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Professional Use of Pesticides in Wildlife Management – An Overview of Professional Wildlife Damage Management

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Abstract: Wildlife damage management is an important, often neglected, part of the wildlife management profession. Wildlife sometimes cause significant damage to agricultural crops and livestock, forests, rangelands, private and public property, other wildlife and their habitats, and urban and rural structures. Wildlife can also threaten human health and safety. Prevention of wildlife damage may involve use of pesticides and drugs. These include anticoagulant toxicants, acute toxicants, fumigants, repellents, frightening agents, aversive conditioning agents, contraceptives, immobilizing agents, and use of herbicides to alter habitat. This discussion will focus on the Wildlife Services program as professional users of pesticides and will examine the types of pesticides used, the reasons for their use, the magnitude of vertebrate pesticide use, and will touch on the degree of hazard inherent to those uses. Risks to wildlife associated with use of vertebrate pesticides are usually less than those associated with use of conventional herbicides and insecticides— amounts used are small, use sites are limited in area, and vertebrate pesticides generally show some specificity in their action. Also, rather than managing vertebrate pests on a population level, the trend in current wildlife management is to deal selectively with problem animals or problem situations on a local basis.

Key Words: pesticide use, wildlife damage, economics, hazards

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INTRODUCTION

In the wildlife literature there is substantial discussion of inadvertent exposure of wildlife to pesticides and contaminants but little discussion of purposeful exposure of pesticides to wildlife. I will present an overview of pesticide use in the wildlife damage management profession focusing on Wildlife Services program personnel as professional users of pesticides, a discussion the types of pesticides used, the reasons for their use, the magnitude of vertebrate pesticide use, and will touch on the degree of hazard inherent to those uses.

Wild animals are valuable natural resources and vital components of a healthy ecosystem. Wildlife provides economic, recreational, and aesthetic benefits (Decker and Goff 1987), and, to many people, the knowledge that wildlife exists is a positive benefit in itself. The rich wildlife resources in the United States are an important part of our heritage. For over 70 years, wildlife conservation agencies have focused on preserving and even increasing populations of many species of wildlife in the U.S. In many cases, such as for white-tailed deer (*Odocoileus virginianus*) and Canada geese (*Branta canadensis*), these conservation efforts have been very successful.

While wildlife abundance is desirable, conflicts between humans and wildlife occur and can be economically important. Determining the volume of wildlife-caused losses to agricultural products and other resources is difficult, and comprehensive information is not available. However, what is available shows that wildlife-caused losses are increasing, with total estimated losses resulting from wildlife damage approaching $3 billion (Conover and Decker 1991, Conover et al. 1995).

Wildlife damage management can be defined as the alleviation of damage or other problems caused by or related to the presence and behavior of wildlife. It is an often neglected, important integral component of wildlife management (Leopold 1933, Berryman 1989, Franklin 1985, The Wildlife Society 1990). The need for wildlife damage management is usually a direct result of human population growth. As human populations have expanded, much original wildlife habitat has been eliminated or modified into urban and agricultural environments rather than native habitats. Populations of many wildlife species have decreased, yet the changes in land use patterns have created an unnatural environment where other species have proliferated and become pests.

While it is acknowledged that wildlife species sometimes cause significant damage, the problems are not usually easily solved and the solutions are often hotly debated. The science of modern wildlife management involves manipulating the structures, dynamics, and relationships of wildlife populations, habitats, and people to achieve specific human objectives (Giles 1978). Because wildlife is considered a renewable natural resource, it is managed accordingly to preserve species, maintain animal populations for both consumptive and nonconsumptive purposes, and control excess nuisance species (Wolfe and Chapman 1987). Maintaining a diversity of species and ecosystems is an important consideration in professional wildlife management; however, wildlife management decisions are based not only on biological rationale, but also on human needs. Political pressures rather than science increasingly affect wildlife management decisions (Wolfe and Chapman 1987). State and federal agencies have a mandate to provide for the welfare and perpetuation of wildlife but these agencies must also be responsive to the public by resolving damage and other problems caused by wildlife.

