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INTRODUCTION

National Wildlife Research Center—Mission and Location

The mission of the U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service's (APHIS) Wildlife Services (WS) program is to provide Federal leadership in managing problems caused by wildlife. The National Wildlife Research Center (NWRC) functions as the research arm of WS by providing scientific information on the development of socially acceptable methods for wildlife damage management. As part of WS' strategic plan to improve the coexistence of people and wildlife, it has identified four goals: (1) developing methods, (2) providing wildlife services, (3) valuing and investing in people, and (4) enhancing information and communication. WS is dedicated to helping meet the wildlife damage-management needs of the United States by building on the Center's strengths in these four key areas. This report documents the highlights of NWRC-funded research in fiscal year (FY) 2001 and is structured around these program goals.

The headquarters of the NWRC is located on the 43-acre Foothills Research Campus of Colorado State University (CSU) in Fort Collins, CO. During 2001, NWRC made significant progress toward building out its Master Plan on that site. Construction was initiated on an outdoor animal research complex and associated research support structures. APHIS also completed the bidding process for construction of an office, lab, and a food storage/preparation addition to the Center's existing indoor animal research facility. Planning was initiated on additional facilities in which to conduct invasive species and wildlife disease research. Upon completion of the Center's master plan over the next several years, NWRC and its U.S. regionally based field stations will truly be the only wildlife research complex of its kind in the world devoted exclusively to providing new, science-based solutions to the complex issues of wildlife damage and associated human health and safety problems.

Survey of Research Needs of the WS Program

NWRC is committed to conducting research that addresses the needs of the WS program and its cooperators and stakeholders. As a result, in 1989 and 1996 APHIS' WS surveyed all WS State Directors to assess the national research needs of the WS program. Each survey resulted in a list of research needs, and management determined their relative priorities to the WS program. These 1989 and 1996 surveys, along with congressional directives and input from the WS Deputy Administrator, have guided NWRC's allocation of resources to specific research projects that address the WS program's priority research needs.

In Spring 2001, the WS management team requested that WS research needs and their relative priorities be updated. The objective was to determine the spectrum of wildlife damage problems faced by the WS program and its customers that needed to be better addressed through additional scientific

information, new damage-management methods, or improvement in existing methods. The NWRC Assistant Director led a team consisting of an Assistant Director from both WS Western and Eastern Regional Offices to assess WS program needs.

In April 2001, the WS Deputy Administrator asked WS State Directors and NWRC scientists to identify their three most important research needs. Members of the National Wildlife Service Advisory Committee to the Secretary of Agriculture (NWSAC) also were asked for their input. By July, the NWRC Director had received a list of 103 different research needs. To obtain a shorter list that reflected relative priorities of the program, each team member, with input from his/her respective office, identified the top three to five research needs within the areas of bird and mammal research. Prioritization criteria considered (1) the rank order of needs as submitted by the WS State Directors; (2) the extent of research effort over past years versus the need for future information, techniques, and solutions; (3) the availability of exiting information and techniques that may simply need refinement versus the need for new techniques; (4) the value and magnitude of the resources affected; (5) the WS national, regional, or State importance; and (6) the actual perceived importance to customers.

Table 1 lists the priority research needs (in no particular order) in the areas of bird and mammal research. Priority needs of bird

research relate to understanding and finding solutions to resolve bird problems to/in crops (e.g., blackbirds), aquaculture (e.g., cormorants), airports, urban–suburban situations (e.g., crows, geese, gulls), and livestock (e.g., vultures). Priority needs of mammal-related research relate to understanding and finding solutions to resolve mammal damage to timber (e.g., ungulates), riverine habitats (e.g., beaver), agriculture (e.g., rodents), and livestock and native wildlife (e.g., predators). In addition, WS determined that research was needed on wildlife disease transmission relative to human health and safety and livestock production, and wildlife population monitoring relative to economic issues, management effectiveness, and environmental mandates.

The bird and mammal research needs identified in table 1 are considered to be the highest priority needs of the WS program and also reflect the needs of many of WS customers. These priority research needs, in addition to congressional and other directives, guide the NWRC Director in implementing new research projects as current projects are completed, specific objectives within current projects are achieved, and additional resources become available.

TABLE 1—HIGHEST PRIORITY RESEARCH ISSUES DETERMINED FROM 103 SPECIFIC IDENTIFIED NEEDS IN THE 2001 RESEARCH NEEDS ASSESSMENT CONDUCTED BY THE APHIS WS PROGRAM

BIRDS

Improve existing and investigate new methods to protect agricultural crops (e.g., sunflower, sprouting and ripening rice) from blackbird damage.
More specifically, needs were identified related to developing nonlethal techniques (e.g., repellants, frightening devices, barriers, habitat management, and reproductive inhibitors); improving lethal chemical tools (e.g., improve baiting strategy and enhance acceptability of DRC–1339—Starlicide®); and developing methods to estimate mortality or "take" of blackbirds during operational use of these tools for blackbird damage control in sunflowers and rice.

Conduct research on the impacts of fish-eating birds (primarily double-crested cormorants and American white pelicans) to the aquaculture and sport fish industries.
More specifically, needs were identified related to understanding cormorant depredation and impacts to sport fisheries (e.g., crappie, bass, and walleye), the crawfish industry, and other natural resources (e.g., roosting vegetation) and American white pelican impacts on sport fisheries and their local movement patterns in commercial aquaculture areas relative to both damage and transmission of catfish diseases. Additional needs were identified relating to developing new, nonlethal methods (e.g., repellants, behavior-contingent disruptive stimuli) to reduce these species' adverse impacts on commercial and sport fishery production.

Investigate hazards, solutions, and strategies to resolve bird and other wildlife problems at airports.
More specifically, needs were identified related to continuing investigations of nonlethal methods (specifically habitat management techniques) and initiating new investigations of nontraditional ecosystems, such as desert environments, as they relate to wildlife–aviation strike hazards.

Investigate the roosting preference, behavior, and dispersal techniques for crows and ravens in urban or suburban environments.

Investigate and develop new and improve existing tools and strategies to resolve the impacts of geese, gulls, and terns in a variety of urban or suburban situations.
More specifically, needs were identified related to developing efficient, longlasting damage-management techniques (e.g., barriers, harassment and hazing methods, contraceptives, Avitrol™, egg removal, and repellants), and addressing issues related to geese and human health and safety (e.g., potential disease transmission), gulls and urban property damage (e.g., using rooftops and landfills), and terns and natural resource impacts (e.g., predating salmon smolt).

Conduct research into understanding the problems and developing methods (e.g., harassment, taste repellants, toxicants) to reduce the negative impact of black vultures and turkey vultures on livestock production and property (e.g., homes, watercraft, and communication towers).

MAMMALS

Develop methods to protect timber and forest resources from wildlife damage.
More specifically, needs were identified related to evaluating existing and identifying new repellants and barriers, and assessing the economic implications of various mitigation methods and strategies.

Conduct research to understand and resolve the impact of beavers on aquatic ecosystems.
More specifically, needs were identified related to developing methods to census local beaver populations, describing and quantifying their economic impacts, and evaluating existing (e.g., repellants, barriers, lures, and toxicants) and alternative (e.g., relocation) management practices to reduce beaver damage to forest, agriculture, urban or suburban, and riverine environments.

Evaluate and develop tools and techniques for use in integrated pest management strategies for rodents in both agricultural and native habitat ecosystems.
More specifically, needs were identified related to evaluating ecologically sound and economically feasible methods (e.g., repellants, barriers, toxicants, odor and taste attractants, and microencapsulation methods) to reduce negative impacts of prairie dogs, rats, pocket gophers, and ground squirrels.

Conduct behavioral and techniques-development research for canids as related to developing effective predation damage-management programs for livestock in agricultural situations and for protecting human health and safety in urban or suburban situations.
More specifically, needs were identified related to improving existing and developing new alternative tools, using state-of-the-art technologies (e.g., improved capture devices such as snares and lives traps, reproductive inhibition techniques, vaccines and associated delivery systems, as well as selective attractants and repellants) for primarily coyotes, cougars, and bears in agricultural settings, and coyotes and fox in urban or suburban settings.

Examine the growing and expanding negative impact of predators (e.g., coyotes, foxes, wolves, and raccoons) on wildlife resources (e.g., deer and antelope), including, but not limited to, threatened and endangered species (e.g., sage grouse, turtles, terns, and rails).
More specifically, needs were identified related to evaluating existing and developing new, effective predation damage-management tools and strategies for use in these expanding, predator–wildlife conflict situations.

WILDLIFE DISEASES AND POPULATION MONITORING

Develop methods to survey and monitor emerging wildlife diseases and reduce the risks of the transmission of those that pose a threat to human health and safety and livestock production.
More specifically, needs were identified related to understanding the demography, movements, and behavior of raccoons and foxes as related to oral rabies vaccination programs, and deer and cattle as related to bovine tuberculosis transmission; and developing methods (e.g., barriers, reproductive inhibitors, and vaccines) to reduce the risk of disease transmission.

Develop methods to better monitor problem wildlife species populations as related to their economic impact, management effectiveness, and environmental mandates (e.g., National Environmental Protection Act [NEPA] requirements).
More specifically, needs were identified related to improving and/or developing practical methods to census overabundant wildlife populations, assess damage, determine "take," and quantify the effectiveness of management strategies (e.g., nonlethal *v.* lethal methods), with particular emphasis placed on those species most often addressed by the WS program (coyotes, blackbirds, and beavers).

DEVELOPING METHODS

Goal: Increase effective methods available for wildlife damage management.

BIRD RESEARCH PROGRAM

Title: Economic Impact and Management of Bird Predation at Aquaculture Facilities in the Southeastern United States

Goal: Determine the magnitude of and develop methodology to reduce damage by cormorants, wading birds, and pelicans on southern catfish, baitfish, and crawfish farms.

Double-Crested Cormorant Satellite Telemetry—During 2001, NWRC biologists continued studies using satellite radio transmitters to investigate the continental movements of double-crested cormorants in North America. One study involved monitoring the movements of 25 radio-transmitter-equipped cormorants that had been captured adjacent to catfish farms in Alabama, Arkansas, Louisiana, and Mississippi between 1999 and 2001. The results will permit determining the migratory behavior of these cormorants. A second satellite telemetry study also involving 25 satellite transmitters installed in each of the 2000 and 2001 breeding seasons at a cormorant colony on an island in Lake Ontario, NY, is enabling NWRC researchers to better understand the foraging distribution and subsequent migratory behavior of these breeding cormorants in the Northeast.

American White Pelican Disease Ecology—NWRC researchers, in collaboration with parasitologists at two State universities, have initiated a study to determine the species of trematode currently infecting commercially grown catfish in the mid-South, and to determine if fish-eating birds can serve as hosts for this parasite. Biologists at the NWRC Mississippi field station artificially infected four captive American white pelicans with larvae of candidate *Diplostomula* spp. trematodes that were isolated from infected catfish collected from commerical ponds. Adult specimens of this parasite were later found in three of the four pelicans, indicating that American white pelicans definitely have the potential to transmit this disease among catfish ponds.

Morphology of whole specimens, sections of the specimens, and molecular analyses of this DNA are being used to identify the trematode species. No other parasites were present in the test subjects. Additional study is planned to investigate the potential of double-crested cormorants and great blue herons to serve as hosts for these trematodes.

Abundance and Distribution of Cormorants on Mississippi Catfish Ponds—In April 2001, NWRC biologists successfully completed the field phase of a study to evaluate the distribution and abundance of double-crested cormorants on catfish aquaculture ponds in the delta region of Mississippi. Preliminary evidence from aerial surveys indicated that cormorants foraged daily on an average of more than 25 percent of the surveyed ponds between February and April 2001, after which the cormorants began migrating north. The average numbers of birds observed per pond ranged from 5 to 46, depending on the month of the survey.

NWRC researchers will use producer surveys, geographic information systems (GIS) technology, and satellite imagery to relate the distribution and abundance of cormorants to the type and condition of the ponds and the health status of fish in them. Results will help relate economic loss estimates to the type or stage of catfish production and will also provide a basis for estimating the greater economic losses of catfish to cormorants in the delta region of Mississippi and lead to management strategies to alleviate these impacts.

Catfish Consumption by American White Pelicans—A controlled foraging experiment was recently completed in 2001 that determined the number of catfish consumed by captive American white pelicans at the NWRC Mississippi field station. Daytime videography and nocturnal observations (via night vision equipment) revealed that pelicans actively forage during both day and night hours. One pelican consumed 20 catfish in 69 minutes and 47 catfish between 4 and 10 p.m. NWRC biologists will develop bioenergetic and economic predictions regarding the foraging ecology and impacts of pelicans associated with aquaculture facilities in the mid-South.

Nonlethal Techniques To Minimize Cormorant Impacts to Southern Aquaculture—Rapidly increasing populations of double-crested cormorants over the past two decades are a growing concern for aquaculture producers in the Southeastern United States. These birds often congregate at night in groups of several thousand or more and forage at nearby catfish farms during the day. To date, the most effective method for limiting cormorant damage to aquaculture has been to move cormorants away from roost sites near aquaculture facilities. Traditionally, biologists and farmers have used using nonlethal pyrotechnic noisemakers to disperse cormorants from their night roosts. However, there is increasing concern that such activity might disturb nontarget species, such as waterfowl. Researchers at NWRC's Mississippi field station evaluated the use of low-powered lasers for moving cormorants from roost sites near southern aquaculture farms. The low-powered lasers were found to be as effective as pyrotechnics in moving cormorants from their night roosts without harming the target birds or disturbing other, nontarget species. This research has added an additional tool to be used as part of an integrated effort for managing double-crested cormorant damage to aquaculture.

Title: Development of Methods To Manage Depredation and Nuisance Problems Caused by Vultures

Goal: Understand the relationships between various habitat and land-use variables and problems caused by vultures and develop effective management techniques for reducing predation losses and property damage.

Management Methods To Disperse Vulture Roosts on Communication Towers—Communication towers provide attractive roost sites for black and turkey vultures. This roosting behavior creates problems, however, for tower operators, nearby businesses, and owners of adjacent homes. To alleviate these problems, NWRC scientists evaluated the effectiveness of suspending vulture carcasses or taxidermic effigies from towers to disperse vulture roosts at six sites in northern Florida. At each site, vulture numbers decreased immediately after installation of the stimulus, and roosting at the study sites completely ceased within 10 days. The effect was independent of the composition of the roost and occurred regardless of which vulture species was used as the carcass or taxidermic effigy. At one site, the roost was even substantially reduced using a commercial plastic goose decoy painted to resemble a turkey vulture. At three sites, the deterrent effect persisted up to 5 months even after the carcass or effigy was removed from the tower. Hanging a vulture carcass, taxidermic effigy, or even an artificial decoy, from a tower creates an unfavorable roosting environment for vultures and offers a simple, effective means to manage problem roost situations.

Development and Evaluation of Management Techniques for Reducing Blackbird Damage to Ripening Sunflower Crops and Feedlots

Goal: Develop new and/or improved methods to reduce blackbird damage to ripening sunflower crops and feedlots.

Avian Use of Ripening Sunflower Fields in North Dakota—NWRC and university scientists conducted intensive nontarget bird surveys in 12 sunflower fields located in a few counties in North Dakota during August through October 2000. The objective was to document birds that could be negatively affected by applications of DRC–1339-treated rice, when used to reduce blackbird damage to sunflowers. The 12 test fields were visited 7 times, for a total of 84 field surveys. All birds were identified as to species, sex, and age, if possible. Thirty seed-eating nontarget birds (excluding the blackbird family) were observed in the sunflower fields, including 16 species of sparrows and 3 species of finches. Nontarget members of the blackbird family that were observed and are sensitive to DRC–1339 included one bobolink and two western meadowlarks.

Habitat Characteristics Around Fall Blackbird Roosts—Blackbirds in the northern Great Plains congregate in large flocks during the late summer and often roost overnight in cattail marshes and cause significant damage to nearby sunflower fields during the day. Wetland managers might be able to predict likely locations of blackbird roosts if they know their habitat characteristics. During 2000, NWRC biologists analyzed aerial photographs to quantify the habitat around 11 major (>10,000 blackbirds) and 9 minor (<10,000 blackbirds) roosts in the sunflower-growing region in North Dakota. The availability of various habitats around these major and minor roosts was similar, although the mean distance to the closest sunflower field was marginally greater for major roosts than minor roosts. Additional research is warranted to elucidate the possible relationship between roost location and sunflower fields.

Title: Management of Bird Damage to Rice

Goal: Develop new or improved management strategies for reducing bird damage to rice.

