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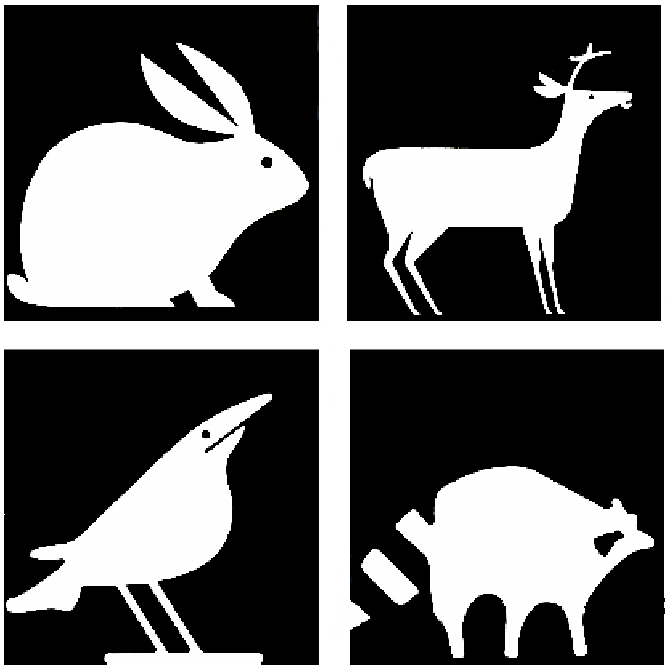
# Proceedings of the Eighth Eastern Wildlife Damage Management Conference

# THE EIGHTH EASTERN WILDLIFE DAMAGE MANAGEMENT CONFERENCE



*Proceedings*

# PROCEEDINGS OF THE EIGHTH EASTERN WILDLIFE DAMAGE MANAGEMENT CONFERENCE

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James A. Parkhurst

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CLOSING REMARKS

# HISTORICAL FORCES SHAPING AMERICANS' PERCEPTIONS OF WILDLIFE AND HUMAN-WILDLIFE CONFLICTS

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Abstract: From colonial times until the 19th century, the dominant American view of wildlife and its management was dualistic—wildlife species were divided into good animals (those which had commercial value or could be eaten) or bad animals (those which threatened the colonists' safety or food supply). Philosophically, early colonial Americans believed that the environment was to be manipulated for man's purposes. Under the impact of modernization, Darwinian influence, over-exploitation of resources, and environmentally-conscious professionals, Americans in the late 19th century began to appreciate the recreational value of wildlife and to develop a more protective attitude toward it. Still the dichotomy between good and bad wildlife prevailed, with "good" species now being those that could be hunted. The world wars and the Great Depression halted the tilt toward a more protective approach to wildlife as Americans became more concerned with economic matters and agricultural productivity. Only during the prosperous post-World War II era, did the "ecological" approach to wildlife seem to gain ascendancy over the traditional dualistic, consumptive views. Implementation of protective game laws and science-based wildlife management had their intended result as wildlife populations soared to levels not seen since colonial times. However, these increasing wildlife populations had unexpected consequences as they moved into urban areas and wildlife damage intensified. Since World War II, more Americans have shown a greater interest in, and concern about, their wildlife legacy. However, this increasingly diverse clientele for wildlife has resulted in a period of rising tensions and deepening divisions within society about how wildlife should be managed.

Key Words: history, wildlife acceptance, wildlife damage management

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## COLONIAL AMERICA: 1620-1776

Among Europe's earliest settlers in North America were the Puritans who settled in New England and left a tangible record of their attitude toward wildlife and its management. Although their legacy to the American nation is an enduring one, with the "work ethic" and "sense of mission" being among the best-known aspects of this heritage, their attitude toward wildlife and their efforts at wildlife management also are important.

The Puritan view of wildlife was dualistic—there were "good" wildlife and "bad" wildlife based on how the species affected the Puritans' economic and self-survival needs. "Bad" wildlife species threatened human safety or food supply. "Good" wildlife species could be eaten or had commercial value. This attitude would remain the prevailing American view of wildlife until the 20th Century.