Wildlife damage management is conducted on a national level by the U.S. Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) Wildlife Services (WS) program. The WS program is directed by law (Animal Damage Control Act of March 2, 1931) to protect American agriculture and other resources from damage caused by wildlife. Wildlife Services has personnel in most states who provide both technical assistance and direct control of damage.

TYPES OF DAMAGE CAUSED BY WILDLIFE

Professional wildlife damage specialists are called upon to resolve a broad scope of problems caused by wildlife. Wildlife cause damage to agricultural industries through depredations of crops, livestock, or forest resources. Buildings and other structures and properties can be damaged by animal nesting, burrowing, feeding, or other activities. Wildlife also create nuisance and human safety and health problems, and sometimes negatively affect other wildlife. Damage can be relatively minor, or it can be severe enough to affect the livelihood of producers or property owners.

Agricultural Industries

Agricultural crops, livestock, aquaculture facilities, and timber can represent important supplemental food sources for many species of wildlife. The dollar value of wildlife damage to agriculture in the United States has been estimated at between $600 million and $1.6 billion annually (U.S. GAO 2001). A NASS survey of 20,000 agricultural producers (Wywialowski 1994) found that 55% of the farms in the United States reported wildlife damage during 1989, with wildlife-caused losses estimated at about $461 million. If the surveyed producers estimated their losses accurately and their losses represented producers nationwide, then wildlife-caused damage to agricultural products (based on the mean of producers' estimates) may have been as high as $1.3 billion in 1989 (Wywialowski 1994).

Agricultural Crops

Nearly half of all field crop producers suffered losses to wildlife in the 1989 NASS survey (Wywialowski 1994) and the damage value was estimated at $237 million. Deer were the main wildlife group causing damage in the northeastern and north-central United States, with over 41% of producers citing losses; deer were also rated the number one wildlife problem species by farm bureaus, state agencies, and extension agents (Conover and Decker 1991). Birds cause more than $100 million in losses each year to corn, sunflower, wheat, sorghum, rice, and fruit crops (Pierce 1970, Stone et al. 1972, Crase et al. 1976, Stickley et al. 1979, Kelly et al. 1982, Besser 1985, Besser and Brady 1986, Hothem et al. 1988, USDA APHIS 1994). Much of the damage is caused by non-native species such as starlings and sparrows that have displaced native species in many areas. Millions of starlings congregate in urban roosts in the eastern U.S., causing not only crop damage, but also creating nuisance and disease problems. Waterfowl can cause millions of dollars in economic losses to grain crops each year (Knittle and Porter 1988). Annual bird damage to fruits and nuts has been estimated at $22 million for cherries, grapes, and nuts (Besser 1985), $8.5 million for blueberries, and $4 million for grapes (Crase et al. 1976).

Livestock

Of the agricultural producers surveyed that raised livestock or poultry, 20% have experienced wildlife-caused losses (Wywialowski 1994). Direct losses of sheep, lambs, and goats from predators have been estimated at $68 to $150 million annually (Wade 1982, Terrill 1988, Wywialowski 1994, U.S. GAO 2001). In 1990 alone, 490,000 sheep and lambs valued at $21.7 million and 129,400 goats valued at $5.6 million were lost to predators in the United States (NASS 1991). In 1991, the National Agricultural Statistics Service estimated predator losses of 106,000 cattle and calves valued at $41.5 million (NASS 1992). In 2002, predators killed nearly half a million livestock, mostly lambs and calves, valued a t about $70 million (U.S. GAO 2001). Coyotes were the largest cause of livestock losses, particularly in the western states, although bears, mountain lions, and other predators were also a concern. Coyote populations have proliferated in recent decades– where formerly coyotes occurred only in the west, they now occur in all eastern states in the U.S. (Green et al. 1994).