Blackbirds cause millions of dollars of damage to seeded and ripening grain crops each year in the United States. NWRC biologists evaluated Flight Control™, which contains the active ingredient anthraquinone and is registered with the Environmental Protection Agency (EPA) as a bird repellant for Canada geese on turf, for reducing blackbird depredations on newly planted rice seed and on ripening rice. Both the number of blackbirds using treated fields and the damage to newly planted rice seed were reduced in fields where the seed was treated with Fight Control at a 2-percent concentration just before planting. Counts of rice seedlings in treated and untreated exclosures suggested Flight Control was not phytotoxic to rice seed. To determine chemical residues at harvest, NWRC scientists initiated a 2-year study following the EPA Residue Chemistry Test Guidelines, which required evaluation of 12 field trials (6 each year) in the region where Flight Control will be used, i.e., Louisiana, Arkansas, Texas, and Missouri. Results from the first year's trial were very favorable. All 36 samples of rice collected at harvest from the 6 field trial sites and milled to the brown rice stage were below the minimum limit of detection of 0.05 p/m. These results will be part of a data package to obtain an Experimental Use Permit to test Flight Control as a rice seed treatment on a large scale in Louisiana.

Potential Repellant for Coot Damage to Sprouting Rice—American coots consume considerable amounts of sprouted rice seed from farmers' fields in Louisiana. One possible method of combating these losses is through the use of a seed treatment repellant, such as anthraquinone-based Flight Control. NWRC scientists conducted large pen tests at a university research station to evaluate the repellancy of Flight Control to coots. Four groups of three birds were placed in pens for 3 days. Each pen was constructed over planted rice and divided into a treated and untreated plot. Following the 3-day test, coots were removed and the remaining seeds allowed to germinate. While there was a trend for increased sprout density in the treated plots, the rice sprout counts revealed no statistical difference between treated plots and untreated plots. Although not conclusive, these results are encouraging and suggest that further evaluation is warranted.

Nontarget Bird Use of DRC–1339 Bait Sites—Blackbird damage to newly planted rice is an economically important problem for many producers in Louisiana, Texas, Arkansas, and Missouri. DRC–1339 avicide has been used on staging areas to reduce blackbird populations prior to rice planting. To evaluate potential impacts on nontarget birds, NWRC scientists monitored nontarget use of DRC–1339 bait sites on 35 sites in Louisiana and 8 sites in Texas during operational baiting programs. Savannah sparrows were the predominant nontarget bird observed on about 90 percent of the bait sites. Snow geese and white-fronted geese occurred in the greatest numbers but were observed only on a few sites. The remaining nontarget birds, meadow larks, mourning doves, and cardinals, were observed on only a few sites and in very low numbers. To determine the effects of DRC–1339 on these nontarget species, NWRC scientists initiated a laboratory feeding trial using 2-percent DRC–1339-treated brown rice diluted 1:25 with untreated brown rice. Trials on savannah sparrows and Canada geese showed no mortality after a 5-day exposure to the bait. Even if mortality should occur, the numbers of nontarget birds observed on these bait sites is sufficiently low to not have an adverse effect on overall populations. Further evaluations will be conducted in 2002 on the other species observed using bait sites.

Title: Defining and Reducing Wildlife Hazards to Aviation

Goal: Provide a scientific foundation for WS programs at airports throughout the USA to reduce wildlife hazards to the aviation industry.

Aircraft Collisions With Gulls Reduced 48–99 Percent at a New York Airport, 1991–2000—In 2000, the WS program successfully completed its 10th year of assistance to State agencies and a New York airport in a program that has annually reduced laughing gull collisions with aircraft by 76 to 99 percent compared to baseline years, 1988–90. Strikes by other gull species were reduced 48 to 76 percent over the same time period. In this joint operational and research program, biologists have removed 58,000 laughing gulls and 6,000 other gulls at the airport. During this time, the nearby nesting colony on Federal land that is the source of the bird strike problem has declined by about 65 percent, from 7,600 nests in 1990 to 2,700 nests in 2000.

An analysis of data from leg bands recovered from 610 gulls shot at John F. Kennedy International Airport (JFKIA) indicated that many gulls hatched in colonies in New Jersey >60 miles from JFKIA have immigrated to the colony next to JFKIA to nest as adults. Because many Atlantic coast colonies of laughing gulls have been increasing, there has been a large cohort of birds available to replace birds removed at JFKIA. Therefore, an annual shooting program at JFKIA, while effective in reducing the number of gull–aircraft collisions, has not eliminated the nearby nesting colony or caused a decline in the regional breeding population.

A long-term alternative to shooting would be a program of harassment, habitat alteration, or nest destruction at the colony site itself to relocate the colony away from the airport. However, a relocation program has not been possible because the nesting colony resides on a fully protected wildlife refuge.

Comprehensive Report Published Summarizing 10 Years of Data on Wildlife Strikes With Civil Aircraft in the USA—Biologists at NWRC's Sandusky, OH, field station, in cooperation with a staff wildlife biologist from another Federal agency, have published an analysis of the 28,150 reported bird and other wildlife collisions with civil aircraft in the United States for the 10-year period 1990–99. The 62-page report, published by the Federal Aviation Administration's (FAA) Office of Airport Safety and Standards, was distributed during February 2001 to 650 airports nationwide that are certified for passenger traffic and to all USDA WS State offices. This report summarizes the nature, characteristics and trends of strikes by phase of flight, altitude, aircraft type, engine configuration, wildlife species and other factors.

Birds were responsible for 97 percent of the reported strikes, and mammals and reptiles, the remaining 3 percent. Waterfowl (32 percent), gulls (30 percent), and raptors (15 percent) caused 77 percent of the aircraft-damaging bird strikes. Deer were responsible for 96 percent of the mammal and reptile strikes causing damage.

This analysis indicated that wildlife strikes cost the U.S. civil aviation industry more than $389 million/year between 1990 and 1999. Nineteen aircraft were destroyed, and 91 human injuries and 6 deaths were reported as a result of wildlife strikes to civil aircraft. This report, the most comprehensive analysis of wildlife strikes ever produced, provides objective data to define the extent and nature of wildlife problems with aviation so that research and management programs to reduce strikes can be properly focused, justified and evaluated. NWRC, through an interagency agreement with the FAA, has maintained the National Wildlife Strike Database for Civil Aviation since 1995.

Coyote Hair Is Effective Deer Repellant—The white-tailed deer population in the United States has increased from about 350,000 in 1900 to 26 million in 2000, creating many conflicts with public safety and agriculture. For example, about 500 civil aircraft collisions with deer were reported in the United States between 1990 and 2000. Direct removal of deer can reduce the potential for deer–aircraft collisions and agricultural damage. However, such action is often controversial and provides only short-term relief. An inexpensive, effective deer repellant would have many uses as part of integrated programs to lessen conflicts between deer and humans.

From January through March in 2000 and 2001, biologists at NWRC's Sandusky field station examined the effectiveness of coyote hair as a deer feeding repellant in experiments at the 5,400-acre Plum Brook Station of the National Aeronautics and Space Administration (NASA) in northern Ohio. Corn consumption was measured at five sites where mesh bags containing coyote hair and five sites where empty bags were hung near troughs of corn. In both winters, coyote hair dramatically reduced deer intrusions to the feeding troughs

and consumption of corn over 5-week treatment periods. For example, during 2001, deer intrusions into the five feeding sites with coyote hair remained below 24 percent of pretreatment levels for the entire 5-week test. In contrast, deer intrusions into the five control feeding sites increased more than twofold from pretreatment levels by week 5 of the test. It is particularly noteworthy that these levels of repellancy were achieved under late-winter conditions with a high-density (>60 deer/mi^2) population.

Coyote hair might be used as an inexpensive method to help reduce deer activity on small airports that cannot afford deer-proof fencing or to minimize deer movements through gates at larger airports. To make this technique more practical for airport use, tests are now planned to isolate the organic chemicals in the hair responsible for repellancy so that a synthetic repellant can be manufactured.

Title: Emerging Technologies To Resolve Human–Wildlife Conflicts: Cell Culture, Repellants, Antisweet and Antinutrient, and Behavorial Methods

Goal: Discover new technologies and adapt existing methods for the development of nonlethal methods in the resolution of conflicts between humans and wildlife. Technologies will focus on identifying creative methods to screen repellants and enhance their efficacy to reduce crop depredation by birds. Technologies to be evaluated include cell culture for high through-put screening of candidate repellants, structure-activity relationships of terpenoid repellants, identification of antisweet and antinutrient agents, and behavioral methods to enhance hazing techniques.

Cell Culture Helps To Understand Mechanisms of Chemical Repellants—Previous behavioral work to screen and identify new chemical repellants has required the use of numerous animals. To reduce the number of animals required in the repellent discovery process, NWRC scientists in collaboration with scientists from private industry have perfected a cell-culture repellent-screening method for mammal and avian models (rat and chicken). Scientists are able to isolate and maintain trigeminal ganglion cells for use in tests to evaluate the repellent potential of chemicals. Five animals can yield approximately 3,000 usable cells, vastly expanding the capacity to conduct experiments without having to use a large number of animals during the discovery process. Scientists can now monitor cellular activity of up to 50 cells simultaneously. The cell-culture method also allows more precise characterization of the mediating mechanisms behind repellancy, and that improved characterization will ultimately lead to the design of more efficient and potent repellants.

In particular, NWRC and Monell scientists can now efficiently address the issues of whether laboratory models are good surrogates for wildlife species and explore the taxonomic differences in how animals detect various repellants. This information will facilitate the design of target specific repellants.

Title: Waterfowl as Disease, Parasite, and Noxious Weed Reservoirs in Urban and Agricultural Landscapes

Goal: Understand and develop management recommendations related to the contribution and impact of Canada geese as vectors for disease, parasites, and noxious weeds on human health and safety in urban landscapes and on animal health in agricultural landscapes.

During 2000, fecal samples from Canada geese were collected throughout the year from a number of sites in Fort Collins, CO. This was the first study to exhaustively characterize the prevalence of *Escherichia coli* serogroups in any wildlife species. The overall prevalence for *E. coli* ranged from 2 percent during the coldest time of the year to 94 percent during the warmest months of the year. During March through July, when nonmigratory geese dominated the local goose population, the prevalence of enterotoxogenic (ETEC) forms of *E. coli* was 13.0 percent. During the same period, the prevalence of enterohemorrhagic (EHEC) forms was 6.0 percent, while prevalences for enteroinvasive (EIEC) and enteroagglomerative (EAEC) forms were 4.6 and 1.3 percent, respectively. All samples positive for *E. coli* were examined for genes coding for virulence factors, including: SLT–I, SLT–II, eae, hly–A, K1, LT, STa, STb, CNF1, and CNF2. Three isolates were positive for human virulence factors, representing a 2-percent prevalence for feces containing potential human toxins. Genes for STb were isolated from ETEC strains O–8 and O–167, while the gene for K1 was isolated from an O–8 (ETEC) serogoup. These data will prove useful in focusing attention on the risks that increasing populations of urban Canada geese may pose to public health.

MAMMAL RESEARCH PROGRAM

Title: Developing Tools and Strategies To Reduce Mammalian Impacts on Forest Resources

Goal: Provide feasible nonlethal solutions and improved rodenticides for forest managers to resolve problems encountered with selected wild mammals.

Evaluating Commercial Deer Repellants—Chemical repellants can be a socially appealing, nonlethal alternative to reduce deer damage to plants in some situations. New products are continually being marketed, but their ability to repel deer is highly variable. Materials with good efficacy demonstrated under stringent conditions, such as protecting a highly palatable plant in the midst of dense animal populations with few alternative foods, in all probability will be effective under less stringent conditions. However, the reverse is not necessarily, and rarely, true.

Biologists at NWRC's Olympia, WA, field station tested 20 repellants to evaluate current products and identify trends that could be used to predict efficacy of future products. Repellant-treated western redcedar seedlings were placed in pastures with black-tailed deer. The number of bites taken from each seedling was recorded at weekly intervals for 18 weeks during the winter. Four of the five most effective commercially available repellants contained ingredients that emitted sulfurous odors (egg, blood meal, meat meal or sodium salts of mixed fatty acids). The five repellants were tested in spring, when trees were growing and more palatable to deer.

Only Plantskydd™ and Deer Away Big Game Repellent® powder reduced damage. However, unlike the winter study, the Deerbuster's™ and Bye Deer® sachets were hung on stakes at half the height of the seedlings instead of near the terminal buds. When an additional study was conducted with the sachets mounted near the terminal buds so that the repellants could drip from bags onto the plants as in the winter study, Deerbuster's sachets and Bye Deer sachets reduced deer foraging. In general, products containing ingredients that emitted sulfurous odors were more effective than products containing other active ingredients, and topical repellants were more effective than area repellants.

Economic Impacts of Wildlife on Forest Resources—The negative impacts of wildlife on forest resources can be extensive. The full impact of wildlife on forest resources is frequently difficult to assess because the spatial and temporal scale of forests makes the resource complex. Although damage is most often considered in terms of reduced productivity or delayed harvest cycles, attempts to replace trees after a harvest or a fire can be complete failures because of foraging wildlife.

NWRC biologists worked with the forest industry to summarize available information on the economic and environmental consequences of wildlife damage to forest resources. Center biologists concluded that the Committee on Animal Damage Survey of the Western Forestry and Conservation Association conducted the most thorough evaluation of wildlife damage to forests in the Pacific Northwest in 1963 and 1964. That study estimated that 30 percent of the tree seedlings planted would be damaged if no preventive practices were implemented. Planting rates on unprotected sites were 75 percent of those on protected sites, and trees protected from animal damage were 33 percent taller than unprotected trees after 5 years.

Updating these economic numbers to reflect present-day values, NWRC scientists determined that the level of damage in the 1963–64 study would result in an annual financial loss in Oregon of $333 million. They also estimated that the total predicted reduction in value of the forest asset in Oregon if no animal damage management was practiced would be $8.3 billion. A 1999 survey conducted by the Oregon Forest Industry Council also provides insight to the economic losses caused by mountain beaver ($6.8 million) and bear ($11.5 million) in that State.

Improving Conibear Traps To Capture Beavers—Beavers can inflict severe damage to agricultural crops and infrastructures, such as roads and culverts. Beavers are responsible for water impoundment destruction and direct timber losses of $38 million annually in Mississippi alone. Trapping efforts to reduce beaver damage are an increasing activity for WS personnel. While nontarget species are infrequently captured during efforts to capture beavers, WS wants to further minimize this risk. A device such as a tension adjustable (TA) trigger may reduce nontarget catch because traps equipped with this device require more pressure to be placed on the trigger before the trap activates. Some WS State programs using the TA triggers requested NWRC to assist them in assessing whether these triggers, when placed on body-gripping traps set for beaver, reduced captures of other animals.

In this evaluation, 12 WS specialists from 6 States made similar sets using traps with and without the TA triggers in the course of operational trapping for beaver damage management. In all, 251 trap sets were made using standard nonadjustable trap triggers and 247 with the TA triggers. The number of beaver captures was slightly lower with the TA trigger (83) than with the nonadjustable trigger (109), but the average weight of beavers captured was similar regardless of trigger type (approximately 30 pounds).

Turtles were the most frequent nontarget animal captured with either trigger type. Capture of nontarget aquatic mammals (e.g., otter, nutria, muskrat) was low for both types of triggers but slightly higher with the TA triggers (5 percent of trap sets) than for the nonadjustable triggers (3 percent of trap sets).

Opinions about the TA triggers expressed by study participants ranged from positive because of the materials and construction to negative because of the additional effort required to set and monitor trigger pressure. Study participants concluded that the primary variable in maintaining low numbers of nontarget captures was the professional knowledge and skill of the individual trapper and that the TA triggers did not affect selectivity of the trapping effort.

Title: Selective Targeting of Adult Territorial Coyotes To Manage Sheep Depredation: Efficacy and Methods

Goal: Determine the efficacy of selective removal of adult territoral coyotes whose space overlaps pastured sheep as a strategy to reduce depredation losses, and determine how to selectively target these coyotes.

Selective Removal of Breeding Coyotes Is Effective in Reducing Sheep Depredation—Results for research at the Hopland Research and Extension Center, CA, from 1994 to 1999 are now available on the effects on sheep losses of selectively removing breeding coyotes from territories experiencing depredation. In this research, breeding pairs of coyotes were the primary predators of sheep, and they killed sheep only within or on the periphery of their territories. Removal of either or both members of a breeding pair reduced or eliminated predation in that territory during the subsequent 3-month period.

Sheep killing resumed sooner in territories that overlapped pastures with lambs than in those that did not. For territories with access to lambs, the average interval until killing resumed approximated the time it took for a replacement pair of coyotes to become established.

Removal of breeding coyotes during the nonlambing season did not reduce losses during the following lambing season. Although less than a third as many coyotes were removed during selective control as during nonselective control, lamb losses were significantly lower. Losses did not differ between periods with no control and those with nonselective control.

Title: Ecology, Behavior, and Management Methods for Predators To Protect Livestock and Wildlife Resources

Goal: Develop information on the population ecology, behavior, and management of coyotes and other predators in relation to predation on livestock, game animals, and threatened and endangered species; assess the impacts of coyote depredation management techniques and programs; develop attractive baits and lures for target-specific delivery of pharmaceutical substances; and identity and test chemical repellants, deterrent methods, and delivery systems that reduce livestock depredation.

