wildlife Services program, the National Wildlife Research Center (NWRC) is charged with developing tools and information for protecting agriculture, human health and safety, and property from problems caused by wildlife, including birds. Increasingly the NWRC is being asked to provide basic ecological information on the population status of various bird species, and its role is expanding from a reactive one of providing management options to that of predicting long-term implications of various management actions. This paper describes several areas of research by NWRC scientists to address population-level questions in support of WS mission.

KEY WORDS bird research, methods development, National Wildlife Research Center, Wildlife Services

The National Wildlife Research Center (NWRC, Center) is the methods-development arm of the U.S. Department of Agriculture's Wildlife Services (WS) program. The NWRC is dedicated to developing tools and information to resolve conflicts between humans and wildlife. Scientists at the NWRC work on a broad variety of problems involving protecting agriculture, human health and safety, property, and the quality of the environment. NWRC scientists have a broad range of expertise, including wildlife biology, animal behavior, population modeling, natural resource economics, wildlife damage management, physiology, pharmacology, epidemiology, virology, toxicology, immunology, reproductive physiology, chemical and drug registration, wildlife DNA forensics, chemistry, and formulation chemistry.

NWRC scientists conducted research on a broad range of bird species and problems since the 1930s, when the Bureau of Biological Survey (BBS) established a Division of Food Habits in Denver, Colorado. In 1939 the BBS was reorganized into the newly formed Denver Wildlife Research Center when the BBS was transferred to the newly created U.S. Fish and Wildlife Service (USFWS). During the 1940s, BBS bird research focused on determining the food habits and impacts of major agricultural bird pests, primarily blackbirds and crows. During the 1950s, 1960s, and 1970s, a great deal of effort was directed at identifying and developing avicides and repellents such as Avitrol (Guarino and Schafer 1967, Dolbeer 1981), PA-14 (Heisterberg et al. 1987), DRC-1339 (DeCino et al. 1966, Schafer et al. 1977), and Mesurol (Guarino 1972, Crase and DeHaven 1976) to protect sprouting crops, grains (rice, corn, and sunflower) and fruits (grapes, cherries, and blueberries), and to reduce large roosting congregations of blackbirds, particularly in the southern U.S. (Otis 1987, Stickley et al. 1987, Glahn et al. 1991). Since the 1980s NWRC scientists have continued to evaluate nonlethal repellents and harassment and dispersal techniques (Tobin 2002). This research has contributed to: 1) the registration of methyl anthranilate for protecting turfgrass and ripening fruit and reducing use of standing bodies of water (Cummings et al. 1991, Dolbeer et al. 1992, Avery et al. 1996); 2) the registrations of Nicarbazin as a reproductive inhibitor for Canada geese (*Branta canadensis*, Bynum et al. 2005) and for feral pigeons (*Columba livia*, Avery et al. 2008a); 3) development of DiazaCon as a reproductive inhibitor for monk parakeets (*Myiopsitta monachus*, Yoder et al. 2007, Avery et al. 2008c); 4) the implementation of cattail management programs for reducing blackbird (*Agelaius phoeniceus*, *Quiscalus* spp.) roosting habitat around sunflower fields (Linz et al. 1995); 5) the development of decoy crops for reducing blackbird damage to sunflower (Cummings et al. 1987, Hagy et al. 2008); 6) the evaluation of lasers for dispersing various species of birds (Glahn et al. 2000a, Blackwell et al. 2002a); 7) the registration of Flight Control as a foraging repellent against geese (Dolbeer et al. 1998, Blackwell et al. 1999) and sandhill cranes (*Grus canadensis*, Blackwell et al. 2001); 8) the development and implementation of harassment techniques for dispersing roosts of cormorants (*Phalacrocorax auritus*), vultures (black—*Coragyps atratus*, turkey—*Cathartes aura*) and crows (*Corvus spp.)*, Mott et al. 1992, Glahn et al. 2000b, Avery et al. 2002, Tillman et al. 2002, Tobin et al. 2002, Seamans 2004, Avery et al. 2008b); and 9) advances in using lighting to enhance avian avoidance response to approaching aircraft (Blackwell and Bernhardt 2004, Blackwell et al. 2009).