Aquaculture

Commercial aquaculture is a relatively new commodity in the U.S. For example, catfish production in Mississippi grew from one commercial pond in 1965 to over 40,000 ha of ponds in 1991 (Mott and Boyd 1995). Cormorant (*Phalacrocorax auritus*) and heron (*Ardea herodias*) populations have increased concomitantly and damage caused by these fish-eating birds increases annually. In a survey of hatcheries in the eastern U.S., Parkhurst et al. (1987) cited an average yearly loss to fish-eating birds of about $7,600 per hatchery. Stickley and Andrews (1989) and Glahn and Brugger (1995) estimated annual loss of catfish to cormorants in just the Mississippi Delta at between $2 million and $3.3 million. In a survey of catfish producers from 15 states, 69% reported some wildlife-caused losses, with estimated national losses to aquaculture estimated at $12.5 million (U.S. GAO 2001, Wywialowski 1994).

Forests

Mammals can cause extensive damage to forests. Reforestation after clearcutting is sometimes unsuccessful because of damage to planted seedlings by pocket gophers (*Thomomys* spp.*)* and other small mammals, black bear (*Ursus americanus*), deer (*Odocoileus hemionus*), and elk (*Cervus canadensis*). Pocket gophers increase in numbers on areas that are opened up by tree harvest, insect and disease losses, or wildfires, so populations can reach high numbers on disturbed sites. On the Nez Perce National Forest, Idaho, the number of pocket gopher mounds ranged from 300 per acre on minimally disturbed sites to more than 6,000 per acre on severely disturbed areas (Boyd 1987). Despite repeated reforestation attempts, some areas in the Pacific Northwest remained unforested for over 25 years after they were cut because of mammal browsing.

Disease

The WS program works both in urban and rural areas. Over 50% of the calls to the WS program currently come from urban areas, where humans are increasingly encroaching on wildlife habitats and creating suitable habitat for other species. A few species, like starlings, sparrows, pigeons, raccoons, squirrels, foxes, skunks, and coyotes, adapt easily to urban habitats. Living in close proximity to wildlife increases the possibility of disease transmission from wildlife to humans. In 1999, there were 16,423 reported cases of 11 wildlife-related diseases reported in the U.S. (U.S. Centers for Disease Control and Prevention 1999). Lyme disease accounted for the majority of cases. Unfortunately, most incidences of disease transmission from animals to humans are not reported (Conover et al. 1995), but numbers can be high. For example, 94% of the people living in the Ohio River Valley have had histoplasmosis (Henderson 1983), a respiratory disease caused by inhaling spores of a fungus that commonly grows on soil enriched by bird feces under blackbird (*Agelaius phoeniceus*) and starling (*Sturnus vulgaris)* roosts.

Recently in the U.S., the majority of rabies cases have occurred in wild rather than domesticated animals. Within the last few years Wyoming and Texas have both experienced rabies outbreaks spread by skunks (*Mephitis mephitis*), foxes (*Urocyon cinereoargenteus*), and coyotes (*Canis latrans*). Two canine rabies epizootics emerged in Texas in 1988, one in coyotes in South Texas and the other in gray foxes in West-central Texas. The South Texas epizootic alone has resulted in 2 human deaths and over 3,000 people have required post-exposure rabies injections (Oertli et al. 2002); at a cost of $1,200-$1,500 per person, this equates to a cost of $3.6 million just for post-exposure injections (pers. comm., Gayne Fearneyhough, Texas Dept. of Agric.). Since 1995, the Texas vaccination program has distributed 14 million doses of oral rabies vaccine over 220,100 square miles of South and West-central Texas. Over 78% of the coyotes tested from South Texas were positive for the biomarker included in the bait material and 49% have shown evidence of immune response to the vaccine. There were no cases of canine strain rabies reported in 2000 so it is hoped that the virus has been eliminated from Texas.

Human Health and Safety

Conover et al. (1995) estimated that there are approximately 8,000 collisions between military aircraft and wildlife (mostly birds) each year, causing about $112 million in damage. There are also approximately 6,000 bird strikes to civilian aircraft annually (U.S. GAO 2001). From 1960 to 1988, 104 human fatalities resulted from bird strikes to civilian aircraft (Conover et al. 1995). Globally, wildlife strikes have killed more that 400 people and destroyed over 420 aircraft (Cleary et al. 2002). A strike by a flock of snow geese to a Boeing 747 at John F. Kennedy International Airport in 1995 resulted in $6 million in repairs (Cleary et al. 2002).