Economics of Predation Management—Predation management is controversial, and its implementation is sometimes unpleasant, especially when compared with management actions such as habitat restoration. In the past, debate has focused on the choice of methods, whether or not toxicants should be used, and other issues connected by a greater or lesser degree to biological considerations. More recently, however, the debate has focused less on issues of ecological harm or humaneness of method and more on questions concerning the economics of predation management. Critics have charged that costs exceed benefits and that Federal funds are being spent to subsidize a small number of livestock producers.

NWRC scientists at Logan, UT, in collaboration with the WS Utah State operational program examined these issues. The available evidence suggests that livestock protection activities are economical, with benefit:cost ratios ranging from 3:1 to 27:1. Likewise, predation management activities to protect wildlife show benefit:cost ratios ranging from 2:1 to 22:1. Activities performed to protect human health and safety undoubtedly show the greatest return on investment, although they are the most difficult to quantify. It is important to note that this investigation focused on the application of nonlethal and lethal methods used by WS personnel, and the use of nonlethal methods by others, mainly livestock producers. In the future, additional nonlethal methods are increasingly likely to be considered for application by WS personnel. These alternatives may be considerably more expensive than current lethal strategies. Accordingly, benefit:cost ratios for predation management will likely decline with increasing costs of management. Whether or not these ratios diminish sufficiently to warrant concern may be one of the factors to consider when deciding if alternative methods can be practically implemented, and for what purposes (e.g., livestock protection *v.* protection of threatened and endangered species).

Factors That Influence the Success of Aerial Hunting Operations—Aerial hunting is an effective tool for the removal of problem coyotes. However, factors that predict hunt success remain largely obscure. To address this issue, WS pilots in 5 Western States recorded meteorological data, ground conditions, and flight circumstances (e.g., purpose of flight, whether or not a ground crew was used) between December 1998 and August 1999. The 426 flight records were evaluated in relation to coyotes seen and coyotes killed per hour of aerial hunting, with the pilot as a covariate. Air temperature and the use of a ground crew were significantly and negatively related to the number of coyotes killed per hour of aerial hunting. Degree of preventative control, cloud cover, and snow cover were significantly and positively related to the number of coyotes killed per hour of aerial hunting. Other variables that influenced success were the resource to be protected (i.e., more coyotes were killed during cattle protection activities than during sheep protection activities) and lunar phase. Hunts on days of full moons were associated with the greatest number of coyotes killed per hour of hunting, hunts on days of quarter moons were associated with intermediate numbers, and hunts on days of new moons were associated with the fewest coyotes killed per hour. Variables that were not significantly related to coyotes killed per hour were windspeed, steepness of terrain, barometric pressure, and shotgun cartridge type. These findings may have practical implications for increasing the efficiency of both aerial survey and aerial hunting operations important for coyote damage management.

Title: Alternative Capture Systems and Aversive Stimulus Applications for Managing Predation

Goal: Identify, develop, and evaluate advanced capture systems and aversive stimuli applications for predation management, emphasizing animal behavior and engineering approaches.

Using Electronic Technology To Resolve Conflicts Between Humans and Predators—Several efforts are underway with cooperating organizations to test electronic frightening devices developed as prototypes by NWRC scientists. The conceptual basis for the effectiveness of behavior contingent stimuli was initially examined using coyotes in pen studies. Then, a predator-activated Electronic Guard frightening device was developed and field-tested in an area where wolf predation on calves had occurred. Based on examination of tracks and radio telemetry locations, the initial field study indicated that the device, activated by radio collars on approaching wolves, successfully repelled previously depredating wolves from a calving area.

Because of the potential usefulness of this device, two prototype radio collar-activated predator-frightening systems have been produced and are currently being used by WS specialists to manage wolf conflicts. Current efforts are aimed at lowering cost and improving ease of use of the device by incorporating wireless and miniaturized components. Assistance with this work was provided by the U.S. Fish and Wildlife Service (FWS), with funding support from Defenders of Wildlife.

In cooperation with WS operations personnel, the Turner Endangered Species Fund, the University of Montana, and Defenders of Wildlife, NWRC scientists have also initiated work to determine the effectiveness of electronic collars for conditioning wolves not to attack livestock. Based upon previous work indicating the effectiveness of the aversive stimuli produced by the collars for conditioning coyotes, NWRC personnel are testing the concept using captive wolves in Bozeman, MT.

In similar cooperative efforts with the State of Wyoming, NWRC scientists are developing prototype systems for automatically attaching radio telemetry collars to large predators. This attachment method would allow radio marking of animals near predation sites without requiring capture and handling. The concept could dramatically increase the applicability of radio and aversive collar applications for large predators.

Title: Holistic Management of Rodents and Other Vertebrate Pests in Hawaii

Goal: Develop safer and more effective methods to reduce the agricultural, natural resource, and human health impacts of rodents and other introduced pests in Hawaii.

A Simulation Study of the Broadcast Application of Rodenticide Bait in a Native Hawaiian Forest—Introduced rodents continue to have significant negative impacts on agriculture, human health, and native ecosystems in Hawaii. Rodent control is considered a high priority for many species and ecosystem restoration plans in Hawaii. Broadcast rodenticides have successfully been used to control introduced rodents in New Zealand. This apparent success caused wildlife biologists in Hawaii to seek regulatory approval for the use of similar techniques there. In 1995, a State registration for the use of anticoagulant bait blocks in bait stations to reduce rat depredation in Hawaiian native ecosystems gained regulatory approval. A broad coalition of Federal, State, and nongovernmental wildlife-management agencies and private industry is currently collaborating to obtain a similar aerial broadcast registration for rodenticide use in conservation areas. Several research steps are necessary to request regulatory approval for this technique.

One essential research step in support of a broadcast registration for rodenticides in natural areas in Hawaii is in the process of being completed at the NWRC Hilo, HI, field station. This study is an assessment of the relative risk that the broadcast application of

rodenticide bait poses to Hawaiian forest bird communities. Fieldwork for this study has been completed in three different forest habitats on the islands of Hawaii and Maui using two different formulations of placebo bait. Nontarget risk assessment has two components: bait acceptance and toxicity if bait is consumed. This study was designed to assess bait acceptance.

Risk was assessed by comparing placebo bait uptake to the relative abundance of specific avian species within a particular avian community. Vertebrate uptake of placebo bait was monitored in each site using infrared monitors and cameras. With data from three of eight replicates analyzed (approximately 7,600 observations of vertebrate bait consumption) only 85 observations, all from one site, documented bait consumption by a single avian species, the introduced red-billed leiothrix. Rats were documented consuming bait 7,500 times.

These data suggest that there is a relatively low direct risk to native Hawaiian forest birds from the broadcast of pelletized rodenticides and will be used to support multiagency efforts to obtain regulatory approval of the aerial broadcast application of rodenticide bait for conservation purposes in Hawaii.

Efforts To Develop Control Techniques for Introduced Neotropical Tree Frogs in Hawaii—Two species of *Eleutherodactylus* tree frogs native to the Caribbean—the *coqui* and the *planirostris* (greenhouse frog)—have recently become established in the Hawaiian Islands. Since their introduction via the import horticultural trade, these species have rapidly expanded their range on the islands of Hawaii, Maui, Oahu, and Kauai.

There are two ways that new tree-frog populations are being spread in the State. The first is the accidental transport via horticultural products or material from infected nurseries or gardens to uninfected areas. The second is the intentional introduction of frogs by citizens into sites previously uninfested. Both activities are considered illegal under Hawaii State law.

Surveys of frog sites on the islands of Hawaii (210 reported and 94 verified frog sites) and Maui (39 reported and 39 verified) indicate that frog populations have become firmly established in nurseries, parks, residential gardens, resort areas, and lowland forest habitats. The number of reported locations has significantly increased on these two islands in the last 2 to 3 years. Frog populations also have been documented on the islands of Oahu and Kauai, and there is concern these populations will continue to spread. In one horticultural site on the island of Hawaii, one species of tree frog has been documented to obtain densities comparable to the native range in Puerto Rico (>2.1 frogs/m^2 or ~21,000 frogs/ha). Localized loud vocalization of male frogs (80–90 dB) throughout the nighttime hours has also been a source of numerous angry complaints from sleepless residents and tourists alike.

There is a concern on the part of Federal, State, and private agencies in Hawaii that introduced *Eleutherodactylus* frogs pose a serious threat to these natural and agricultural resources. *Eleutherodactylus coqui* can reach densities of greater than 24,000/ha and is capable of consuming approximately 114,000 arthropod prey items per hectare in a single night in its native range in Puerto Rico. It is believed that the tree frogs, once established in native habitats, could prey on endemic arthropods as well as compete indirectly and directly with native birds for limited food resources. Tree frogs may also be a vector for plant nematode eggs, and the recent discoveries of nonnative frogs in certified nurseries make the frogs a potential quarantine issue that could greatly affect the exportation of disease- and pest-free nursery products from the State.

Laboratory Screening of Chemical Control Materials—Restricting the transfer of infected plant materials via the horticultural trade or by the casual public has the potential of stemming further spread of frogs to uninfected areas. However, the mechanism for strict quarantine and enforcement is not currently in place. An immediate solution is needed to reduce or eradicate localized populations that serve as reservoirs for new infestations. Current trapping techniques proved to be inefficient in field trials conducted by the NWRC's Hilo field station. Cultural practices (destruction of infected plant material or habitat) or hand capture may be effective on a small scale; however, chemicals appear to be the only broad-range and cost-effective immediate method of controlling frog populations.

NWRC biologists screened 35 different pesticides registered for invertebrate control in ornamental nurseries and floriculture in Hawaii, pharmaceuticals and food additives, and surfactants. One of two commercially available pesticides containing resmethrin (7.1 µg active ingredient per mL), a synthetic pyrethroid, was found to cause greater than 50 percent mortality to tree frogs tested at registered or recommended dosage rates. No surfactants tested were found to cause frog mortality rates greater than 50 percent. Caffeine and ibuprofen, a food additive/pharmaceutical and a pharmaceutical compound, respectively, were found to cause greater than 50 percent frog mortality to both *E. coqui* and *L. planirostris* at selected dosages. Salicylic acid (aspirin) caused greater than 50 percent frog mortality in *planirostris* under selected test conditions.

Further laboratory evaluation of the dermal toxicity of caffeine to both species of tree frog was conducted because caffeine was the only compound tested that was practical for wide-scale field use. In subsequent trials, dermal exposure to caffeine and water solutions

caused 90 percent or greater mortality to *E. coqui* and *L. planirostris* over a 5-day period when 0.9-mL and 2.0-mL dermal applications of 3.1 percent, 6.3 percent, and 1.3 percent caffeine and water solutions were tested.

Field Efficacy Trials of Caffeine Solutions—During 2000, field trials were conducted in Hawaii on the directed spray application of three different caffeine solutions for controlling introduced *Eleutherodactylus* frogs in floriculture and nursery crops in Hawaii. The relative abundance of these frogs in treatment and control sites was measured using three independent techniques: (1) *Eleutherodactylus* relative abundance, (2) frog chorus volume, and (3) trap occupancy rate. The directed spray application of 0.5-percent, 1.0-percent, and 2.0-percent caffeine solutions reduced *E. coqui* abundance in test situations on or bordering infested ornamental plant nurseries on sites in eastern Hawaii. Treatment of plots with a single spray application of a 2.0-percent concentration caffeine solution caused a 100-percent decline in the relative abundance of *Eleutherodactylus* frogs.

Hawaii State agencies are leading a coordinated effort to control introduced tree frogs in infested sites. Hawaii has submitted the documentation to EPA for an Emergency Use Permit to allow the spray application of caffeine in sites infested by introduced tree frogs. Efforts to control tree frog populations will be coordinated with affected landowners, farmers, and county, State, and Federal agencies. Initially, tree-frog control efforts will be conducted with existing staff on a small scale in a limited number of infested sites and will be tightly monitored. Because funding for tree-frog control efforts is currently limited, county, State, and Federal agencies will not be able to address this issue on a wide scale.

PRODUCT DEVELOPMENT RESEARCH PROGRAM

Title: Development and Evaluation of Rodent Damage-Management Methods, With Emphasis on Repellants, Barriers and Attractants

Goal: Develop new and improved repellent and barrier strategies for damage caused by voles, pocket gophers, rats, and ground squirrels to agricultural crops and property. Develop rodent detection methods and attractants to enhance effectiveness of existing tools, including rodenticides.

Repellant Reduces Buried Cable Gnawing by Gophers—Documented cases of gnawing damage to buried communication and power cables by pocket gophers have been reported over many years. There is a continuing need for improved methods for preventing this damage, and its importance is increasing as cable repair and replacement costs rise. Field trials conducted in irrigated alfalfa by NWRC researchers in Fort Collins, CO, have shown that communication cable samples inserted directly into the underground burrow systems of northern pocket gophers can be protected from gnawing damage by using a repellent treatment consisting of 2-percent capsaicin in a viscous polybutene carrier.

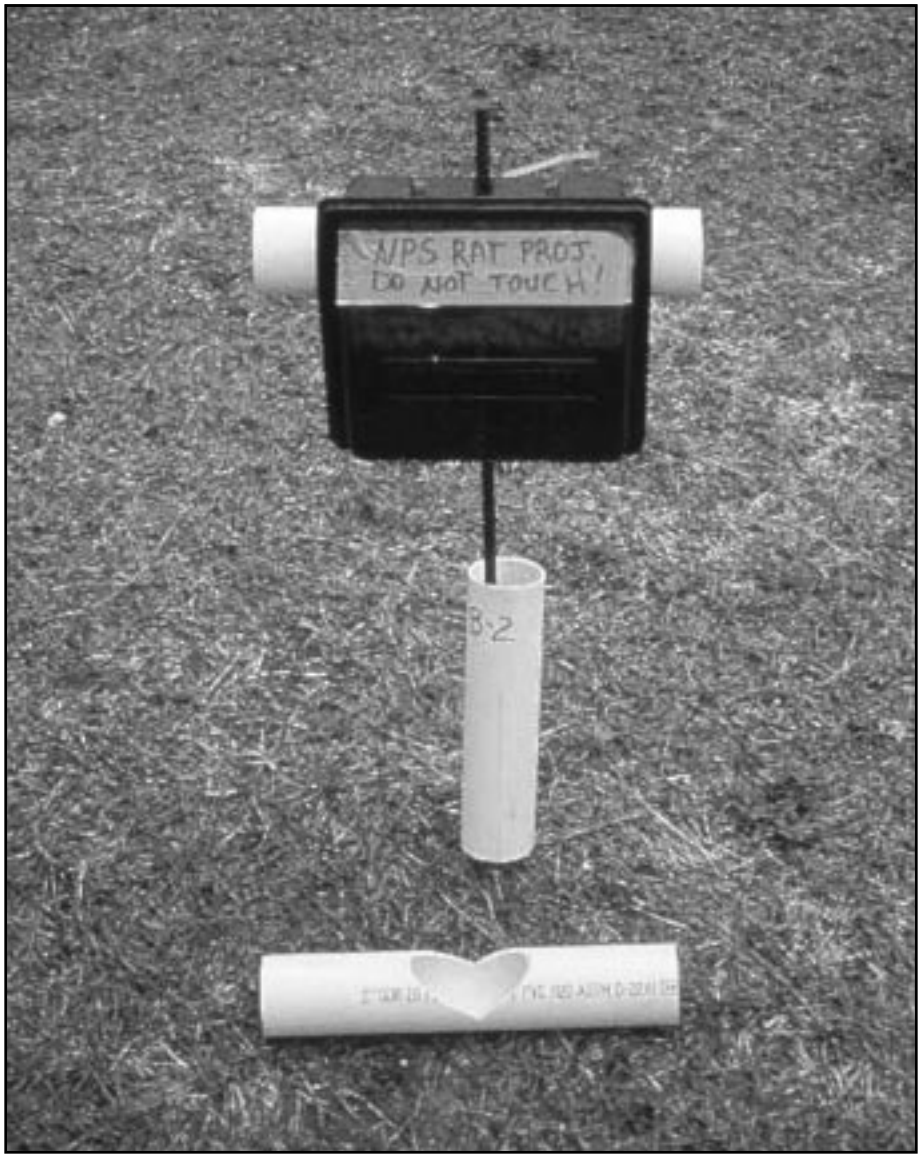
These ingredients were injected within a shrink tubing material surrounding the cable samples and placed in the burrows of 40 gophers for 3 to 6 weeks. In comparison with untreated samples exposed in the underground burrows, the repellant reduced damage to cable samples by between 77 percent (depending upon the width of cable) and 85 percent (depending upon the depth of cable gnawed).

Researchers also tested a commercially available repellent cable treatment with capsaicin contained within a rubberized plastic coating. This treatment reduced damage as assessed by the width of gnawed cable by 34 percent but did not reduce the depth of cable gnawed. Results from 92 samples suggest that using a viscous polybutene carrier that increases oral contact and irritation as gophers attempt to gnaw on cables can enhance the repellent effect of capsaicin. However, when capsaicin is applied in a dried form in a rubberized coating, the repellent effect is greatly reduced.