Also enduring for centuries was the Puritan philosophy toward "wilderness" and its inhabitants, which was rooted in Biblical notions. The Old Testament, a part of the Bible with which the Puritan settlers were very familiar, cites the term "wilderness" at least 245 times. Puritans believed that wilderness was a place of evil and hardship that had to be "subdued" or "conquered" or "vanished" before the

Puritans could create their "city on a hill" (which was their reason for coming to North America). In diaries, addresses, and memorials of the period, the Puritans articulated this need to transform—and eradicate—portions of the wilderness to "tame" it. God, as Genesis hinted, had ordained man to establish dominance over nature. Two such targets of eradication were the native inhabitants and "bad" wildlife (Nash 1979, Reed and Drabelle 1984, Conover and Conover 1987, Conover and Conover 1989).

Thus, the Puritans had both moral and practical reasons to "make war" on wildlife. In these early years, starvation was a very real concern of these colonists. Any threat to their subsistence, particularly predation of livestock, was very serious indeed. By destroying predators that threatened their livestock, the Puritans were trying to protect an important source of food upon which their lives depended. Livestock's importance to the early English settlers was indicated, for instance, in the journals of William Bradford and John Winthrop, leaders of the Plymouth and Massachusetts Bay colonies, who noted the arrival of sheep, goats, swine, and cattle (Walcott 1936, Conover and Conover 1987, Conover and Conover 1989).

These attitudes toward predators were translated into action by means of bounties that Puritan colonies paid for dead wolves (*Canis lupis*) and other predators, such as mountain lions (*Felis concolor*). For instance, soon after the Puritans settled the New Haven colony in 1639, they established a bounty on wolves and foxes (*Vulpes* spp.). The intention of the colonists was not merely to manage predator populations, but to eradicate them. For instance, as wolf populations declined, bounties increased dramatically to encourage the removal of the last few wolves (Conover and Conover 1987, Conover and Conover 1989).

Hunting with dogs and trapping were the primary means of predation control in the 1600s. The Massachusetts Bay legislature, for example, ordered towns in 1648 to use "so many hounds as they thinke meete [sic]...that so all meanes may be improved for the destruction of wolves." Other methods of predation control included habitat destruction. In particular, swamps were drained and cleared as a means of eliminating threatening predators (Trumbull 1850, Hoadly 1857, Conover and Conover 1989).

Wildlife threatened the colonists' food supply not only through livestock predation, but also from crop damage by birds (particularly "sterlings" or red-wing blackbirds [*Agelaius phoeniceus*]) that fed on ripening corn. Again, bounties were offered as incentive for damage control, such as when New Haven in 1648 offered 10 shillings for every thousand blackbirds killed. Passenger pigeons also were targeted by colonial farmers because they destroyed grain crops (Hoadly 1857, Conover and Conover 1987).

In the area of predator control, the Puritans scored success. Wolves, the main predation threat, practically were eliminated from Massachusetts, Connecticut, and Rhode Island by the end of the colonial period (although wolves did remain in the more sparsely settled northern New England region).

While successful in eliminating the "bad" wildlife, Puritans had mixed results trying to protect the "good" species of animals that had commercial value or provided food. The beaver (*Castor canadensis*) especially was important to early New England settlers due to the monetary value of its pelts when shipped back to England. As William Bradford, leader of Plymouth Colony, noted in 1623, his settlers had "...no other means to procure them foode [sic] which they so much wanted, and cloaths allso [sic]" than by

acquiring beaver pelts for commercial exchange. Beaver pelts in New England, like tobacco in the Chesapeake colonies, were such important commodity for survival that they were used as legal tender for a time (Conover and Conover 1989). But the beaver supply soon was exhausted and the fur trade in New England declined. In Connecticut, the beaver population dwindled within the first 10 to 20 years of English settlement (Conover and Conover 1989).

Deer (*Odocoileus virginianus*) populations in the settled portions of New England suffered similar declines. Deer hides had been coveted colonial exports and venison was an important food source. The value of a deer for hide and meat compared favorably with the value of corn. In 1681 in Connecticut, while corn was valued at 2.5 shillings/bushel (Trumbull 1859), a deer skin was worth 6 pence per pound and venison was priced between 1-2.5 pence/pound (McCabe and McCabe 1984, Conover and Conover 1987). But, like beaver, deer were over-hunted (Dexter 1917, Nettles 1927). Despite various, belated management efforts by the colonial leadership, deer practically were eliminated from southern New England even before the American Revolutionary War.