Deer are becoming a severe threat to human safety and health in the northeastern U.S. Based on a survey of 35 states, 538,000 deer (*Odocoileus* spp.) collided with vehicles in 1991 (Romin 1994). After estimating unreported collisions and collisions in the remainder of the states with deer, Conover et al. (1995) estimated that over 1 million deer-vehicle collisions occur annually in the U.S. At an average repair cost of over $1,500 per vehicle, damages would amount to approximately $1.1 billion (Conover et al. 1995). Rue (1989) reported a 4% human injury rate and a 0.029% fatality rate from deer-vehicle collisions, which would mean about 29,000 injuries and 211 human fatalities annually (Conover et al. 1995). This impact will likely increase because of the increasing deer populations and increasing number of vehicles on roads in many states.

Effects on Other Wildlife

A little-known problem faced by wildlife damage managers is protecting waterfowl and endangered or threatened species from predators. Mammalian predators, especially red foxes (*Vulpes fulva*), striped skunks, raccoons (*Procyon lotor*), and mink (*Mustela vison*), seriously impact waterfowl nesting success in small wetland areas surrounded by agricultural lands by preying on eggs, chicks, and adult birds (Cowardin et al. 1985, Sargeant et al. 1984); predators have contributed to a significant decline in waterfowl production in the Dakotas. Exotic predators also cause problems for wildlife. In Hawaii, rats (*Rattus* spp.) and mongooses (*Herpestes auropunctatus*) have contributed to the extinction of over half the native birds that were present on the islands 100 years ago. Predation by the brown tree snake (*Boiga irregularis*) has similarly reduced populations of birds and lizards on the island of Guam (Rodda et al. 1999).

Prevention of the many and varied types of wildlife damage discussed above involves an integrated pest management approach that may include use of pesticides and drugs. The remainder of this manuscript addresses the WS program's use of chemicals to help resolve damage situations. The WS program's written policy manual and related procedures state that in carrying out animal damage control activities, field personnel are to give preference to nonlethal methods when practical and effective. The WS program has numerous methods of reducing damage that do not use chemicals, such as scaring devices to repel cormorants and egrets from aquaculture ponds, and use of guard dogs to reduce coyote depredation on sheep. However, in this manuscript I will limit the discussion to pesticide solutions to wildlife problems.

PESTICIDE USE IN WILDLIFE DAMAGE MANAGEMENT

A variety of pesticides are used by the Wildlife Services program, including anticoagulant and acute toxicants, fumigants, repellents, frightening agents, immobilizing agents, aversive conditioning agents, reproductive inhibitors, and herbicides (to alter habitat). In some cases, toxicants are used to reduce populations of a damaging species.

Compared to state, local, and private pest control operators, Wildlife Services conducts little rodent control with anticoagulants (used primarily for commensal rodent control and for some field control of species such as ground squirrels) or strychnine (widely used underground to control pocket gophers to prevent damage to forest seedlings, agricultural crops, and home landscaping). The rodenticide used most frequently by WS is zinc phosphide, an effective and safe rodenticide that has been in use for over 50 years with very few non-target hazards. For many species of field rodents such as prairie dogs (*Cynomys* spp.) and ground squirrels (*Spermophilus* spp.) it is the only pesticide currently registered for use. Wildlife Services used 455 pounds of zinc phosphide active ingredient in FY2000 (Table 1). Wildlife Services also used 207 pounds of aluminum phosphide and 110 pounds of sodium nitrate in fumigants used directly in burrows to control burrowing rodents where they are damaging rangeland, agricultural crops, or carrying plague.

The most frequently used pesticide by WS for bird management is 3-chloro-toluidine HCl (Starlicide® Complete or DRC 1339). Starlicide® Complete is registered by Earth City Resources to control starlings and blackbirds. DRC 1339 is registered by USDA APHIS and is used to control pigeons (*Columba livia*) where they cause nuisance or disease problems, starlings in feedlots where they consume cattle feed and spread diseases such as histoplasmosis, blackbirds in crops, and ravens (*Corvus corax*) where they are killing endangered species or livestock. Wildlife Services personnel used 113 pounds of active ingredient in FY2000.