Assessing Wildlife Damage in No-Till Agriculture—Nonirrigated, no- or reduced-tillage agricultural practices, coupled with prescribed crop rotation and fallow schemes, have gained increased attention as a potential way to reduce soil erosion and moisture loss and to increase soil nutrients within the Great Plains agricultural community. Published accounts of small mammal surveys in eastern Colorado have traditionally generated low capture success (~5–10 percent) and low species diversity.

In an effort to document potential wildlife impacts to no-till agriculture, NWRC scientists surveyed small-mammal populations on research crops at a dryland agroecosystem project near Briggsdale, CO. Trap grids were set for 4 consecutive nights in July and again in September 2001. Grids were randomly placed in corn, fallow, millet, pea, soybean, sunflower, and wheat plots. During the first period, only 26 captures (excluding 10 recaptures) occurred in the 798 trap-nights, a 3.3-percent capture success rate. During the second period, only 1 capture (excluding 3 recaptures) occurred in the 834 trap-nights, a 0.1-percent capture success rate. Altogether, only four rodent species were caught: deer mouse, northern grasshopper mouse, thirteen-lined ground squirrel, and western harvest mouse. Most frequent captures and recaptures occurred in wheat and sunflower plots, but these plots were located near wooded areas and farmsteads (good rodent refugia), which probably explains the higher capture success in these crops.

While the low capture success concurs with prior data for eastern Colorado, the drought conditions in 2000 may have been responsible for the extremely low captures, the recaptures, and the lack of species diversity. While it is doubtful that rodents at these low densities posed much of a threat to no-till crops in this study, it became apparent that extensive wildlife damage to corn and soybeans was occurring before harvest. Corn damage was attributed to raccoons and deer; soybean damage was attributed to jack rabbits.



Remote Cameras Used in Ground Squirrel Baiting Operations—When conducting baiting operations to control populations of fossorial rodents, field crews may need to retrieve carcasses for chemical analyses and secondary hazard assessment. The traditional methods of retrieving fossorial rodent carcasses using telemetry and excavation are time consuming and expensive. Researchers need more innovative, efficient, and effective methods to locate and retrieve poisoned rodents from their burrows. NWRC researchers from Fort Collins evaluated the efficacy of the combined use of a burrow probe camera and a retrieval tool (comprised of a 1-m+ length of flexible plastic tubing with a treble hook attached to one end) for locating and retrieving belowground California ground squirrel carcasses after an anticoagulant baiting operation in southern California in May 2001.

Thirty-one dead ground squirrels were located in 654 burrows probed to a maximum depth of 2 m. Twenty-three of the 31 carcasses were retrieved, 18 with the hook rod and 5 by hand. The other carcasses were too deep to retrieve without excessive digging. Researchers also viewed 18 live squirrels underground, half of which appeared to be affected by the anticoagulant. Other underground sightings included three rattlesnakes, a gopher snake, three lizards, and a burrowing owl chick. The mean depth at which dead squirrels were located was 1.0 m, and the mean depth probed for all burrows was 1.4 m. The average time to probe a burrow was 46.1 seconds. The camera system and hook rod are economical and practical tools for locating and retrieving underground rodent carcasses and for collecting behavioral information on live ground squirrels and other burrow occupants.

Introduced Rats Successfully Eradicated From Buck Island—An NWRC scientist from Fort Collins and the WS Alabama State Director revisited the U.S. Virgin Islands (USVI) in both 2000 and 2001. The area they visited is managed by another Federal agency and has suffered severe damage to native flora and fauna from the introduced roof rat. These biologists, along with an NWRC biologist from the Hilo field station, had visited Buck Island in 1998 to design a rat eradication program. The National Park Service (NPS) then contracted the WS Alabama State office to conduct the eradication program between 1999 and 2000.

After a registration for a 0.005-percent diphacinone bait block was obtained from EPA and the USVI, a grid of bait stations was established over the entire 180-acre island. The bait stations were elevated and modified several times to reduce access by crabs and birds while still allowing access by rats. A final operational baiting was conducted in October 2000.

During the December 2000 and April 2001 trips, undertaken to monitor baiting efficacy, no rats were captured over 5 days in any of the traplines scattered about the island. However, many house mice were captured. House mice (another introduced species) had never been reported on the island, and not one had been previously captured in all rat snap-trapping efforts. A population of house mice had probably been on the island for a long period of time but had been greatly suppressed by the rat population.

The baiting operation probably would have also eliminated the mouse population if the bait stations had not been so modified to protect the bait and reduce nontarget animal access. It remains to be seen if this mouse population will cause as many problems as the rats had caused.

Rodent Habitats Studied at a Kansas Airport—In 1999, NWRC researchers from Fort Collins monitored a successful operational control program using a 2-percent zinc phosphide oat bait for field rodents at a Kansas airport. The rodent population was reduced so birds of prey would not be attracted to the airport and cause an airplane strike hazard. In August 2000, Center researchers returned to the airport to check on the recovery of the rodent population and to assess the habitats preferred by the rodents.

The trap-success rate per 100 trap-nights was lower (9 percent) than before the baiting (20 percent), suggesting that the baiting is still exhibiting an effect 1 year later. However, the 115 captures across diverse habitats suggested that the rodent population was widespread and increasing, and that it would probably soon reach prebaiting densities.

Habitats and land uses appeared to influence rodent densities. The medium-height grass field that had been baited the previous year yielded the most captures. Captures decreased in taller vegetation, tall clover, and riparian areas. The areas supporting the fewest small mammals were the cattle-grazed and short-mowed areas. These findings suggest that habitat management, through mowing or grazing, could reduce the small-mammal populations at airports.

Title: Induced Infertility: A Wildlife Management Tool

Goal: Develop and test economical and effective agents to control fertility in populations of pest mammals and birds.

New Adjuvant Makes a Single-Shot Porcine Zona Pellucida (PZP) Immunocontraceptive Vaccine Possible—Previously, the only adjuvant that has consistently provided high and longlasting immunocontraceptive responses has been Freund's adjuvant. The killed bacteria in Freund's adjuvant recruit immune cells to the site, and the presence of a vaccine–mineral oil emulsion promotes the antigen response by slowing the degradation of the vaccine. NWRC scientists in Fort Collins have developed a new adjuvant using a modification of the currently licensed Johne's disease vaccine which contains *Mycobacterium avium.* NWRC is in the process of obtaining a patent for the new adjuvant, AdjuVac.

This new adjuvant has allowed NWRC scientists to develop a single-shot PZP vaccine for deer. All previous contraceptive vaccines required at least two injections, called a prime dose and a boost dose. This single-shot technology is being tested at Pennsylvania State University, where only 20 percent of the deer given a single shot had fawns. The single shot looks like it will also protect for the second year. The immunized deer will be monitored for 3 or more years to determine if the contraceptive effects will last.

The single-shot PZP immunocontraceptive vaccine developed by NWRC scientists has also been chosen for use in a white-tailed deer population control-feasibility and efficacy trial in Cleveland, OH, that began in March 2001. This study is being conducted under an experimental research permit issued by the Food and Drug Administration (FDA). The Cleveland study site is suffering from the effects of deer overpopulation. Lethal methods have been most commonly used for control of deer populations in this area, but wildlife managers are seeking alternative, nonlethal ways of reducing deer numbers.

In this study, PZP immunocontraception is being tested as a method of population management. The NWRC vaccine prevents fertilization in immunized does. The effectiveness and convenience of a single injection were the reasons this vaccine was chosen for use in this field trial.

Improved Analytical Chemistry Methods for Risk Assessment of Chemistry-Based Wildlife Damage Management Tools—NWRC chemists in Fort Collins have developed new or improved methods for determining the risk to nontarget animals of chemicals developed to reduce damage caused by a variety of wildlife species. The residue data generated with these methods are critical for assuring that the proposed uses of these tools are accompanied by minimal risk to nontarget animals. For example, in collaborative studies with other Federal agencies and the NWRC Bird Research Program, NWRC chemists analyzed nontarget and target birds that were collected from DRC–1339-baited sunflower and rice fields.

The DRC–1339 residues detected in the collected birds strongly suggest that birds feeding on DRC–1339-baited fields pose little risk to scavenging or predatory wildlife that may potentially consume these birds. Similar analytical approaches are being used to assess the safety of using acetaminophen to control brown tree snakes on Guam, using anthraquinone to reduce bird damage to lettuce and rice, and using diphacinone to control pest rats on Hawaii. These data and the associated risk assessments must be supplied to regulatory agencies to assure that these chemical-based wildlife damage management tools are available for use.

Monitoring Blood Chemistry To Expedite the Development of Wildlife Contraceptives—NWRC chemists have identified marker compounds that can be correlated to contraceptive efficacy in the blood of birds treated with the contraceptives diazacholesterol and nicarbazin. The correlation of blood marker compounds to contraceptive efficacy provides an approach to facilitate development of contraceptives for overabundant waterfowl. By monitoring blood levels of these compounds in wildlife, researchers can evaluate the efficacy of contraceptive formulations in only several weeks. Additionally, such studies can be conducted throughout the year. This approach offers a tremendous increase in research efficiency compared to evaluating the contraceptive efficacy of formulations under field conditions. Such field studies require large numbers of birds, several months, and may only be conducted once a year (during breeding season). Additionally, the quantification of these blood marker compounds may also be used to facilitate the ultimate field testing of a promising contraceptive formulations. In this scenario, blood samples may be obtained and analyzed to determine what percentage of the pest birds are actually consuming the bait and/or how much bait the subjects are consuming.

Title: Improved Assessment, Sampling, and Economic Methods for Wildlife Damage Management

Goal: Develop and validate new techniques to assess, sample, and quanitify wildlife damage management, plus determine related benefits and costs.

Optimizing Control of Predators To Prevent Depredations on Sea Turtle Nests—Unchecked, raccoons and armadillos prey on a high percentage of sea turtle nests on many Florida beaches. Hobe Sound National Wildlife Refuge on Florida's east coast was established to provide and protect nesting habitat for three species of threatened or endangered sea turtles. All three species build nests and hatch their young from spring to fall. This pattern results in at least 6 months where nests are vulnerable to predation, but funds are only available to hire a WS employee for 1 month to control predators.

An NWRC Fort Collins biologist worked with Florida WS personnel to develop and test a passive tracking method for indexing predator populations along beach areas of the refuge. The indexing data were used to help increase the efficacy and efficiency of these control efforts by (1) optimizing the timing for conducting control, (2) minimizing labor by targeting specific areas for control, (3) assessing control efficacy, (4) identifying raccoon reinvasion patterns, and (5) providing predictive data regarding the next year's turtle nesting season.

The proportion of nests predated when using the tracking index to monitor numbers and location of predations in conjunction with control was 28 percent, the lowest rate in years. In 1999, with the same level of control but without the benefit of predator monitoring, the predation rate was 42 percent. Without control, nest predation has been as high as 95 percent. Research is continuing to improve the monitoring method, especially by refining the method for more sensitivity to armadillos.

Benefit:Cost Projections for Golf Course Use of a Turf Repellant—Canada goose feces on fairways and greens could cause reduced purchase of golf course fees. In 2000, NWRC scientists estimated the economic variables related to using wildlife damage repellants on golf courses. Direct benefit:cost ratios were computed for a commercial repellant (ReJex-It®) registered for use to prevent loafing and grazing of waterfowl on turf. Estimates assumed (1) local summer greens fees ($46/18 holes and $25/9 holes), (2) busy "starting times" of foursomes (i.e., 7.5, 18-hole rounds/h between 5:30 a.m. and 5:30 p.m. and 7.5, 9-hole rounds/h between 5:30 p.m. and 7:00 p.m.), and (3) commercial pricing of ReJex-It at $69.95/gal at a recommended application rate of 2.5 gal/ac. Iterative calculations were derived based upon potentially reduced sales of greens fees (i.e., 2, 4, 6, ... 30 percent) due to golfer dissatisfaction over goose feces and varied applicator costs (i.e., $2, $4, $6, $8, and $10/ac) for areas of 8 and 25 ac.

Under the hypothesized scenario, spraying of only limited acreage is profitable even if complete repellancy of geese, as measured by no droppings, is assumed. The break-even point (benefit:cost = 1.0) for use of the repellant occurs when a 12-percent and 24-percent loss of greens fees is expected for 8 and 25 ac, respectively. Application costs seemed to have minor effects on the ratios, at least for the range of $2.00 to $10.00/ac.

An Economic Analysis of Integrated Rodent Control in Swine Production Facilities—A comprehensive economic analysis of rodent control at swine production facilities was conducted using funds provided by the pork industry. An interdisciplinary working group of scientists from NWRC, academia, industry, and other government agencies was assembled to identify key input variables and cost values associated with rodent damage and control at swine production facilities. Data from production models, scientific literature, product literature, and personal experience were incorporated into an interactive STELLA Systems Model. Use of this model allowed predictions of benefits and costs for varied inputs of house mouse damage and control; outputs were site specific. A Web site on rodent control [http://itg3.unl.edu/rodent —username "rodent" and password "tnedor"] was established to promote use of the model, increase producer awareness of the costs associated with rodent damage, and provide information on integrated strategies for managing rodents at swine-rearing facilities. While the model is relatively robust and complete, it still has certain gaps in research-based information, particularly in the areas of economic impacts of rodents on swine disease, food safety, quality assurance, and farming.

Title: Development of an Avian Infertility Tool for Application in Goose Management

Goal: Test the effectiveness and develop for use the contraceptive nicarbazin for reproductive control of geese.

Field Efficacy Study With Nicarbazin in Fort Collins—Canada geese damage crops and deface property with their feces. In addition, they can pose health risks when feces contaminate potable water supplies. In recent years, resident goose populations have been growing. In such situations, it may be neither practical nor desirable to control resident populations through the use of hunting. Contraception provides a potential nonlethal alternative to manage resident geese populations.

Nicarbazin is a promising oral contraceptive that traditionally has been used to treat coccidiosis in chickens. In the spring of 2001, nicarbazin was coated onto cracked corn and fed to two Fort Collins goose populations. Baiting occurred daily at loafing sites and within some nesting territories. Nest boxes were checked periodically for eggs and hatching. Any eggs that did not hatch were collected for analysis.

Nicarbazin reduced hatchability at one site by 70 percent. In addition to monitoring nesting success, geese were fitted with neck collars to allow for the monitoring of movements outside of the nesting season.

Nicarbazin Dose Study in Penned Geese—During spring 2000, a study was conducted in Wisconsin testing the potential of nicarbazin as a contraceptive on Canada geese. The study objectives were to evaluate the ability of wildlife managers to hand-feed adequate daily doses of nicarbazin to individually marked resident Canada geese and to evaluate the efficacy of nicarbazin for reducing the reproductive success of the

geese. The study was conducted prior to and during the egg-laying period at a wildlife sanctuary that has a large population of free-ranging resident geese that were accustomed to being fed by people.

Twenty-five adult females were marked with individually identifiable neck collars, 16 of which had radio transmitters affixed to them. Nicarbazin slow-release grit pellets and capsules containing nicarbazin were fed during March and April 2001. To increase acceptance by geese, grit pellets and capsules were concealed in breadballs or kernels of corn. Each day, marked geese were offered three grit pellets containing 125 mg nicarbazin per pellet and one capsule containing 125 mg nicarbazin, but daily doses received by individual geese varied throughout the study because geese did not always come to the feeding site.

Due to the rapid clearing of nicarbazin from a goose's system (3 or fewer days), none of the geese ingested adequate daily doses before and during the nesting period, so the nicarbazin treatments were less successful than expected. Of the marked geese, only six established nests within 60 miles of the study site and received continued doses of nicarbazin. Of the 35 eggs laid by these geese, 83 percent hatched. The data collected on "resident" geese movement patterns and nesting locations showed that a large proportion of the resident geese nested in remote, inaccessible areas, away from the sanctuary. Traditional management techniques such as nest destruction would not be applicable with these geese.

The results strongly support the need for an orally fed reproductive inhibitor that is administered prior to and during nesting. The biggest challenge to developing an orally fed reproductive inhibitor will be to produce a bait that is palatable relative to other food sources at the time of breeding, when geese typically switch to a green grass diet, and to develop methods to entice birds to bait sites at a time when they are pairing up, becoming territorial, and moving to nesting sites.

Title: Field Evaluation of Chemical Methods for Brown Tree Snake Management

Goal: Develop techniques to help control brown tree snakes on Guam and prevent their dispersal from that island.

The brown tree snake (BTS), an accidentally introduced species to the island of Guam, has decimated that island's native fauna and poses a similar threat to other Pacific island ecosystems. NWRC scientists are field-testing chemical methods for controlling the BTS. NWRC is evaluating toxicants, attractants, repellants, and fumigants that could be used in an integrated program to control the BTS on and prevent its dispersal from Guam and reduce or help control snake populations in other island situations. The Center's goals are to field-test these methods for efficacy and make them available for use by a variety of individuals and organizations, including WS, Federal and State agencies, natural resource managers, military personnel, and others to use in controlling the BTS.