Increasingly the NWRC is being asked to provide basic ecological information on the population status of various bird species in support of the WS mission to protect American agriculture, property, and human health and safety from the negative impacts of wildlife (Bruggers et al. 2001, Clark et al. 2006). Understanding the population status and dynamics of problem species is essential to projecting how populations respond to proposed management actions and for providing a scientific foundation for management actions (Dolbeer 1998, Blackwell et al. 2004). Although NWRC traditionally has been focused on assessing impacts and developing control methods, the National Environmental Policy Act (NEPA) requires that all Federal agencies, including WS, document the impact of their activities on the quality of the environment. NWRC research provides critical information in support of WS NEPA documents. The USFWS, under the authority of the Migratory Bird Treaty Act (MBTA), must make similar evaluations when issuing bird take permits, including depredation permits issued to WS. However, given resource limitations and other priorities, the USFWS frequently is not able to collect data that are necessary to evaluate various management options for species typically of concern to WS and its stakeholders. NWRC's role increasingly is expanding from a reactive one of providing management options to that of predicting long-term implications of various management actions. My objective is to describe several areas of research to address population-level questions in support of WS missions to manage human-bird conflicts.

BLACK VULTURES

Black vulture populations have increased 20-fold and expanded their range northward during the past several decades. Concomitantly, conflicts with livestock producers, homeowners, and other concerned citizens, as well as requests to WS for assistance, have also increased (Lowney 1999, Avery 2004). WS Operations biologists employ various nonlethal hazing approaches for mitigating vulture conflicts, including noise-makers, lasers, and effigies to disperse troublesome roosts (Tillman et al. 2002, Avery et al. 2006). Sometimes it is necessary to lethally remove some birds to reinforce nonlethal harassment methods and to reduce local troublesome populations. However, a lack of reliable information on the status of regional populations at times has been an impediment to obtaining the necessary regulatory approval for obtaining depredation permits.

The two main sources of information about the continental status of vultures in North America are the Christmas Bird Count (CBC, http://www.audubon.org/Bird/cbc/) and the Breeding Bird Survey (BBS, http://www.pwrc.usgs.gov/BBS/). In both the BBS and the CBC, increases in observation frequencies are associated with increasing populations. However, it is not possible to count all birds of a species, and both CBC and BBS are fraught with shortcomings that limit their utility for estimating populations or evaluating take requests. The CBC is sponsored by the National Audubon Society and is the oldest and largest wildlife survey in the world. It is conducted annually in December when more than 40,000 volunteers record all birds encountered within circular count areas throughout the U.S. Participants vary widely in their birding ability, circles are not randomly located across North America, and counts are not adjusted for habitat type. The BBS is a cooperative effort between the U.S. Geological Survey (USGS) and the Canadian Wildlife Service to monitor the status and trends of North American bird populations. Data are collected by volunteers along thousands of randomly established roadside routes throughout the continent. Like the CBC, the BBS has several shortcomings that preclude extrapolating numbers of birds observed to bird densities or abundances over large geographic areas. It likely over-counts birds that can be seen or heard from roads, it is biased towards birds that are active within 4 hours of sunrise, and it does not account for habitat type.

To better understand the factors contributing to the population growth of black vultures, scientists from the NWRC field stations in Ohio and Florida used demographic data from a 14-year study in North Carolina to construct a deterministic 5-stage population model (Blackwell et al. 2007). The annual growth rate indicated by this model was consistent with the growth rate of the post-DDT era BBS population trend for black vultures. Blackwell et al. (2007) found that the proportional contribution of adult survival to population growth rate far exceeded the contribution of fertility, and they suggested that the rapid growth rate of the black vulture population of North Carolina is due primarily to high rates of adult survival and to a lesser extent, fertility, and possibly to birds breeding at an age younger than previously assumed. They encouraged agencies seeking to understand and project population trends to use their model.

In another study, scientists from the NWRC Florida and Ohio field stations collaborated with biologists from the USFWS and the USGS Patuxent Wildlife Research Center to establish a defensible framework for estimating allowable take of black vultures (Runge et al. 2009). This framework is based on harvest theory and a method known as Potential Biological Removal (PBR) that was developed to assess the take of mammals under the Marine Mammals Protection Act. The PBR relies not on knowing the population level of a species, but rather on estimating the minimal population level and the growth rate of the population. The PBR essentially estimates how much of the annual growth of the population can be removed without endangering the future viability of the population. The PBR incorporates a mechanism for formally including policy considerations in the decision-making process that allow for the level of risk that can be tolerated and whether the goal is to maintain the population at its current level, to allow for further growth, or to reduce the population.