Wildlife Services conducts some management of predators using pesticides. APHIS has a conditional registration for technical Compound 1080 for use only in the Livestock Protection Collar (LPC), a device placed around the neck of a few sheep where coyotes are killing lambs, that will target specifically only those coyotes doing the killing. APHIS also maintains a registration for the M-44, a spring-loaded device containing sodium cyanide that is placed in areas where coyotes or other predators are killing livestock. An attractant draws the coyote to the device and when the coyote pulls the top of the M-44, it receives a lethal dose of sodium cyanide. Wildlife Services also used 352 pounds of sodium nitrate in the gas cartridge, a fumigant for use in coyote, fox, and skunk burrows.

Whenever possible, wildlife damage managers attempt to recommend nonlethal solutions to wildlife damage problems. Increasing use is being made of immobilizing agents, repellents, and habitat modification. An immobilizing agent, alpha-chloralose, is being used in urban areas to capture and relocate nuisance waterfowl (Woronecki and Thomas 1995). Repellents are being developed for use in many situations, including keeping birds off landfills, where they are attracted to garbage, and off airports, where they are attracted to pools of fresh water that accumulate on runways, taxiways, and grassy areas. Researchers determined that birds will avoid landfills and pools of water treated with methyl anthranilate (MA)– a chemical widely used as a grape flavor additive in soft drinks and other human foods (Dolbeer et al. 1993). Canada goose populations have increased in many urban areas over the past 20 to 30 years to the point that their feces constitute a nuisance and health hazard. The same chemical repellent has proven effective in repelling geese from golf courses and parks (Cummings et al. 1992, 1995). Mesurol has been registered by APHIS as a repellent placed in eggs to deter ravens from eating eggs of endangered birds.

Herbicides are being used as a solution to prevent blackbird damage to sunflowers. Each summer, millions of blackbirds congregate in cattail marshes in Minnesota and the Dakotas. From these marshes the birds fly to nearby fields to feed on sunflower seeds, causing significant damage. Wildlife managers are increasingly using the herbicide glyphosate (Rodeo®) to reduce cattail habitat, which in turn reduces blackbird concentrations and associated damage to sunflower fields (Linz et al. 1993). While reducing habitat for blackbirds, the resultant opening up of the marshes provides more waterfowl breeding habitat. Use of glyphosate by Wildlife Services increased from 356 gallons in the early 1990s to 1,429 gallons in 2000 (Table 1).

VERTEBRATE PESTICIDE RISKS

Most of the pesticides mentioned above hold some potential for risk to wildlife. However, risks associated with use of vertebrate pesticides are usually small, especially when compared to other pesticides. There are several factors that limit wildlife risks from use of vertebrate pesticides, including: 1) safeguards provided by the registration process, 2) the low volume of use of these pesticides, 3) the limited area of use, 4) specificity in the action of these pesticides, and 5) the fact that the pesticides are targeted to specific animals or situations.

Registration Safeguards

The pesticide registration process itself lends a large degree of safety to pesticide products. Before a pesticide product can be marketed and used to manage a wildlife damage problem, the product must be registered with the Environmental Protection Agency (EPA), the federal agency responsible for regulating the sale, distribution and use of pesticide products. Originally, registration of pesticides was required to protect the consumer from fraudulent use claims. However, as awareness developed of the potential impacts of pesticides on humans and the environment, the registration process has become a means not only for regulating the use patterns of pesticide products, but also for ensuring that human safety and environmental health are considered (Fagerstone et al. 1990).