Dermal Toxicant Delivery to the BTS by an Automatic Aerosol Device—Previous investigations have shown that commercial insecticide aerosol formulations registered by EPA are dermally toxic when sprayed on physically restrained BTSs. In an effort to use insecticide aerosols for practical snake control applications, a passive aerosol dispenser was evaluated under laboratory conditions for delivering pyrethrins containing the synergists piperonyl butoxide and N–octyl bicycloheptene. NWRC scientists developed an infrared (IR) electromechanical aerosol dispenser that directs a spray for 3 seconds to the body of a snake when the IR beam is tripped by the snake as it crawls into a pipe to investigate a dead mouse lure. Operational use of passive aerosol dispensers could be in warehouses and cargo staging areas, where there is potential for snakes to enter into sea and air transportation systems. Snake mortality with pyrethrins in concentrations of 0.25, 0.5, 1, and 2 percent was 17, 43, 60, and 88 percent, respectively. These results are encouraging. However, this was the initial evaluation of the passive aerosol dispenser, and refinements such as optimal spray particle size, carrier for the active ingredients, and convenient electrical power supply need to be made to increase its efficacy and practicality. Also, the dead mouse is not a practical lure for this device because it decomposes in 2 to 4 days. An artificial lure with a longevity of at least 7 days would make this device more effective.

Postmortem Residues of Acetaminophen in the BTS—Dead neonatal mice (DNM) baits containing 80 mg acetaminophen are effective toxicants for the BTS under field conditions, but the environmental fate of acetaminophen residues in dead snakes is not

known. To address this issue, residues of acetaminophen in BTSs killed by consuming a dead mouse bait treated with 80 mg acetaminophen under laboratory conditions were determined by NWRC chemists. Five test groups, each containing three control and six treated snakes, were evaluated. Control snakes, fed an untreated bait, were euthanized. Postmortem Day 0 snakes were immediately frozen and the other groups were exposed in an environmental chamber to field ambient temperature and humidity conditions for 1, 2, 3, and 4 days. Of the 30 treated snakes, 28 consumed the bait and all died, including 7 snakes that regurgitated the bait.

Total acetaminophen residues in snakes that regurgitated the bait ranged from 0.3 to 1.2 mg during the postmortem period. For the snakes that did not regurgitate, the average acetaminophen residues were 38, 24, 30, 5.1, and 4.7 mg at postmortem days 0, 1, 2, 3, and 4, respectively. The percentage of acetaminophen recovered from the initial dose of 80 mg ranged from 48 percent at postmortem Day 0, to 6 percent at postmortem Day 4. Residue data will be used for making potential secondary hazard assessments for the endangered Marianas crow and other potential scavengers and will be submitted to EPA to support registration of acetaminophen as an oral toxicant for the BTS.

Toxicity of Acetaminophen and Caffeine 40 mg Tablets in "Heavy" BTSs—There is a wide range in the size of the BTS on Guam, and an oral dose of toxicant must be sufficiently potent to be effective for large snakes. The majority of NWRC's toxicity studies have been conducted with snakes weighing between 40 and 100 g, but larger snakes are frequently encountered in the field. Previous studies with 80 mg acetaminophen and caffeine tablets in DNM baits resulted in 100-percent mortality in large snakes weighing about 140 to 300 g. This study was conducted to determine the toxicity profile of 40 mg acetaminophen and caffeine baits on large snakes. Mortality was 90 percent for caffeine and 100 percent for acetaminophen in snakes with mean body weights of almost 200 g. None of the snakes regurgitated the caffeine baits and only 1 of the 10 snakes regurgitated the acetaminophen bait, but it died. Although the 40-mg caffeine dose did not kill all the heavier snakes, the 80-mg dose did. Caffeine would be an acceptable substitute for acetaminophen should major obstacles develop in its use for operational control.

Acetaminophen Toxicity in Crabs—Crabs also are nontarget animals that could be exposed to acetaminophen by feeding on treated baits (primary toxicity) or by feeding on snakes killed by acetaminophen (secondary toxicity). In tests conducted on Guam under laboratory conditions with individually caged coconut and hermit crabs, no mortality or sign of toxicosis were observed in any of the trials with either species. In all the primary toxicity test trials, crabs ate the bait matrix, but the majority of them avoided eating the acetaminophen tablets. In the coconut crab secondary toxicity test, no mortality or signs of toxicosis were observed from eating snakes that died after consuming 160 mg acetaminophen, which is twice the dose used in field trials. These test results indicate that primary and secondary hazards of acetaminophen to crabs are negligible. These data are also being used in support of an EPA registration for acetaminophen as an oral toxicant for BTS.

Comparison of Trapping and Baiting—During 2001, NWRC researchers and Guam-based WS operations staff collaborated on a demonstration project to test and develop an operationally practical and cost-effective integrated pest management strategy to reduce BTS populations. This demonstration project, which consisted of trapping and toxicant baiting techniques, was conducted with the military in 20 rectangular forested plots totaling 150 ha. Snakes had been previously trapped on some plots by Guam WS opera-

tions staff 12 months prior to the initiation of this study. Two replicates, each consisting of five previously trapped and five untrapped plots, received acetaminophen toxicant treatments.

In the first replicate, the mean toxicant bait take on the five previously untrapped forest plots was initially 80 percent and declined to 21 percent after 4 weeks of baiting. In the second replicate, mean toxicant bait take on five other previously untrapped forest plots was initially 62 percent and declined to 25 percent after 4 weeks of toxicant use. The mean toxicant bait take in the first replicate on five previously trapped forest plots was initially 56 percent and declined to 14 percent after 4 weeks of toxicant use. In the second replicate, mean toxicant bait take on five other previously trapped forest plots was initially 44 percent and declined to 24 percent after 4 weeks of toxicant use.

These results indicate that toxicant baiting is an effective control technique but also that, even with 12 months of continuous trapping effort, many snakes remain uncaught. A cost:benefit analysis of this integrated operation effort is underway.

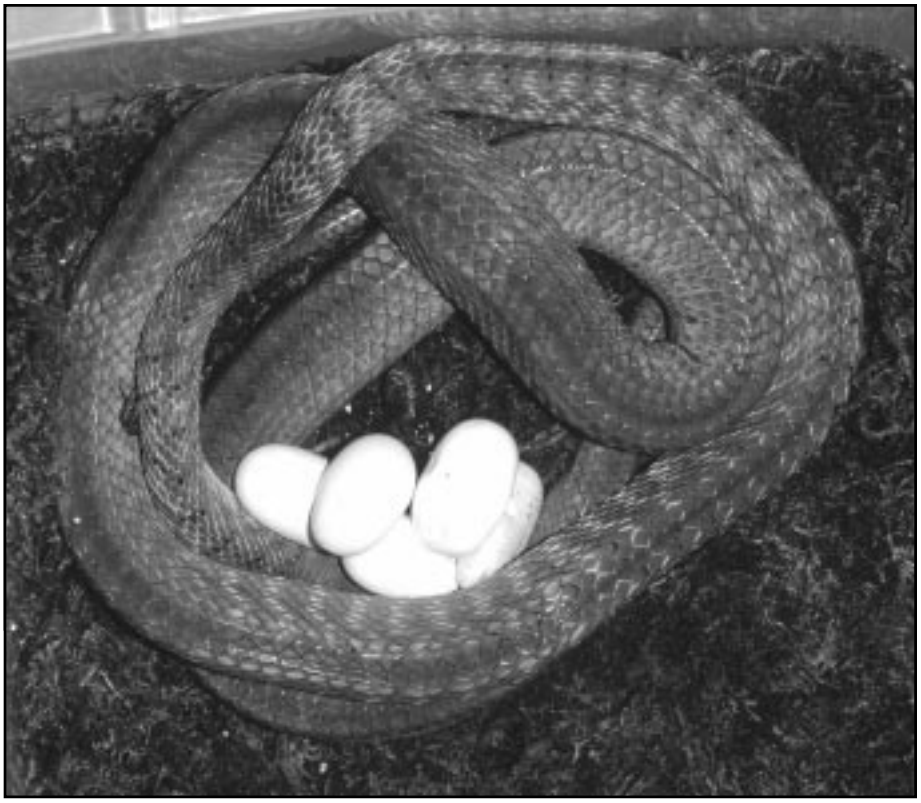
Guam Rail Restoration and BTS Baiting—A study was initiated to collect data to assess the potential risk to Guam rail restoration in sites on Guam where acetaminophen is placed in DNM for BTS control. The study was conducted in two parts over a 12-day period. The first study assessed if 20 Guam rails hatched and raised on Guam that have never encountered DNM as a food item would feed on DNM placed on the ground of the holding pen or placed in a food bowl in the holding pen. The second study assessed if four Guam rails hatched and raised in zoos in the United States that encountered DNM in the past as a food item would feed on DNM placed on the ground of the holding pen or in a food bowl.

To briefly summarize the results, no Guam rails that were hatched and captive-reared on Guam ate DNM. However, all rails that were captive-reared in zoos and sent to Guam as part of the breeding program ate DNM. Six rails were observed eating DNM. In five cases, DNM were eaten whole. In the sixth, the mouse was torn apart before being eaten.

These results suggest that captive-reared rails that may have previously been fed DNM are likely at some risk in sites where toxicants placed in DNM lures are used. However, the assessment of risk needs to be placed in the context of the baiting strategy, delivery mechanisms, and behavior of the rails.

Successful Reproduction of the BTS in Captivity—As part of a multiagency effort to develop methods for controlling this species, NWRC research also focuses on developing methods for inhibiting reproduction. As a prerequisite step to this effort, wild-caught adult BTSs were brought into captivity at the NWRC in May 2000 to form the nucleus of a potential breeding colony. The objective was to develop a method for inducing reproduction in the laboratory so potential reproductive inhibitors could be evaluated in a controlled laboratory setting. After a 250-day acclimation period followed by a 78-day simulated wet season (i.e., cool temperatures and high humidity), pairs of snakes were set up and observed for mating activity.

Of 52 pairings involving 10 males and 23 females, 10 pairing attempts culminated in successful intromission by a male. However, relatively few individuals were involved; these 10 successful pairings involved only 4 of the 10 males and 4 of the 23 females. Of the 23 females in the colony, 3 females each laid 1 clutch of eggs. Eight of 18 eggs from 2 of the clutches hatched at between 84 and 91 days. None of the three eggs in the third clutch hatched. All hatchlings appeared to be healthy.



Dissections of all eggs that did not hatch revealed that all such eggs were infertile. As judged by their appearance and by palpation, a number of additional females developed enlarged ovarian follicles, but for reasons unknown, these follicles were resorbed.

The mating and egg-laying of the BTS at NWRC is an important achievement as it marks only the second time in the United States this species has successfully been bred, and possibly only the fourth time worldwide. Moreover, the information gained from this work should provide greater success at inducing reproduction in captivity, enabling future laboratory testing of potential reproductive inhibitors.

PROGRAM SUPPORT

Registration Highlights

Registration and Reregistration Status of APHIS Vertebrate Pesticides—The NWRC Registration Unit is responsible for coordinating the development of data required for maintaining or expanding authorized uses of APHIS vertebrate control products. To meet this responsibility, the Registration Unit works closely with scientists to ensure that research results will be acceptable for regulatory purposes and that study designs meet EPA and FDA regulatory guidelines. In addition, the Registration Unit responds to requests from field personnel for new products or changes to existing products that will improve their ability to manage problem wildlife. Technical assistance and information are provided to State WS personnel, Federal, and State agricultural and conservation agencies, as well as other nongovernment individuals and groups.

Vertebrate pesticide products developed by APHIS are registered with the EPA under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). In 1988, FIFRA was reauthorized by Congress. As a consequence, EPA was required to reassess every active ingredient used in pesticides for reasons of public and environmental safety and product efficacy. APHIS held registrations for seven active ingredients when FIFRA was reauthorized: an avicide (DRC–1339), two rodenticides (strychnine and zinc phosphide), a fumigant (a gas cartridge that contains carbon and sodium nitrate), and two predacides (compound 1080, used in the Livestock Protection Collar, and sodium cyanide, used in the M–44). Requirements for reregistering all seven active ingredients used in APHIS' 18 end-use products have been fulfilled. In addition to previously registered compounds, within the last 1.5 years APHIS successfully registered an avian repellant, Mesurol™ (methiocarb), for the protection of endangered and threatened species. Table 2 lists vertebrate control pesticides developed by APHIS, as well as authorized target species and use sites for each product.

In 2001, the Registration Unit focused efforts on the development of new products, such as a toxicant for the BTS, and on expanding the uses of currently registered products for the protection of endangered species, public health, and agriculture. The following items highlight some of the major activities.

M–44: In conjunction with WS state offices in Idaho and Utah, an Experimental Use Permit (EUP) has been requested to evaluate the efficacy of using the M–44 to control canine predators to protect ground-nesting birds, primarily the sage grouse. Sage grouse populations have been declining and are now so low that the species has been nominated for examination by FWS as a candidate for threatened or endangered status. Predation has been shown to be a significant contributor to this decline. If approved, this EUP will provide the data necessary for changing the M–44 label to include the protection of ground-nesting birds and provide wildlife managers another tool to prevent species declines.

DRC–1339: The primary registration activity for DRC–1339 products has been the submission of a label amendment requesting shortened plant-back intervals and reduced harvest restriction for rice and sunflower crops grown on the small acerage used as bait sites. Data from a 14C–DRC–1339 confined rotational crop study were submitted to support this label amendment request. These data show that residues detected in crops harvested in bait sites are not DRC–1339 and are not of toxicological concern. A decision on plant-back intervals is expected by the EPA in early FY 2002.

At the request of an agricultural commodity group, the Registration Unit served as a technical consultant and study coordinator for developing additional toxicological data for DRC–1339. Acute toxicity testing was conducted on three species of songbirds to better assess the potential nontarget risks of blackbird control operations.

Acetaminophen: During FY 1999, APHIS obtained a 3-year Emergency Use Registration from EPA to use acetaminophen as a toxicant to control the BTS on Guam. During FY 2001, the Registration Unit developed the data package to obtain a full Section 3 registration under FIFRA, for use of acetaminophen in bait stations on Guam and other island ecosystems. More than 50 individual data requirements were submitted to the EPA for this registration application. With the exception of toxicological studies on birds, data were obtained from the open literature or by

TABLE 2—VERTEBRATE CONTROL PRODUCTS CURRENTLY REGISTERED BY USDA UNDER THE FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT (FIFRA)

EPA registration	Product name	Species controlled	Use site
RODENTICIDES			
ZINC PHOSPHIDE BAIT PRODUCTS			
56228-03	Zinc phosphide on wheat for mouse control	Voles, white-footed mice	Ornamentals, orchards, vineyards, rangeland, forests, lawns, golf courses, parks, nurseries, highway medians
56228-06	Zinc phosphide concentrate for rodent and lagomorph control	Voles, mice, rats, hare, woodchuck, ground squirrels, muskrat, nutria	In and around homes, and industrial / commercial, agricultural, public buildings. Orchards (non-bearing), groves, nurseries, vineyards, ornamentals, highway medians
56228-14	Zinc phosphide on oats	Prairie dogs, voles, ground squirrels, white-footed mice	Orchards and groves, rangeland, non-crop borders
STRYCHNINE BAIT PRODUCTS			
56228-11	0.5 percent strychnine milo pocket gopher bait for use in burrow builders	Pocket gophers	Underground burrow systems in open fields, rangeland, and pasture and around airports
56228-12	0.5 percent strychnine on oats field bait	Pocket gophers	Underground burrow systems in open fields, rangeland, and pasture and around airports
56228-19	0.5 percent strychnine milo for hand baiting pocket gophers	Pocket gophers	Underground burrow systems in open fields, rangeland, and pasture and around airports
56228-20	0.5 percent strychnine on oats for hand baiting pocket gophers	Pocket gophers	
BURROW FUMIGANT PRODUCTS			
56228-02	Gas cartridge	Woodchuck, marmot, ground squirrels, prairie dogs	Underground burrow systems in open fields, lawns, noncrop and reforested areas, golf courses, and rangeland

EPA registration	Product name	Species controlled	Use site
PREDACIDES			
BURROW FUMIGANT PRODUCTS			
56228-21	Large gas cartridge	Coyote, red fox, striped skunk	Underground burrow systems in open fields, lawns, noncrop and reforested areas, golf courses, and rangeland
SODIUM CYANIDE PRODUCTS			
56228-15	Zinc phosphide on wheat for mouse M-44 cyanide capsules	Coyote, red fox, gray fox, feral dog	Pastures, rangeland, forests
56228-32	M-44 cyanide capsules—Arctic fox	Arctic fox	Noncrop areas in the Aleutian Islands
COMPOUND 1080 PRODUCTS			
56228-22	Sodium fluoroacetate (compound 1080)—Livestock Protection Collar (LPC)	Coyote	Pastures
56228-26	Compound 1080—LPC manufacturing use product	NA	For use in manufacturing the LPC
AVICIDES			
COMPOUND DRC–1339 PRODUCTS			
56228-10	Compound DRC–1339 concentrate—feedlots	Blackbirds, starlings, grackles, cowbirds	Beef cattle, poultry, and swine feedlots
56228-17	Compound DRC–1339 Concentrate—gulls	Gulls	Landfills and airports
56228-28	Compound DRC–1339 Concentrate—pigeons	Pigeons	Structures: rooftop containers, bare ground in fenced areas
56228-29	Compound DRC–1339 Concentrate—livestock, nest, and fodder depredations	Raven, crow, magpie	Protect livestock, nesting waterfowl, endangered species, and fodder or silage
56228-30	Compound DRC–1339 Concentrate—staging areas	Blackbirds, starlings	Bird staging areas
AVIAN REPELLANTS			
56228-33	Mesurol 75 percent wettable powder aversive conditioning egg treatment	Crows, ravens	Noncrop areas adjacent to nesting areas of threatened or endangered species

research conducted by NWRC scientists. NWRC conducted nine studies that directly related to nontarget species hazards. These and other data were summarized and provided the basis of a hazard assessment for species potentially affected by a baiting program.