Other important sources of food, such as turkeys (*Meleagris gallopavo*), also were over-harvested. And once again, belated efforts to protect the diminishing bird populations failed. Over-harvesting by New Englanders, however, was not the sole cause of the region's decline in wildlife populations. Habitat alteration also was important, as Puritans cleared the land for farming and cut the trees for lumber. In addition, the proliferation of colonial livestock, which competed with native herbivores for food, added new stresses on the region's flora and fauna. Today, New England has a flourishing population of deer, beaver, and turkey. But this resurgence of wildlife stems from management programs developed after 1900 (Dunlap 1988, Tober 1989, Chasko and Conover 1988).

**AMERICA: 1776-1880**

From the beginning of the United States as an independent country through the post-Civil War years, American attitudes toward wildlife scarcely changed. Wildlife retained its dual function for Americans: a source of food or revenue and an obstacle or hindrance to be eliminated. Westward expansion was the predominant theme in American history from the 1770's to 1880's. And the colonial pattern of human over-exploitation of natural resources would be repeated continuously as setters moved across the North American continent.

An important causative factor in westward expansion was man's constant over-exploitation of beavers because the trappers' constant need to locate unexploited beaver populations took the trappers further and further west. As trappers explored the West and returned with their pelts, their descriptions of the trans-Mississippi West fueled interest in westward expansion (Trefethen, 1975, Anderson 1991).

Meanwhile, the westward-bound American farmers, who followed the trappers to the frontier, continued to detest "bad" wildlife. They held the dominant Anglo-American view that the "wilderness" must be conquered. In this dominant mindset, predators—wolves, mountain lions, coyotes (*Canis latrans*)—served "as symbols of the savage wilderness" that early Americans had sought to tame (Kellert and Berry 1980, Kellert and Westervelt 1982, Feldman 1996). For instance, consider the American experience in Ohio in the early 19th century. Insight into the views held by this new wave of Americans settling in the West is provided by Historian Stephen Ambrose, who wrote:

> "'Getting rid of it'—with 'it' meaning anything or anyone who stood in the way of progress—was a universal American passion and a commonplace experience for all those living in the Old Northwest."

Later, he adds, "This assault on nature . . . owed much to sheer need, but something also to a compelling desire to destroy conspicuous specimens of the fauna and flora of the wilderness . . ." What was the result of this Anglo-American move into Ohio? Writes Ambrose, "The Ohio Valley today has neither trees nor animals to recall adequately the splendor of the garden of the Indian which the white man found and used so profligately" (Ambrose 1975).

Another example of this dominant mind-set that advocated the eradication of "wilderness" is provided by General Philip Sheridan, Civil War hero and, in the post-Civil War era, commander of the military department of the Southwest. His aim was to eliminate the Native American by eliminating the bison (*Bos bison*) population. In late 1870, he traveled to Austin to address the Texas Legislature, which was debating a bill to protect buffalo herds. According to one source, Sheridan warned the Texas legislature

> ". . . that they were making a sentimental mistake by legislating in the interest of the buffalo. He told them that instead of stopping the hunters, they ought to give them a hearty, unanimous vote of thanks, and appropriate a sufficient sum of money to strike and present to each one a medal of bronze, with a dead buffalo on one side and a discouraged Indian on the other."

Specifically, Sheridan said:

> "These men [the buffalo hunters] have done in the last two years and will do more in the next year, to settle the vexed Indian question, than the entire regular army has done in the last thirty years. They are destroying the Indians' commissary...Send them [bison hunters] powder and lead, if you will; but, for the sake of a lasting peace, let them kill, skin and sell until the buffaloes are exterminated. Then your prairies can be covered with speckled cattle, and the festive cowboy, who follows the hunter as a second forerunner of an advanced civilization" (Marcus and Burner 1991).

Sheridan's contemporary, John R. Cook, a buffalo hunter, applauded the General's perspective and added a new dimension of social Darwinism to the older (Christian) ideological perspective. Put succinctly, Cook argued that the Native Americans' and bison's demise was ". . . simply a case of the survival of the fittest." Influenced by the conservative social Darwinism of the age, Cook saw the decline of both ". . . as a process that not only was inevitable, but would lead to the establishment of a more advanced civilization on the North American continent" (Marcus and Burner 1991).