In the U.S., pesticides must be registered under the 1988 amendments to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Under FIFRA 88, all pesticides containing an active ingredient first registered before November 1984 were required to be reregistered within a 9-year period. In 1988 approximately 600 groups of related pesticide active ingredients, representing 1,150 individual active ingredients in 45,000 formulated products, required reevaluation. FIFRA 88 specified a 5-phase Reregistration process; Phase 1 (completed in 1989) was a listing of the active ingredients of the pesticides that would be reregistered on 4 lists in order of descending concern to EPA. In Phase 2 (completed in 1990), registrants submitted a notice of their intention to seek reregistration of their pesticides, identified missing and inadequate data for the technical product, and committed to supplying data within 1 to 4 years. Data were considered inadequate if they did not meet Good Laboratory Practice standards. During Phase 3, registrants submitted data to EPA and identified any adverse effects of the pesticide. During Phase 4, EPA reviewed submissions from Phases 2 and 3, identified outstanding data, and issued Data Call-Ins for additional data. Phase 5 involves the final review of data by EPA, followed by a regulatory action (such as reregistration or cancellation), and is still ongoing for some pesticides such as zinc phosphide.

In addition to imposing a 9-year reregistration period, FIFRA 88 greatly expanded data requirements. These rigorous data requirements greatly increase the knowledge about pesticides and their effects and help ensure that environmental problems will be identified early. Data requirements for all pesticides fall into several broad categories (Fagerstone et al. 1990, Ramey et al. 1994): 1) Product Chemistry studies provide a profile of the physical and chemical characteristics of the pesticide product; 2) Wildlife and Aquatic Organisms studies determine toxicity to non-target species, primarily in the laboratory but also in actual field studies. These tests include avian toxicity and reproduction, fish toxicity, and invertebrate toxicity; 3) Toxicology or Human Health Hazard studies assess hazards to humans according to duration and route of exposure to the pesticide. Studies include acute toxicity tests and chronic reproduction, neurotoxicity, teratogenicity, and oncogenicity studies; 4) Nontarget Plant Hazard Evaluations studies determine pesticide effects on seed germination and vegetative vigor; 5) Environmental Fate studies monitor the movement, degradation and metabolism of the pesticide in soil, water and air; and 6) Residue Chemistry studies are used to determine pesticide residues in plants or animals, leading to requests for tolerances that specify acceptable residue levels on food items. In addition, for vertebrate pesticides, EPA routinely requires efficacy and nontarget hazards data not generally required for other types of pesticides.

Table 1. Maximum annual use of chemicals by APHIS WS during FY 1988 through FY 1991 and during FY 2000. Amounts are stated in pounds of active ingredient, unless otherwise noted.

Chemical	FYs 1988-1991[2]	FY 2000[3]
Rodent Toxicants		
Anticoagulants	0.002	0.79
Cholecalciferol	0.02	-
Strychnine[1]	46	1.7
Zinc Phosphide	535	455
Rodent Fumigants		
Aluminum Phosphide	450	207
Sodium Nitrate (Gas Cartridge)	303	110
Predator Toxicants		
Sodium Cyanide (M-44 Capsules)	220	68
Compound 1080 (L.P. Collar)	0.05	0.87
Predator Fumigant:		
Sodium Nitrate (Coyote Gas Cartridge)	1,114	352
Mammal Repellents	<1	0.4
Mammal Immobilizing Agents	1.5	1.7
Bird Toxicants		
DRC-1339 (feedlots)	115	94
DRC-1339 (other uses)	36	19
Strychnine[1]	<1	-
Fenthion[1]	1 gallon	-
Bird Immobilizing Drug (alpha-chloralose)	<1	0.7
Bird Frightening Agent (Avitrol)	1.5	0.5
Bird Habitat Manipulation (glyphosate)	356 gallons	1,429 gallons
Bird Repellents	4	20

[1] Strychnine above-ground uses and fenthion use in the bird perch were canceled after 1988.
[2] USDA APHIS (1994)
[3] WS MIS Table 8, http://www.aphis.usda.gov/ws/tables/00tables.html

Low Volume of Use

The second characteristic that provides a margin of safety for vertebrate pesticides is the low volume of use compared to insecticides, fungicides, and herbicides. The total use of pesticides in the U.S. (for residential, agricultural, and other uses) averaged approximately 1.3 to 1.4 billion pounds per year from 1979 through 1986, then stayed at about 1.2 billion pounds through 1997 (Swanson 1990, Aspelin and Grube 1999). About 70% of the total was used in agriculture. Agricultural pesticide use increased dramatically from 320 million pounds in 1964 to over 800 million pounds in 1981 (Gianessi and Anderson 1993). Since 1981, the volume of agricultural pesticide use has remained fairly constant. Amounts of pesticides applied on U.S. croplands in 1992 versus 1997 were: fungicides– 129 versus 132 million pounds; herbicides– 454 versus 461 million pounds; insecticides–149 versus 182 million pounds; and other (fumigants, growth regulators, and defoliants)– 160 versus 211 million pounds (Gianessi and Anderson 1993, Gianessi and Marcelli 2000).