Strychnine and Zinc Phosphide Consortia: NWRC staff members coordinated two consortia, the Strychnine Consortium and the Zinc Phosphide Consortium. The primary consortia activity last year was development of a human poisoning-incident data submission for rodenticides containing zinc phosphide. The submission summarized all incident data collected by the American Association of Poison Control Centers, Toxic Exposure Surveillance System during 1993 through 1998.

FDA Wildlife Drug Authorizations—APHIS has five Investigational New Animal Drug (INAD) authorizations with the FDA that allow interstate transport of the compounds for experimental purposes. Three of the compounds—GnRH vaccine, PZP vaccine, and 20,25–diazacholestrol (Diazacon)—are being tested as wildlife contraceptives. The other two compounds, alpha–chloralose and propiopromazine hydrochloride, are immobilizing agents. Table 3 provides a list of compounds under APHIS INADs, species the compounds have been tested on, and species proposed for future work.

Two of the INADs are for immunocontraceptive vaccines containing GnRH and PZP. Research efforts are underway to develop a dart-delivered single-shot vaccine that would be effective for multiple years. The current focus of registration activities on PZP and GnRH involves determining data requirements for FDA approval and consulting with scientists on registration requirements and study design.

The immobilizing agent alpha–chloralose is authorized for use to live-capture waterfowl, coots, and ravens. It is currently available as a powder and must be mixed with corn oil prior to injecting it into individual bait materials. Research has shown that tableted alpha–chloralose is equally safe and effective on waterfowl. In addition, since it does not require prior mixing and using syringes to treat bait materials, it is a safe and easy alternative for field biologists. Consequently, APHIS has requested that the FDA allow the use of tableted alpha–chloralose in addition to the powdered formulation currently used under INAD 6602 for capturing waterfowl.

Regulatory Assistance Provided to Federal, State, and Nongovernment Organizations—WS program personnel or other Government and nongovernment cooperators often contact the NWRC Registration Unit for information when preparing Environmental Assessments, Environmental Impact Statements, and Section 7 consultations with the FWS. NWRC is the primary supplier of these data to the WS program and its cooperators. Often responses to these inquiries entail preparing unique summaries and interpretations or NWRC research. NWRC personnel are providing technical assistance to a consortium of State, Federal, and nongovernmental organizations in Hawaii by developing a registration package and risk assessment for registering diphacinone as an aerially delivered anticoagulant rodenticide to control rats in conservation areas. These efforts are designed to lower rat populations and reduce rat predation on forest nesting birds. Submission of this registration request by the State of Hawaii is expected in FY 2002.

Information Transfer Activities—With the cooperation of headquarters staff, the Registration Unit expanded the NWRC Web site at http://www.aphis.usda.gov/ws/nwrc to include sample copies of the most current APHIS vertebrate pesticide labels as well as WS "Tech Notes," which provide information on the proper use of APHIS pesticide products. Current information on NWRC's investigation of wildlife immobilizing and contraceptive agents can be found at http://www.aphis.usda.gov/ws/nwrc/RegUnit.htm.

The Registration Unit continues to develop a fully searchable, electronic toxicology database (DRC Database—Denver Research Center). This database contains data for 6,800 chemicals that were screened for toxicological and repellancy properties at the Denver Wildlife Research Center between 1960 and 1987. This database provides rapid access to the results of more than 23,000 individual toxicity tests conducted with up to 127 species (7 plants, 84 birds, 32 mammals and 1 amphibian). Final preparations are underway to publish the contents of this database in the APHIS Publication Series. Additionally, efforts are underway which will allow posting the entire database in a searchable form on the NWRC Web site.

TABLE 3—USDA VERTEBRATE CONTROL PRODUCTS CURRENTLY AUTHORIZED FOR INVESTIGATION BY THE U.S. FOOD AND DRUG ADMINISTRATION

INAD no.	Product name	Authorized species	Research comments
WILDLIFE IMMOBILIZING AGENTS			
6602	Alpha–chloralose (AC)	Pigeons, coots, ravens, waterfowl (Anseriformes)	AC can only be used to live-capture birds. It cannot be used as a toxicant. It is currently available as a powder for formulating with corn oil. APHIS has requested that FDA allow the use of tableted AC for waterfowl in addition to the powdered product. On a case-by-case basis, the FDA has authorized the use of AC to remove peafowl, wild turkeys, and black-crowned night herons.
9528	Propiopromazine hydrochloride	Wolves, coyotes, feral dogs	Current research evaluates capture rates and the rate of nontarget incidents. No registration activity is pending.
WILDLIFE CONTRACEPTIVE AGENTS			
10006	Gonadotropin releasing hormone (GnRH) (Gonacon®)	White-tailed deer, coyotes, prairie dogs, and other rodents	NWRC has been involved in testing GnRH on white-tailed deer, coyote, Norway rats, and rabbits. Current projects involve bison, and domestic pigs; plans are being made for work on wild horses and California ground squirrels. The registration unit is assisting with product registration plans for a single-shot GnRH vaccine.
9958	Porcine zona pellucida (PZP) (Zonacon®)	White-tailed deer, mule deer, coyotes	NWRC has been involved in testing PZP on white-tailed deer, coyotes, and rabbits. Current projects are evaluating a single-shot vaccine on white-tailed deer. The registration unit is assisting with product registration plans for a single-shot GnRH vaccine.
10700	20, 25 diazacosterol dihydrochloride (Diazacon™)	Black-tailed prairie dogs	Diazacon was previously registered by the EPA as a pigeon contraceptive (Ornitrol™). NWRC has been involved in testing diazacosterol on black-tailed prairie dog, Norway rat, and voles. Currently, projects are evaluating the ring-necked dove and Norway rat; additional work is planned on the black-tailed prairie dog. FDA authorization is not currently being pursued for diazacosterol.

PROVIDING WILDLIFE SERVICES

Goal: Provide high-quality wildlife damage-management services for our customers that result in the protection of agriculture, wildlife and other natural resources, property, and human health and safety.

NATIONAL SUPPORT

Buck Island Reef National Monument Rat-Eradication Project—NWRC scientists from Fort Collins collaborated in December 2000 with biologists from the Alabama WS State office during a rat-eradication project in the USVI. Buck Island is a U.S. National Park and has suffered severe damage to native flora and fauna from introduced black (roof) rats. Sea turtle eggs and nests have been particularly vulnerable to the rats. Based on the team's earlier recommendations in February 1998, the NPS distributed a registered 0.005-percent diphacinone bait block in a grid of bait stations covering the entire 180-acre island, with a final baiting conducted last in October 2000. The December 2000 visit was to determine efficacy of the rat control program.

While no rats were captured over 5 days in any of the five trap-lines placed on the island, many house mice were captured. House mice (also an introduced species) had never been reported on the island previously, and none had been captured in all the previous trapping efforts. It is surmised that a population of house mice had probably been on the island for a long period of time, but had been suppressed by the black rats. Removal of the rats could have allowed irruption of the house mice. It remains to be seen whether this burgeoning mouse population will now impact the island's flora and fauna.

Beaver Damage at Arizona Demonstration Project—NWRC is collaborating with the Arizona WS program in response to a request by a State agency in the Southwest for research to identify means to resolve problems caused by beaver. The agency is restoring critical riparian and wetland habitats that were previously lost because of water resources development in the Phoenix metropolitan area. The restoration area is approximately 9.2 miles in length and 1 mile wide, encompassing about 5,600 acres and has been developed to determine the net benefit such a system and associated riparian habitat will have in the Salt, Gila, and Aqua Fria River area. This demonstration project has already successfully established a small wetland habitat occupied by a variety of flora and fauna. Unfortunately, excessive beaver activity is negatively affecting current status.

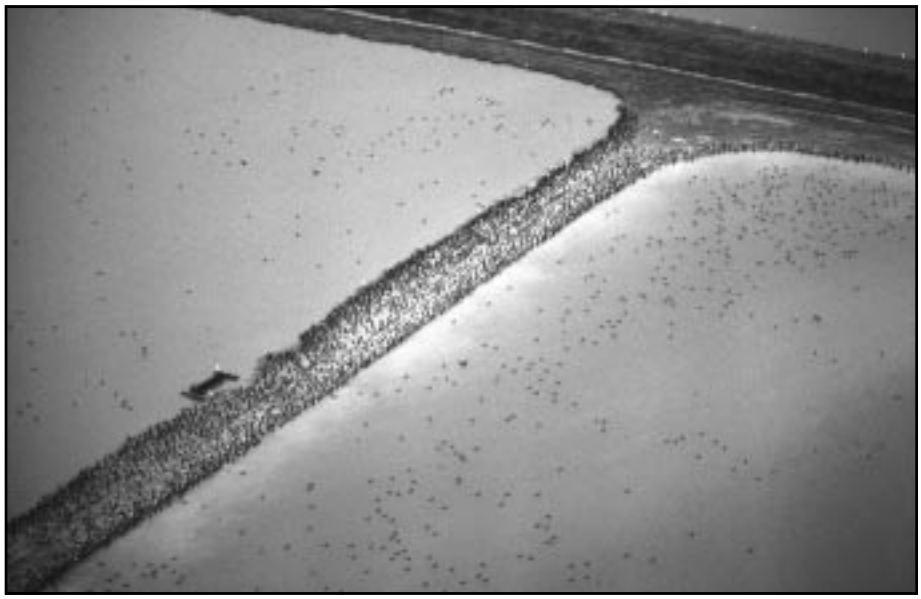
Although animal foraging is an expected and natural component of a balanced ecosystem, beaver activity at these sites has become destructive. Some areas have been rendered barren of aquatic plants, while numerous trees have been cut or girdled, and extensive burrowing has undermined dikes and islands. Lethal removal of animals is not a viable option, and a current lack of feasible sites prohibits relocating all but a few animals.

An NWRC scientist visited this site in March 2001 to assess the interest and feasibility of developing and obtaining funding for a multiyear research project to develop a strategy combining nonlethal approaches to deter destructive beaver activity while suppressing numbers by reducing reproduction and invasion rates.

Catfish Aquaculture Farm Damage Reduction—While conducting aerial surveys of double-crested cormorants and American white pelicans in March 2001, a biologist from the NWRC's Starkville, MS, field station located a catfish aquaculture farm with a particularly severe bird depredation problem. Approximately 5,000 pelicans and 1,500 cormorants were observed actively foraging in catfish ponds on the farm. The NWRC wildlife biologist immediately contacted a WS Specialist in Stoneville, MS.

The two biologists met at the site and dispersed the pelicans and cormorants from the area using a nonlethal laser device. Additionally, the biologists contacted the current owners and assisted with owner efforts to contract for harassment efforts at the site. Aerial surveys conducted later in March documented the complete absence of American white pelicans from the site and a reduction in cormorants from 1,500 to 3 individuals.

Michigan Bovine Tuberculosis Outbreak—WS has received emergency funding from USDA to help resolve the bovine tuberculosis (TB) outbreak in cattle in Michigan. It appears that wildlife play a role in disease transmission by providing a reservoir for the disease as white-tailed deer and various carnivores collected during surveillance hunting and trapping have tested positive for TB. Three NWRC scientists joined Michigan WS staff in attending the 2-day conference on bovine TB in Lansing in March 2001. This forum, with more than 100 attendees, provided an update on the status of the outbreak and activites underway to combat it. The WS group was also able to meet with key participants from several State and Federal agencies, as well as Michigan State University researchers, to discuss roles and plan future research and management needs and collaborations.



The WS group then visited the outbreak area in northeastern Michigan where TB-positive cattle have been found on 14 farms. Based on the meetings and visits, WS personnel were able to assess the wildlife research and management needs. Research priorities include identification of deer–cattle interactions, development of barriers to prevent deer movement onto cattle pastures, study of the potential use of coyotes as a sentinel species, and determination of other possible wildlife reservoirs and hosts of the disease. NWRC has developed a multiyear research project to address bovine TB and wildlife disease issues.

Skunk Rabies Vaccination Project—Several NWRC employees from Fort Collins assisted WS biologists in implementing a skunk rabies vaccination project during May in Flagstaff, AZ. The project was in response to a request to WS from State and Federal agencies for help in controlling the spread of the virus. In January 2001, one skunk tested positive for a bat variant of rabies. Since this initial case, 17 road-killed, trapped, or nuisance skunks submitted to the Arizona Health Department have tested positive for the deadly virus. All areas within a 35-mile radius of Flagstaff were under quarantine until the end of July. Pet owners within this radius were advised to bring free-roaming pets indoors, keep pets leashed when on walks, and ensure that all pets are vaccinated against the disease.

WS has set up a quarter-mile grid system over the quarantine area for trapping and monitoring skunks. Skunks trapped within the core area where rabid skunks were previously found were euthanized and tested for rabies. Those trapped outside this core area were weighed, vaccinated, ear tagged, and released. Within the first 2 weeks of monitoring, 7 of 22 trapped skunks were euthanized, and 15 were vaccinated. Monitoring data indicate the WS program successfully halted this rabies outbreak in Flagstaff.

Gull-Billed Tern Predation in San Diego Bay—A small population of gull-billed terns nests in San Diego Bay near nests of the endangered western snowy plover and California least tern. Some gull-billed terns have been observed preying on the chicks of these endangered species. It is unknown whether predation is a random event by an individual tern or if multiple gull-billed terns from the colony prey on chicks.

During June 2001, in cooperation with California WS personnel and other Federal personnel, NWRC researchers developed a safe and effective trapping technique to capture and mark individuals birds. Following marking, personnel observed tagged gull-billed terns foraging in least-tern and snowy-plover nesting areas. These data will help both our collaborators and WS in developing a management strategy for the terns.

American White Pelicans Banding Initiative—For the fourth year, biologists from the NWRC's Starkville field station, with the help of 65 personnel from Federal and State agencies and wildlife conservation groups, banded 2,700 American white pelicans at the Chase Lake National Wildlife Refuge in North Dakota in July 2001. Chase Lake is the largest breeding colony for these birds in the United States. The pelicans breed in the north-central United States and Canada and migrate to the lower Mississippi River Valley for the winter.

Aquaculture producers in the Southeast are becoming more concerned about the impact of the pelicans on their industry. The birds not only feed at commercial aquaculture facilities but also appear to be the avian host for the trematode tentatively identified as *Bolbophorus* spp. Several producers have recently suffered crippling fish losses due to heavy infestations of these trematodes.

Observations of marked pelicans will enable researchers to estimate reproduction rates, age-specific survivorship, and colony fidelity. This study will provide information for assessing the population status of this species and evaluating management alternatives.

Air Force Base Habitat Management Plan—A scientist from NWRC's Sandusky field station was invited to a Federal military base in Massachusetts in July 2001 to discuss NWRC's current research on grass management for airports and to review proposed habitat management plans for the base. Though airports can provide important habitat for birds whose numbers are in decline, bird–aircraft collisions are a major safety concern; therefore, habitat management must focus on minimizing birds in aircraft movement areas. A compromise plan was agreed upon for the airbase to provide habitat for upland sandpipers and grasshopper sparrows while minimizing attractive habitat near runways and

taxiways. All grass within 300 to 500 feet of runways and taxiways will be mowed as needed to maintain height at 7 to 14 inches. Grassland habitat outside these zones will be mowed only once every year after completion of the nesting season. In addition, some brushy areas away from aircraft movement will be converted back to grasslands to replace lost nesting habitat for plovers and sparrows near runways. Bird numbers and strike rates will be monitored to determine the effectiveness of this mowing plan and adjustments that may be needed.