DOUBLE-CRESTED CORMORANTS

The interior population of double-crested cormorants, once on the decline due to the use of pesticides and human persecution, has rebounded dramatically over the past several decades and today is perceived as a major pest by many aquaculturists, sport fishermen, and conservationists (Glahn and Stickley 1995, Tobin 1999, Glahn et al. 2000c, Dorr 2006). In 1998 the USFWS issued a standing depredation order that allows for the lethal take of cormorants to reduce predation on fish farms in 13 states. In 2005 this depredation order was expanded to allow for the take of birds in roosts near aquaculture farms, and a new depredation order was issued that allows the take of cormorants to protect natural resources. Under terms of these depredation orders, the USFWS is to evaluate the effectiveness and cumulative impact of take under the order (USFWS 2005a, b).

Scientists at the NWRC Mississippi field station have devoted much effort towards documenting the growth of cormorant populations in the Delta region of Mississippi and other parts of the South, and to learning more about the demography of this species (Glahn et al. 2000b, Glahn and King 2004). Since 1990 they have organized an annual count of all cormorants at all known roosts in the delta region of Mississippi (Glahn and Stickley 1995, Dorr 2006). These data have been instrumental in supporting the decision by the USFWS to issue permits that allow aquaculture farmers to shoot cormorants that are causing or about to cause damage on their fish ponds. Since 2006 staff at the NWRC Mississippi field station, with partial support from the USFWS and in collaboration with WS operations in Alabama, Arkansas, and Mississippi, also have monitored the growth of southern cormorant breeding colonies. NWRC scientists have also analyzed cormorant banding (Dolbeer 1991, King et al. 2010) and radio-telemetry (King et al. in press) data to learn more about population trends and migratory movements of this species.

In an attempt to better estimate and monitor abundance of cormorants on aquaculture farms, scientists from the NWRC Mississippi field station (Dorr et al. 2008) evaluated aerial surveys in a stratified cluster sampling design. Their findings pointed to the need for increased sampling effort to obtain desired levels of precision, and they recommended additional evaluation of both their method and related survey methods to develop and evaluate depredation management efforts. Evaluation of management effectiveness with respect to reducing damage ultimately is dependent on accurate measurement of cormorant use of catfish aquaculture.

Researchers from the NWRC field station in Sandusky, Ohio, with colleagues from the USGS and Canadian Wildlife Service, constructed a deterministic stage-classified matrix population model to gain insight into the relative contribution of various population parameters to understand the dynamics of double-crested cormorant populations on Lake Ontario (Blackwell et al. 2002b). They found that cormorant population growth was most sensitive to survival of birds about to turn age 3 and older, and demonstrated that survival of older birds exerts more control on populations than changes in fertility.

Researchers with the NWRC Mississippi field station, in a collaborative effort with Mississippi State University, the Canadian Wildlife Service, the Ontario Ministry of Natural Resources, the USFWS, and Ontario Parks, compared reproductive parameters of three geographically distinct cormorant breeding areas across southern Ontario to provide data necessary to evaluate approved management actions (Chastant 2008). Chastant (2008) banded about 9,000 pre-fledged cormorants, conducted intensive observations to determine survival and return rates, and collected data on age-specific breeding and survival. Chastant (2008) used the observed cormorant breeding colony demographics to model cormorant populations and the effects of population manipulation on population growth rates. Results indicated that a combination of adult culling and egg-oiling have the greatest potential for reducing population growth.

A researcher at the NWRC Mississippi field station is collaborating with a professor at Mississippi State University and a post-doctoral fellow to model the cumulative effects of management on the spatial patterns and population dynamics of cormorants in the interior of North America (B.S. Dorr, U.S. Department of Agriculture, National Wildlife Research Center, personal communication). They are using a Bayesian hierarchical model to evaluate the cumulative effects of locally driven control efforts. They hope to determine demographic mechanisms of control methods using elasticity analyses and simulate the effects of different controls in a spatial context. The use of hierarchical methods allows for determination of the effects of management at scales ranging from specific colonies, meta-populations, and the entire interior population of cormorants.

PENTOSIDINE

Very little is known about the demographics of many bird species of concern to WS, especially long-lived species like double-crested cormorants, black vultures, and turkey vultures. Understanding the age structure of populations of these species would facilitate the construction of age-based population models that can be used to predict future population growth trends and to determine the effectiveness and impact of various management schemes. Researchers with the NWRC Mississippi and Florida field stations are collaborating with colleagues at West Virginia University to determine the utility of pentosidine as a biological marker for determining the age of double-crested cormorants, monk parakeets, and black vultures (Fallon et al. 2006, Cooey 2008). Populations of these species have increased dramatically over the last couple of decades, but we have very little information about basic life history parameters such as average life span, age structure, and age at first breeding. Pentosidine is a metabolism byproduct that accumulates in the tissues of animals and is thought to increase proportionally with age (Fallon et al. 2006, Cooey 2008). The rate of accumulation varies among species, necessitating species- or species group-specific models. Center investigators are collecting known-age skin samples of cormorants, monk parakeets, and black vultures to determine the utility of pentosidine as a chronological age estimate in these birds.