National use of vertebrate pesticides in the U.S. for wildlife damage management is very low when compared to agricultural pesticide use. For example, annually about 100,000 pounds of zinc phosphide active ingredient and 10,000 pounds of strychnine are used for control of field rodents such as ground squirrels and pocket gophers. About 3,000 pounds of active ingredient anticoagulants are used for commensal rodent control (Rodenticide Registrants Task Force, 1999, comments to EPA). Predator and bird control products are used in even smaller amounts. The Wildlife Services program uses only a small percentage of the pesticides used throughout the U.S. for wildlife damage management. Table 1 compares the maximum WS use of pesticides in any fiscal year (FY) between 1988 and 1991 (USDA APHIS 1994) versus amount used in FY2000 (WS MIS Table 8, web site http://www.aphis.usda.gov/ws/tables/00tables.html).

Annual rodenticide use by the WS program decreased from 581 pounds in the early 1990s to 456 pounds in 1990. Rodent fumigant use decreased from 753 to 317 pounds, and fumigant use for coyote dens decreased from 1,114 to 352 pounds. Less than one pound per year of Compound 1080 was used. DRC-1339 use decreased from 151 to 110 pounds and use of sodium cyanide (M-44) decreased from 220 to 68 pounds. It is of interest to note that while approximately 200 pounds of sodium cyanide are used annually in the M-44 for predator control, about 215 million pounds are used each year in mining operations, causing significant bird mortality. Other chemicals used by the WS program included: bird and mammal repellents; two immobilizing drugs (AC) for use in capturing waterfowl and wild canids; a frightening agent used to reduce populations of birds consuming crops; mineral oil used on gull eggs to prevent their hatching in areas where they are a hazard to aircraft or are consuming eggs of other bird species; and a herbicide to alter blackbird habitat.

Use Sites Limited in Area

Another factor limiting risk from vertebrate pesticides is the use pattern of the vertebrate pesticides. Most are used in very limited areas, such as the gas cartridge (placed in burrows), the M-44 (placed on paths frequented by predators), and anticoagulant rodenticides (delivered in bait boxes that exclude nontarget animals).

Selectivity

Vertebrate pesticides also tend to be fairly selective. Rather than managing vertebrate pests on a population level, the trend in current wildlife damage management is to deal selectively with problem animals or problem situations on a local basis. Some compounds are more toxic to target than to nontarget species; DRC-1339 is more toxic to birds than to mammals and more toxic to target blackbirds than to most other bird species. Pesticide application methods also provide selectivity. A good example of this is the livestock protection collar, a rubber collar filled with Compound 1080 that is placed around the neck of sheep in areas where coyote depredation has been occurring. Because a coyote will usually attack the neck of its prey, a coyote attacking collared sheep receives a lethal toxicant dose. This technique very specifically targets only depredating coyotes. M-44s use a scent to selectively target canids. Nontarget hazards of DRC-1339 are lowered when it is delivered to individual birds in bread or egg baits or placed in bait trays, where it is unavailable to nontarget species.

Future use of vertebrate toxicants is expected to decline still further as alternate methods of reducing damage to crops, livestock, etc. are developed. Much of the current emphasis (and over 75% of the budget) at the National Wildlife Research Center is centered on development of nonlethal techniques such as repellents and wildlife contraception. Although much progress needs to be made, the future for less risky pesticides and the future for healthy wildlife populations looks promising, as wildlife biologists work with toxicologists, reproductive physiologists, and chemists to move toward safer pesticides and chemicals.

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