National Wildlife Strike Database—Since the 1960s, the FAA has maintained a paper-based filing system containing voluntary reports (sent in by pilots and airport personnel) of bird or other wildlife collisions with civil aircraft. Through an agreement with another Federal agency, NWRC's Sandusky field station has compiled all reported strikes since 1990 into an online National Wildlife Strike Database. Although 35,000 strikes were reported from 1990 through 2000, NWRC biologists estimate that this number represents only about 20 percent of strikes that actually occurred. This lack of reporting is a major hindrance to defining the nature and costs of wildlife strikes and in developing programs to reduce strikes.

To raise the reporting rate, an online reporting system was developed in 2001 [see http://www.wildlife-mitigation.tc.faa.gov]. Reports increased from 34 in April 2001 to 64 in June 2001. Strikes may still be mailed in to the Federal Aviation Agency (FAA) on Form 5200–7, but NWRC and the FAA are encouraging WS biologists and others working on airports to use the online system.

Pregnancy Detection Test for Wild Canids—The diagnosis of pregnancy in the domestic dog is commonly made with abdominal palpation or ultrasound. Both techniques require experienced staff and cooperative animals. When performed on wild canids, sedation is typically required. A scientist at the NWRC Logan field station has found that relaxin, a hormone synthesized in the placenta, can be detected in coyote blood using commercially available assays. The presence of relaxin is a reliable tool for the detection of pregnancy in coyotes and a valid alternative to palpation. The methodology may be useful with other wild canids.

INTERNATIONAL COOPERATION

NWRC Scientist Assists Mexico in Site Selection and Design for New Airport—In February 2001, a scientist from NWRC's Sandusky field station completed his fifth trip to Mexico since 1996 to assist biologists with the Mexican Government and National University of Mexico in evaluating bird hazards at the existing Mexico City International Airport (MCIA) and at proposed sites for a new international airport. These consultations have been sponsored by the Mexican Ministry of Communication and Transport through an agreement with the FAA. Bird species hazardous to aviation (e.g., waterfowl, raptors, and vultures) are common in the Mexico City region, and the Mexican Government wants to ensure that their existing airport and the new airport are designed and managed to minimize attractiveness to birds.

The biologists censused bird populations in wetland, agricultural, and landfill areas throughout the Mexico City region. Based on these surveys, the biologists made recommendations to not only minimize bird strike hazards at the proposed airport sites but also to develop and enhance important wetlands away from the proposed sites. In addition, the biologists undertook a small-mammal population study at MCIA to determine the food source for raptors and great egrets that frequent the runway areas. The biologists found abundant populations of four rodent species in airport grasslands. Maintaining grass at less than 5 inches high should reduce these rodent populations. Such advanced planning and monitoring is essential for developing and implementing environmentally sound and efficient bird hazard-reduction programs for airports. Bird–aircraft collisions cost the aviation industry more than $1 billion a year worldwide. Bird strikes are of particular concern in Mexico City because of the high elevation (about 7,400 ft) of the existing and planned airport sites.

Hutia Control at a Military Base in Cuba—During May 2001, an NWRC scientist accompanied a wildlife specialist from the WS Virginia State office to a military base in Cuba to assess a rodent damage situation. It was apparent that hutia (known as banana rats) were very numerous at the base and were causing extensive damage to both natural vegetation and landscape plantings. These nocturnal rodents also had been chewing through wires and cables under vehicles and leaving large amounts of feces. Hutia are native to Cuba but are rare outside the base because their large size (10–12 lb) makes them attractive as a high-protein food source.

Examination of dozens of hutia revealed that they are healthy and very successfully reproducing. Hutia appeared to use all types of habitats fully on the base, spending days underground or in trees and foraging extensively throughout the night. Current management by base personnel includes shooting and live-trapping. Management is considering the use of rodenticides in residential and remote areas where shooting is restricted or not practical. WS personnel are also helping to control the many other introduced and feral species that occur at the base, including goats, white-tailed deer, guinea fowl, pigeons, cats, and dogs as part of an effort to restore the native ecosystems.

VALUING AND INVESTING IN PEOPLE

Goal: Promote an organizational culture which values and invests in our people to support their professionalism, competency, and innovation as Federal leaders of wildlife damage management.

Detail to WS Operations—In October 2000, Doris Zemlicka, an NWRC wildlife biologist at the NWRC's Logan field station, received recognition from the Utah WS program. Utah WS State Director Mike Bodenchuk presented the award, which recognized Zemlicka's contributions when she served as both an urban specialist and upland game protection trapper for WS operations.

Douglas L. Gilbert Award—Dr. Michael W. Fall, retired NWRC Mammal Research Program Manager, received this award for outstanding achievements in wildlife sciences at the Colorado chapter of The Wildlife Society's annual meeting in Grand Junction, CO, in January 2001. The Gilbert Award is the most prestigious given by the Society and is intended to recognize professional achievements at the national level. In Dr. Fall's case, the award also recognized achievements at the international level. The award recognized the impacts Dr. Fall has made in the field of wildlife science during his 30-plus-year career as a scientist, research administrator, supervisor, and mentor. Previous recipients of the award include former Denver Wildlife Research Center Director Paul Vohs, Aldo Leopold Award winner and CSU professor Gary White, and current president of The Wildlife Society, Len Carpenter.

2000 NWRC Publication Awards—NWRC Director Richard Curnow presented the 2000 Publications Awards to the NWRC authors of the following publications:

Provenza, F. D.; Kimball, B. A.; Villalba, J. J. 2000. Roles of odor, taste, and toxicity in the food preferences of lambs: implications for mimicry in plants. Oikos 88: 424–432.

Kimball, B. A.; Mason, J. R.; Blom, F. S.; Johnston, J. J.; Zemlicka, D. E. 2000. Development and testing of seven new synthetic coyote attractants. Journal of Agricultural and Food Chemistry 48: 1892–1897.

These publications are excellent examples of the quality of research being done by Center scientists to address the complex issues surrounding predation management.

NWRC Scientist Honored by Airline Pilots Association—Dr. Richard A. Dolbeer, a biologist at NWRC's Sandusky field station, was honored by the 55,000-member Air Line Pilots Association at the Bird Strike Committee–USA/Canada meeting in Minneapolis for "scientific integrity in research and worldwide leadership in reducing wildlife hazards to aviation." After receiving the Association's award, Dolbeer was invited to address its Air Safety Forum in Washington, DC, where he discussed the status and future plans for NWRC research on aviation safety. This NWRC research project represents a cooperative effort that combines the resources of WS, other Federal agencies, private industry, and various airports for the development and objective evaluation of effective techniques for reducing bird–aircraft collisions.

Ohio Community Service Award—Ms. Mona Rutger, an employee of NWRC's Sandusky field station, was recognized by the Sandusky Register as a recipient of the Register Award for 2000. This award recognizes people for outstanding service and commitment to the Sandusky-area community. Rutger operates a licensed wildlife rehabilitation center on her property near Sandusky, where she provides an outstanding wildlife education center for the community. She gave programs for more than 33,736 children during 2000. Rutger incorporates the work done at NWRC into her programs to educate people regarding the need for habitat management and wildlife damage management as a part of wildlife conservation. Because of her extensive experience in maintaining numerous wildlife species in captivity, Rutger is a valuable resource for NWRC scientists working on wildlife damage management research projects at the Ohio field station.

German Student Internship—Work with cooperative student programs by NWRC staff provides excellent learning opportunities for students and additional field assistance for field studies conducted by Center scientists. In 2001, Mr. Andreas Hahn, a forestry and wildlife student from a university in Germany, completed an internship with the NWRC's Olympia, WA, field station. Hahn's primary activity was assisting in a study of the nontarget impacts of a rodenticide application to reduce pocket-gopher damage to tree seedlings on reforestation sites. He also studied the biology and behavior of several North American wildlife species and assisted in providing care for research animals, met with State, Federal, and private forest managers to learn various approaches for managing timber and forest resources in the Pacific Northwest, and toured the forest nursery operation at a State agency. Students from Hahn's university will continue to participate in this cooperative program to gain experience in research on wildlife impacts on forest resources in the United States.

Information Transfer Awards—Several WS employees representing both research and operations were selected to receive notable USDA recognition during FY 2001. NWRC's Information Services Unit, including Diana Dwyer, Laurie Paulik, Aimee Noble, and Nancy Freeman, received the USDA Unsung Heroes Award from the USDA Organization of Professional Employees. The award recognizes the contributions of this group of dedicated NWRC individuals in disseminating wildlife damage-management information to the WS program and its many public stakeholders through a variety of methods including reports, literature searches, information packets, university career days, State fairs, and international symposia. This award was presented in May 2001 in Washington, DC, during Public Service Recognition Week.

Another group of WS employees also was selected to receive the USDA 2001 Secretary's Honor Award for its involvement in the development of the "Living With Wildlife" readers and activity sheets. Craig Coolahan, Douglas Hall, Diana Dwyer, and Kathleen Fagerstone, along with Bette Blinde, executive director of the Colorado Foundation for Agriculture, have produced 10 4-page readers that interactively inform elementary students about the many diverse issues associated with beaver, blackbirds, brown tree snakes, Canada geese, cormorants, cougars, coyotes, deer, and raccoons. To date, 150,000 copies of these readers have been published and used in the classroom. The Secretary's Honor Award is one of the most prestigious departmental awards given to employees. Secretary Ann Veneman presented the award in June 2001 in Washington, DC.

Colorado State University Undergraduate Research and Creativity Symposium—CSU in Fort Collins annually hosts an Undergraduate Research and Creativity Symposium at which students present their research. Three CSU undergraduate students that have been working with a scientist in the NWRC Fort Collins headquarters between 2000 and 2001 received recognition in 2001. Ms. Stacey Wynia, a senior from the College of Natural Sciences (Department of Biology), received an All Symposium Award of Highest Distinction for her research on *Campylobacter* spp. and Canada goose feces. This research showed that human-pathogenic forms of *Campylobacter* occur in 13 percent of goose feces in Fort Collins, CO.

Ms. Megan Parks, a junior from the Department of Fishery and Wildlife Biology, received a Highest Distinction Award from the College of Natural Resources for her work on the efficacy of terpenoids as bird repellants. Her research showed that citronella-like compounds may be useful as natural-product-based bird repellants.

Ms. Katy Patz, a junior from the Department of Animal Science, received a Highest Distinction Award from the College of Agriculture for her research on silica uptake in common grasses. This research showed that silica content of bluegrass, rye, and fescue can be increased by supplemental fertilization. Because herbivores prefer plants without a high silica content, this research may lead to the development of turf varieties that are less preferred by geese.

These awards are the culmination of hard work and dedication on the part of the students and show their commitment to carrying out applied research to better resolve conflicts between humans and wildlife. Other CSU undergraduate students working with NWRC scientists have received similar recognition in the recent past.

APHIS' New ExCEL Program—Ms. Leah Angers and Ms. Cherryl Tope from the NWRC Fort Collins headquarters and Ms. Lilian Kamigaki from the NWRC Hilo, HI, field station were selected to participate in APHIS' New ExCEL program, "New Expanding Competencies Through Empowerment and Learning." Seven of the 21 APHIS employees selected for this program were from WS. The employees completed the first core training component, "Dealing with Change and Transition and Building Self-Esteem," in Washington, DC, during April. Program components will include managing stress, negotiating, working with diverse personalities, and identifying personal strengths.

Visiting Scientist Recognition—NWRC biologist Dr. Larry Clark was recognized as a Visiting Scientist sponsored by the State of Victoria's Natural Resources and Environment (NRE) program, Australia. The Visiting Scientist program was initiated to foster communication between NRE and foreign scientists working in wildlife damage management. As part of the sponsored lecture tour, he also presented the keynote lecture on bioeconomics of vertebrate pest control at the 12th Annual Australian Vertebrate Pest Conference held in Melbourne in May 2001. He also presented seminars on bird control methods to the NRE Horticultural Research Center staff, gave an overview of NWRC predator research projects to NRE dingo control and research groups, and reviewed emerging technologies (such as cell-culture methods to reduce reliance on whole-animal models) for attendees at a special international symposium on animal welfare and research hosted by Monash University, Melbourne, Australia.

Gary White, Aldo Leopold Award Winner, Honored—On September 19, 2001, NWRC was honored to host Dr. Gary White, professor of fishery and wildlife biology at Colorado State University. Dr. White was the 1999 (51st) recipient of the Aldo Leopold Memorial Award for excellence in wildlife research, management, and conservation. He is well known for his leadership in the development of wildlife population estimation software, including CAPTURE, SURVIV, RELEASE, NOREMARK, and MARK.

In the morning, he led a general discussion of the academic training for wildlife students and then fielded diverse questions from NWRC Staff on a range of issues related to wildlife research and management. In the afternoon, Dr. White presented a public seminar titled Perspectives on Rigor in Wildlife Management—a topic of intense personal interest in which he posited that wildlife scientists need quantitative training so as to be able to think logically about wildlife issues. Subsequently,

Dr. Richard Curnow, Director, NWRC, presented Dr. White with a plaque recognizing his contributions to the field of wildlife biology. A tape of his remarks is available from NWRC Library Services.

Dale Nolte Completes a Sabbatical Program in Asia—In August 2001, Dr. Dale Nolte completed an NWRC-sponsored sabbatical program in Southeast Asia and Indonesia. Nolte collaborated with Dr. Grant Singleton of Australia's Commonwealth Scientific and Industrial Research Organization and Dr. Dan Sanchez (University of the Philippines, Los Baños) to present workshops on rodent biology and management for rice farmers in several Philippine provinces. The training program is sponsored by the International Rice Research Institute, and includes descriptions of rodent biology, discussions of current farming practices and rat damage management, community-based rat damage control, and decision analysis when implementing a rodent control program.

Dr. Nolte spent 6 weeks at the Rice Institute working with students and staff to develop protocols for assessing rice-field rat activity patterns. Potential benefits for improving the general knowledge regarding chemosensory attributes and foraging ecology of the rice-field rat also were discussed. Dr. Nolte also met with officials from Vietnam's National Institute of Plant Protections (NIPP) and toured agricultural sites in Vinh Phuc Province, Vietnam, and visited research plots near the village of Tien Phong and pine plantations near Hai Phong.

Visiting Scientist—NWRC is hosting Dr. Steve Horn as a visiting scientist under the Center's sabbatical program during 2001. Horn recently returned to full-time research and teaching at the University of Wyoming after many years of distinguished service as the Dean of Wyoming's College of Agriculture and as Secretary of Agriculture for the State of Colorado. His academic background includes training in wildlife science and experimental psychology. In addition to his administrative responsibilities at Wyoming, Dr. Horn has continued to maintain an active research program. He and his postgraduate student, Dr. Charlie Stith, have conducted ground-breaking research on the use of mifepristone as an orally deliverable reproductive inhibitor in coyotes. Much of this research was conducted in close cooperation with Center staff in Logan, UT. Dr. Horn's sabbatical goals include continuing this work, developing a Web-based graduate certificate program for WS personnel, and gaining experience in the registration process for wildlife pharmaceuticals.

INFORMATION AND COMMUNICATION

Goal: Collect and analyze internal and external information to monitor and enhance program effectiveness. Communicate internally and externally to accomplish our mission and to build an understanding of the Federal role in wildlife damage management.

INFORMATION SERVICES

This past year has been busy and productive for the NWRC Information Services (IS) Unit. The staff received USDA's Unsung Heroes Award for providing excellent information services to WS employees. A staff member also was part of the Living with Wildlife Committee, which received the Secretary's Honor Award for educational products, children's activity sheets, Web-based Choices and Consequences Dilemmas, and training materials they created for WS employees to use in classroom or public forums.

IS staff members worked with WS headquarters and Legislative and Public Affairs staff to produce the WS FY 2000 Information Reports, NWRC Highlights Report, and the NWRC Research Update. The unit leader made presentations on wildlife damage information resources at the Natural Resources Council Meeting, in West Yellowstone, MT, and the Vertebrate Pests of Agriculture, Forestry and Public Lands Meeting in Reno, NV. She also conducted numerous tours of the NWRC headquarters facility and provided information about the NWRC and WS program to visitors.

The unit leader is a member of the APHIS Web Developers Team and leader of the subteam on Web structure and navigation. The team's purpose is to evaluate the APHIS Web structure and develop guidelines for creating and managing Web pages by APHIS units.

NWRC created a WS Image Database of 2,000 scanned slides that will be made available to staff members. A large part of the project was devoted to identifying the slides and creating metadata and the database structure. Instructions for using the product and a Web-ready version will be completed in FY 2002.

NWRC also participated in the CSU Natural Resources Career Fair and staffed a booth at the Denver Western Stock Show with WS Operations personnel and public affairs specialists. The WS booth was awarded the Best Educational Booth Award for 2001.

Library—Construction projects loomed large on the library horizon again in FY 2001. Space was lost, a new counter and cabinetry were installed, and old cabinetry jumped to new locations. Overflow materials edged into surrounding spaces with library employees claiming the right of eminent domain. Our newly installed photocopier/fax/scanner/printer streamlined several important library functions. Interlibrary loan requests can now be sent directly to patrons' electronic mailboxes.