**AMERICAN IN THE GILDED AND PROGRESSIVE ERAS (1870-1917)**

Even as Sheridan, Cook, and others continued to espouse the traditional rhetoric about wildlife, Americans' view of wildlife began to change. Consider the words of the editors of the newly created popular journal, *Forest and Stream*, who stated that their objective was to promote a "healthful interest in outdoor recreation and ... a refined taste for natural objects." Moreover, it was hoped the readers of *Forest and Stream* would become "familiar with the living intelligences that people the woods and the fountains" (Forest and Stream 1873). Clearly such had not been the typical attitude of Americans toward

wildlife in past decades. Since the days of the Puritans in the 17th century, Americans had viewed wildlife, like the wilderness, as an evil to be conquered, subdued, and eradicated. While the older dominant view remained—after all, America's population in 1890 was still rural, as 6 in 10 Americans were farmers—a new, more "humanistic" or "non-economic" view of wildlife was emerging (Norton et al. 1996).

Several factors accounted for the emergence of this new attitude toward natural resources, including the urbanization of American society, the closing of the frontier, and the rise of progressive leaders. By 1890, America surpassed Britain as the world's leading industrial power, signaling a shift in the American power structure from rural or agrarian interests to urban or industrial ones. America had ceased to be a "frontier" country. As the national census announced, the frontier had been closed; wilderness had finally been conquered. The goal of Americans for 250 years had been obtained. But rather than celebrating or having a sense of accomplishment, Americans began to consider what had been lost.

New, Progressive leaders were beginning to agitate for change, at the local and state level, and soon at the national level (Cawley 1993, Norton et. al. 1996). Behind the emergence of these Progressive reformers was a tremendous growth in higher education and professionalism. During the 1870s and 1880s, the number of colleges proliferated, and the range of study expanded. Concomitantly, there came an emphasis on professionalism, ". . . with its imposition of standards, licensing of practitioners and accreditation of professional schools" (Tindall and Shi 1996). Professional wildlife associations also were organized, including the American Ornithologists' Union, established in 1883 in New York City, and the Audubon Society, formed in 1886 (Tober 1989, Anderson 1991).

A new intellectual perspective also began to emanate originally from Charles Darwin's work in 1859, *On the Origin of Species*. Every field of thought after the American Civil War was affected by the ideas expressed by Darwin, as popularized by British intellectual Herbert Spencer, and Yale Professor William Graham Sumner, and others. Although many Americans developed a distorted, simplistic view of Darwinist ideas, they did acquire a greater appreciation of the biological basis of human life (Tindall and Shi 1996). Even Theodore Roosevelt, who played an important role in the early conservation movement, viewed life from an evolutionary perspective (Reed and Drabelle 1984).

Along with these new forces of modernization came the clear realization that wildlife populations were not inexhaustible. The visible over-exploitation of natural resources would help transform attitudes and result in new policies for the management of America's resources. Signs of concern for the over-exploitation of resources had already appeared. Behind the earlier mentioned Sheridan-Texas legislature debate on the protection of bison was the realization that in just a few years, from 1872-1874, nearly 4 million bison were slaughtered. Even earlier, in the late 1850s, the Ohio legislature had debated a bill to protect passenger pigeons, a bird whose numbers once had seemed unlimited but, by the 20th century, had become extinct (Trefethen 1975, Marcus and Burner 1991).

Accompanying this modernization process and public awareness of over-exploitation of resources were two new forces: more leisure time, and the mass media, which catered to and shaped the attitudes of mass society. Newspapers, magazines, and motion pictures proliferated in numbers

and impact.

Playing an important function in shaping the newly-emerging conservationist attitude and in politicizing hunters were popular sports magazines, such as *Forest and Stream*, started by George Bird Grinnell, who also helped to create the Audubon Society. Relatively inexpensive magazines became available after the Civil War owing to technological innovations that produced high-speed printing and low-cost paper, along with advertising revenues and nationwide mail delivery. Among the emerging sports magazines were *The American Sportsman* (1871), *Forest and Stream* (1873), *Field and Stream* (1874), and *American Angler* (1881). During this "conservation" decade, these national periodicals gave sportsmen a public forum for discussion of hunting, fishing, natural history, and conservation (Dunlap 1988, Gray 1993).

