

## 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 Repel-**

**lants**—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 territorial 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 identify 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<sup>2</sup> 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 lightly 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.