Online access to NWRC library resources was greatly enhanced. WebZap, purchased in 2000, is now available to WS employees wishing to electronically request articles and other reprints through the NWRC Library. Nearly 160 authorizations have been entered into the system. Additionally, access to NWRC's subscription databases, ChemBank, PestBank, Agricola, and FirstSearch, is now available though the Web. Web access allows personnel at field stations as well as at NWRC headquarters in Fort Collins to use the databases. More than 113 items were added to the library online catalog.

A seminar on desktop access to library services covered all products available to NWRC employees via their computers and discussed access methods and search tips. The Library Online Catalog was significantly upgraded with a Web-based access search engine.

New project page descriptions and photographs were added to the NWRC Web site, including pages for controlling wildlife vectors of bovine tuberculosis and rabies, develop-

ment and evaluation of rodent damage-management methods, and research on improved assessment, sampling, and economic methods for wildlife damage management. A history features page was initiated and features on NWRC's Logan field station, May Thatcher Cooke, Clinton Hart Merriam, and NWRC's International Programs were produced. A seminars page was added to publicize visiting speakers, and a subject index was added to provide an alternate means of accessing research topics. More than 82 publications were scanned and added, full-text, to the Web. Additionally, all 2001 publications are accompanied by short abstracts. All NWRC job ads were posted on the Web and all Wildlife Services Tech Notes added to the NWRC Registration Unit page. Research program interfaces were redesigned and keywords added. Staff is working retroactively to make Web pages more accessible to individuals with disabilities.

Library personnel responded to more than 400 reference requests and performed more than 150 online searches. Citations were added to the BTS database, duplicates were removed, and keywords were added.

Library staff videotaped more than 28 seminars and scheduled other employees to videotape presentations. All seminars were distributed on CD to all field stations.

Library staff borrowed 1,026 items from other libraries for the use of NWRC employees and lent 408 items to other institutions. Library staff also photocopied and mailed more than 2,530 articles and reports for requesters and distributed more than 2,500 copies of NWRC-authored publications.

Archives—Beginning in January 2001, and continuing to the present, a CSU Public History graduate student has been inventorying and organizing a small section of NWRC slides. The images are entered on a searchable database for easy retrieval. In addition, a temporary employee was hired to work on a digitization project, in conjunction with Legislative and Public Affairs, to index and identify scanned WS images. The final product will be CDs of organized, scanned images that will be sent to WS state offices for use in publications and presentations.

Archives staff completed a reboxing effort to appropriately house the entire NWRC collection of unpublished reports. Putting the records in archival boxes and file folders ensures that they will remain protected. In addition, a collection of more than 100 magic lantern slides, dating from about 1918, have been inventoried and placed in appropriate archival housing. The lantern slides were probably used by staff of the Bureau of Biological Survey (a predecessor agency to WS) to publicize animal control work. Magic lantern slides were widely used in the early 20th century, and the NWRC collection provides a fascinating insight into public presentations that illustrated wildlife damage-control techniques.

An exhibit case now resides in the main hall of the NWRC Wildlife Science Building. A team made up of primarily library and archives staff installed the first exhibit, "Hide and Seek: the History of Telemetry at the National Wildlife Research Center," in May 2001. Exhibits rotate every 6 months and will provide an additional venue to highlight NWRC history and current work. Archives staff continue to feature NWRC history regularly on the employee lunchroom bulletin board. The same material is also added to a rotating history page on the NWRC Web site.

Work was completed on reorganizing and refiling much of the EPA pesticide registration material. Various staff assisted in the effort with the end result of a more coherent, retrievable system for accessing records.

SEMINARS

The NWRC Seminar Program offers a valuable forum for the exchange of ideas among Center staff, field station personnel, visiting scientists, and WS operational staff. During the past year, NWRC hosted 22 seminars, including 11 presentations by speakers from various corporate, state, and foreign wildlife organizations, Center and field station staff, and NWRC job candidates. Presentations were videotaped and distributed to Center field station and WS regional offices. Topics included the WS management information system, chronic wasting disease and other zoonotic diseases, Hawaiian invasive species, vulture roost dispersal, toxicant development for BTS, ground-based radar technology for bird detection, potential techniques for fertility control in wildlife and predator ecology.

NWRC SEMINARS

Speaker	Affiliation	Topic
Phillip Cowen	Landcare Research, Palmerston North, New Zealand	Fertility control for possum management in New Zealand
Mike Riley	WS Management Information System Support Center, Fort Collins, CO	MIS 2000: new and improved data captures
John Loomis	Agricultural and Resource Economics, Colorado State University, Fort Collins, CO	Economic values of endangered species: methods and summary of estimates
Karen Blejwas	University of California—Berkeley, CA	Coyote control to reduce livestock predation: targeting individuals versus populations
Ann Carter	Maui Invasive Species Committee	Maui invasive species committee: how and why?
John Eisemann	NWRC (Fort Collins)	Human poisonings and rodenticies—Do you know where your children are?
Mike Avery	NWRC (Gainesville)	Vulture roost dispersal in Florida—recent trials with lasers and effigies
Adam Kelly	Geo-marine, Inc., Panama City, FL	Radar remote sensing of large bird roosts
Kathleen Fagerstone, Lowell Miller, John Johnston, Christi Yoder, Larry Clark, and Kurt VerCauteren	NWRC (Fort Collins)	Nicarbazin research for nonlethal management of pest avian populations
Michael Miller	Colorado Division of Wildlife, Fort Collins, CO	Epidemiology and management of chronic wasting disease in free-ranging deer and elk
Jim Coleman	Landcare Research, Christchurch, New Zealand	Management of pest birds in New Zealand
Bruce Bryant and Michael Kirifides	Monell Chemical Senses Center, Philadelphia, PA	Cell-culture screening and phytochemical characterization of a natural product repellant

NWRC SEMINARS CONTINUED

Speaker	Affiliation	Topic
Stewart Breck	NWRC (Fort Collins)	The effects of flow regulation on the population biology and ecology of beavers in northwestern Colorado
George Linz	NWRC (Bismarck)	The blackbird business plan: implications for NWRC
Vera Voznessenskaya	Russian Academy of Sciences, Moscow	Predator odors and reproduction in Norway rats
Richard Dolbeer, Sandra Bernhardt, and Scott Barras	NWRC (Sandusky)	NWRC's "Wildlife hazards to aviation project": creating safer skies for all who fly—birds and people
Laurie Paulik and Aimee Noble	NWRC (Fort Collins)	Desktop access to library services
Vanessa Lamb	APHIS summer intern	My summer in Tanzania
Clinton Dennison	Job candidate	Reproduction in three species: a prospectus
Kimberly Bynum	Job candidate	Wildlife immunocontraception: comparison of PZP and PZP–KLH vaccine formulation
Tonya Favinger	Colorado Dept. of Agriculture, Denver	Pesticide registration in Colorado
Dale Nolte	NWRC (Olympia)	Wildlife damage management consultations in Southeast Asia
Jeffrey Homan	NWRC (Bismarck)	Dispersal patterns of red-winged blackbirds staging in South Dakota during spring migration
Gary White	Colorado State University, Fisheries and Wildlife Biology	New biometric tools for wildlife research and rigor in wildlife management

MEETINGS, WORKSHOPS, AND CONFERENCE PRESENTATIONS

NWRC Cosponsors Colorado Front Range Prairie Dog Technical Workshop—NWRC cosponsored the 2 1/2-day Colorado Front Range Prairie Dog Technical Workshop along with the FWS, Colorado Division of Wildlife, Boulder County, and the cities of Boulder and Fort Collins in February 2001. The workshop had about 250 attendees—mostly governmental personnel.

Prairie dogs present numerous challenges to landowners and resource managers because they are considered an important ecosystem component but at the same time can cause various kinds of damage and pose a disease hazard. Invited speakers updated the participants on the topics of prairie-dog biology and ecology, legal status and distribution, socioeconomic issues, and management techniques and strategies. Special topics such as plague management and black-footed ferret reintroductions were also addressed. Several panels on special management challenges were held and various perspectives were presented with considerable interaction on this contentious issue.

Several NWRC staff from Fort Collins participated in the workshop as speakers, moderators, and logistical assistants. NWRC researchers in Fort Collins have begun an evaluation of the effectiveness of techniques such as barriers being used by municipalities and counties in an attempt to reduce conflicts.

European and USA Airport and Airfield Safety Conference and Trade Show—A scientist from NWRC's Sandusky field station represented USDA at the European and USA Airport and Airfield Safety Conference and Trade Show in Helsinki, Finland, June 18–20, 2001. The scientist presented an invited lecture on professional wildlife hazard management at airports to managers of major airports from the United States and Europe.

The lecture emphasized the diversity of work carried out by WS biologists to reduce wildlife hazards at 418 U.S. airports during the year 2000. The scientist also participated in various small-group discussions on emerging issues in airfield safety. The International and American Associations of Airport Executives, the Finnish Civil Aviation Authority, and Finnair sponsored the conference.

International Controlled Release Society Conference—An NWRC scientist from Fort Collins presented a paper at the International Controlled Release Society conference in San Diego held June 23–27. The society, with more than 3,500 members worldwide, is composed of pharmaceutical and veterinary industry scientists; academic, government, and contract lab researchers; and manufacturers.

The scientist's presentation discussed the development of a protective coating for pellets that resists breakdown in the rumen in deer and other ungulates but will break down in the acidic condition of the stomach. Additionally, a double-coated pellet has been developed that has an inner acid-resistant coating as well as a protective coating. Pellets with this double coating will bypass both the rumen and the stomach and break down in the intestine. The double-layered system is being designed to deliver immunocontraceptive agents to deer.

Predator Short Course—Scientists at the NWRC's Logan field station presented an educational program on predators to 42 senior citizens in July 20001. The program consisted of a series of lectures taught by different instructors with expertise in predation management. Presentations covered the ecology of coyotes, current research being conducted at the NWRC field station on predators and predation management, human–wildlife interactions, and predators in urban settings. The program also included a field trip to the Logan field station, which involved an extensive tour of the facility, a research exercise that examined how different pairs of coyotes show different behavioral responses to identical stimuli, and presentations by current graduate students on their thesis projects. This predator short course will become a regular part of the curriculum offered by Utah State University to seniors enrolled in the university's summer citizen program.

Endangered Species Workshop—On July 11 and 12, 2001, WS biologists from the Montana, North Dakota–South Dakota, and Nebraska–Kansas programs and scientists from NWRC's Bismarck, ND, field station attended a workshop on the Endangered Species Act (ESA). A WS Operational Support Staff specialist provided background on the history of the Act, and discussed the relationship between the ESA and the National Environmental Policy Act, providing case studies. The training was timely as the WS operations program in the Dakotas and NWRC scientists are preparing a regional environmental impact statement on blackbird management in those States.

Indonesian Research Institute Seminar—An NWRC Olympia, WA, field station scientist presented a seminar to 40 scientists and staff of the Rice Research Institute in Sukamandi, Indonesia, on July 20, 2001. The group was given an overview of the NWRC and WS program, followed by a discussion of the underlying mechanisms governing animal foraging behavior as related to identifying ways to reduce damage problems. The scientist, as part of the NWRC sabbatical program, spent 6 weeks at the Institute working with students and staff to plan studies to assess the activity patterns of the rice-field rat. Students and researchers also discussed the benefits of improving the existing general knowledge regarding chemosensory attributes and foraging ecology of the rice-field rat.

Local Wildlife Society Meeting—Two NWRC scientists from Fort Collins attended the joint meeting of the Central Mountain and Plains Section of The Wildlife Society and the Colorado Chapter of the Society July 18–20, 2001, in Fort Collins. The 100 attendees from 7 States and 2 Canadian provinces included personnel from State and Federal agencies, universities, and conservation organizations. The meeting provided an opportunity for NWRC scientists to learn more about and discuss issues related to conservation of shortgrass prairie. Many of the issues, such as predation on rare species, disease transmission from wildlife to livestock and humans, and damage by overabundant rodents and ungulates, relate to the mission and activities of WS. The NWRC scientists presented overviews of their research and discussed potential collaborations.

Society for Conservation Biology Meeting—Several WS personnel attended the 15th annual meeting of the Society for Conservation Biology in Hilo, HI, July 26 through August 2, 2001. The meeting was attended by about 1,200 persons from 42 countries. Personnel from the NWRC's Hilo field station served on the local organizing committee for the meeting and provided substantial logistical support.

There were a large number of presentations on exotic and invasive species, including several by NWRC scientists from Fort Collins and Hawaii and WS Operations biologists from Guam. There were also field trips that allowed discussion of ecological restoration efforts once exotic species (feral ungulates or rats) have been removed. It became clear that there is a need for new strategies and tools and for more agency and public support for invasive species surveillance, management, and eradication.

Washington and Alaska WS State Meeting—Biologists from the NWRC Fort Collins headquarters and Sandusky and Olympia field stations attended the Washington and Alaska WS State meeting at Fort Worden State Park, WA, July 30–August 2, 2001. Conference presentations covered a wide variety of subjects including overviews of WS programs. NWRC presentations focused on an overview of research activities, an update on the 2001 WS Research Needs Assessment, a review of Washington's antitrapping initiative and its impact on the WS program, a demonstration of mountain-beaver trapping techniques, and recent research findings for the use of lasers as nonlethal avian repellants.

Presentation on Nonlethal Wildlife Damage Management—A scientist from the NWRC's Logan field station made a presentation to the Governor's task force on nonlethal wildlife damage management in Annapolis, MD, on August 8, 2001. The task force is comprised of 16 members, including representatives from the State Senate, the House of Delegates, Maryland Department of Natural Resources, the American Bird Conservancy, The Humane Society of the United States, the Fund for Animals, USDA WS, the Montgomery County Planning Commission, the Maryland Sportsmen's Association, the University of Maryland College of Agriculture, and several unaffiliated members of the public.

The presentation focused on the need to consider nonlethal methods realistically and within the framework of integrated pest management strategies that include both nonlethal and lethal methods of conflict management. The task force is charged with presenting findings and recommendations to the governor and the State assembly by December 1, 2001.

Brown Tree Snakes 2001 Meeting—A meeting on the BTS was held August 6–10, 2001, on Andersen Air Force Base, Guam, to discuss the current and future status of BTS research and control efforts. WS employees from WS Western Region and the NWRC attended the meeting. General topics included keeping the problem from spreading, reproduction and general biology, population biology and capture strategies, current and future directions for recovery of Guam's wildlife, and toxicants and control agents. Meeting highlights included a visit to the endangered species breeding facility, a tour of the snake control areas around cargo staging areas and airports, and a demonstration by dog handlers and snake-detection dogs.

Oregon WS State Meeting Presentation—Between August 13 and 16, 2001, a scientist from the NWRC's Logan field station made two presentations at the Oregon WS State meeting in Elkton, OR. One of the talks focused on the economics of predation management, while the other outlined current NWRC bird and mammal research activities. About 50 people, including WS personnel, two

Oregon State senators, an Oregon county commissioner, and representatives from the Oregon Fish and Game Department, the Oregon State Police, and various stakeholder groups (forest protection, woolgrowers, cattlemen) attended the conference.

Mid-Atlantic WS meeting—An NWRC Logan field station scientist made a presentation on NWRC research activities and participated in other activities at the annual Mid-Atlantic WS meeting in Crossnor, NC. About 80 people, including WS personnel and representatives from the International Association of Fish and Wildlife Agencies and the Berryman Institute attended this conference.

Joint Bird Strike Committee–USA (BSC–USA) and Bird Strike Committee–Canada (BSC–Canada) Meeting—More than 330 people from 29 countries attended the 3d annual joint meeting of BSC–USA and BSC–Canada held in Calgary, Alberta, August 27–30, 2001. The goal of BSC–USA is to increase communication and professionalism among the many groups and agencies involved with wildlife issues on airports. Forty-five technical papers and posters were presented, including four by scientists from the NWRC's Sandusky field station. A conference highlight was a presentation by the Director of Airport Safety for the ALPA regarding the need for airports to institute measures that minimize wildlife hazards. These hazards cost worldwide civil aviation more than $1.2 billion per year. WS biologists are assuming an increasingly important role in reducing wildlife hazards at U.S. airports, assisting 418 airports in 2000.

High School Biology Class Presentation—An NWRC scientist from the Olympia field station was invited to address students at the Great Bend High School in Great Bend, KS, on August 31, 2001. Speaking to 70 students in 3 advanced biology classes, the scientist reviewed the role of WS and the NWRC in wildlife management. Using specific examples, such as bear damage to timber in the Pacific Northwest and rice-field rat damage in Asian rice fields, the scientist discussed the interrelationship of farming practices and species-specific behaviors that contribute to human–wildlife conflicts. The scientist also stressed the importance of research in understanding and resolving problems through development of new or improved management techniques and tools.

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[Boldface type indicates that an author is employed by NWRC.]

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