DRC-1339 TAKE

DRC-1339 is the most widely used avicide available in the U.S. for controlling certain species of depredating birds. This product, available for use only by WS personnel, is registered for use with blackbirds, European starlings (*Sturnus vulgaris*), crows, feral pigeons, various species of gulls (*Larus* spp.), and selected other species. Under provisions and requirements of NEPA, the Government Performance and Results Act, and the WS Management Information Service, WS biologists must estimate take when they use DRC-1339.

DRC-1339 is a slow-acting toxicant, and birds usually take 1–2 days before succumbing to death. In the meantime, they often leave the baiting site and are difficult to recover for the purpose of estimating mortality. Pre- and post-application bird counts are not reliable for estimating mortality, because of the natural unpredictability and variability of bird populations.

Several biologists from NWRC headquarters in Fort Collins, Colorado collaborated on an empirically derived probabilistic model to estimate the take of target blackbirds from DRC-1339 staging area baiting operations in Louisiana, Missouri, and Texas. Almost 3,000 red-winged blackbirds, brown-headed cowbirds (*Molothrus ater*), and grackles (*Quiscalus quiscula*) were collected as they departed from baiting sites to determine the number of rice grains eaten by each bird, and a distribution of consumption was calculated for each species (R.M. Engeman, U.S. Department of Agriculture, National Wildlife Research Center, personal communication). Based on these consumption distributions, together with species-specific toxicity data, the relative abundance of various species at the bait site, the dilution of the DRC-1339 bait, and the total amount of bait eaten, the model estimates the number of birds of each species taken. Use of this model is restricted to the times of year (spring) and locations (Louisiana, Missouri, and Texas) from which the data were collected.

Researchers from NWRC headquarters in Fort Collins, Colorado and its field station in Bismarck, North Dakota used a combined bioenergetic/toxicological approach to estimate mortality of European starlings baited with DRC-1339 at feedlots and dairies (Homan et al. 2005). Their model also is based on the amount of toxic bait consumed, but it estimates number of birds taken based on the bioenergetic needs rather than empirical estimates. The Homan et al. (2005) model analyzes heat and radiative energy exchanges between the starling body surface and the surrounding environment to estimate daily caloric demand based on a steady-state energy balance, and estimates consumption by using probability distributions to simulate variability in dietary intake at the bait site. Mortality is estimated through a dose-response probit analysis (Johnston et al. 2005).

IMPACT OF BLACKBIRD PREDATION ON SUNFLOWER PRODUCTION

Researchers at the NWRC North Dakota field station used a bioenergetic approach to assess the economic impact of blackbird depredations on sunflower production (Peer et al. 2001). They used values generated from the models to perform a cost-benefit analysis to determine the efficacy of a proposed avicide baiting program. The model included metabolic rates, caloric value and moisture content of sunflower achenes, and percentage of sunflower in the diets of males and females of each of three species of birds. Peer et al. (2001) concluded that the population of all three species combined impacted sunflower production (@$0.26/kg) by $5.2 million annually. Sunflower prices have doubled since 2001, driving blackbird damage over $10 million. Biologists from the NWRC Ohio and North Dakota field stations developed a population and economic model to evaluate whether a proposed spring DRC-1339 baiting program, in combination with habitat management, would be cost-effective in decreasing blackbird depredations of sunflower crops during late summer (Blackwell et al. 2003). They concluded that the realized benefits to sunflower growers likely would be negligible.

DISCUSSION

Migratory birds are a highly valued, publicly owned resource, but many species increasingly present a threat to human health and safety or otherwise conflict with human interests. NWRC scientists strive to develop methods that are not only cost-effective, but also ecologically responsible and socially defensible. The paucity of reliable information about the population status and demography of many species of birds that are of concern to WS can be an impediment to obtaining approval to take remedial action, complying with laws and regulations that require wildlife managers to demonstrate the efficacy and safety of their control programs, and developing biologically sound and sustainable management strategies. Thus, NWRC research to resolve human-avian conflicts increasingly includes studies to address population-level questions to ensure that regulatory decisions are based on good science, and that adequate tools are available for managing problems caused by birds.

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