The growing popularity of sport hunting helped create a more positive attitude toward wildlife. The "transformation" of hunting from a commercial or life-sustaining activity to a sport, an ennobling activity, was, according to Dunlap (1988) ". . . one of the first steps toward wildlife preservation." The greatest advocate of this new view of hunting was Henry William Herbert or (his pseudonym) Frank Forester, an English writer who moved to the U.S. in the mid-1800s. In his writings, he urged fellow Americans to hunt only game animals using "sporting methods" (e.g., not shooting sitting ducks). He also urged hunters to treat their dogs and horses humanely; cruelty to animals, in Herbert's view, indicated that a man was not "a true sportsman and gentleman" (Dunlap 1988).

Forester's advocacy of hunting and sportsman-like conduct began to spread among the upper class who began to appreciate wildlife and adopt a more positive attitude toward it. Sportsmen's clubs began to appear in a few cities before the Civil War; these associations and the concept of sportsmanship spread more rapidly after the war. In the 1870s, for instance, the number of sportsmen's clubs tripled in numbers to over 300. The most prominent was the Boone and Crockett Club, founded in 1887 by Grinnell, editor of *Forest and Stream*, and Theodore Roosevelt, future U.S. president. Roosevelt, and others like him, felt that hunting, like warfare, provided an "an arena for forming and testing the character of Americans that would substitute for the now vanishing frontier. Later generations, going to the field, could re-create the pioneer experience and develop the virtues of the pioneer" (Reiger 1975, Belanger 1988, Dunlap 1988).

Meanwhile, to save their sport as the supply of game declined rapidly, hunters had to take action. They organized and called upon local, state, and federal governments to save the animals by outlawing such unfair or "unsporting" activities as jack-lighting, hunting deer with dogs or in the water, or using baits. Other helpful regulations included lowering bag limits, shortening the hunting season, and restricting the kind of firearms that hunters could use. Finally, these hunting organizations wanted "these new laws enforced, preferably by a professional set of wardens under the direction of a state game commission" (Dunlap 1988). Thus, as a result of these efforts, slowly but surely, a conservation effort was emerging at the state, and then national, level. The 1870s witnessed several important conservation developments, such as the organization of state wildlife agencies in California and New Hampshire and initiation of measures to protect nongame wildlife in Connecticut and New Jersey (Matthiessen 1987, Gray 1993).

Besides the sport hunter, "nature lovers" played an important role in changing

attitudes toward wildlife. This group can trace its origins to the antebellum period, when ideas of European romanticism had inspired writers such as Henry David Thoreau and Ralph Waldo Emerson to view nature (and wildlife) in spiritual terms. This aesthetic appreciation of nature grew in the post-Civil War period among writers and artists. Writes Dunlap (1988), "Wild animals, nature lovers believed, provided an opportunity for spiritual and aesthetic experiences. Contact with them, like appreciation of beautiful scenery, was an antidote to the artificial life of civilization." This group included "foresters, most of whom had been trained in European schools, writers, artists, and businesspeople" (Trefethen 1975, Anderson 1991).

Thus, Theodore Roosevelt, the "hunter," along with "nature lovers" such as John Muir, led the movement to change attitudes toward wildlife in the late 19th century. They preached their message via new popular magazines (such as *Forest and Stream*) and through organized political action. The result was a plethora of laws and regulations aimed at protecting America's natural resources (Trefethen 1975, Belanger 1988, Dunlap 1988).

In response to changes in American attitudes toward wilderness and wildlife, the federal government initiated some important changes in policy for the nation's natural resources. The most famous change was the establishment of Yellowstone National Park in 1872. Meanwhile, numerous forest reserves were established to manage and protect America's timber resources. Yet another indication of policy change was the federal government's creation in 1885 of a wildlife agency, the Division of Economic Ornithology and Mammalogy, in response to pressure from the American Ornithologists Union (Anderson 1991). Federal actions to protect natural resources would expand enormously after 1901, when Vice President Theodore ("Teddy") Roosevelt became President (Trefethen 1975).

Despite America's expanded consciousness about wildlife, the division of animals into "good" and "bad" groups continued, but "good" animals were now those species that could be hunted or provided sport. "Bad" animals were those that preyed upon or competed with the "good" animals. Hence, government policy still was dualistic; actions were taken to protect some species from over-exploitation and to eradicate others. In particular, wolves and mountain lions were targeted as "threats" to be removed through the same methods used since colonial times—trapping and hunting. World War I, however, would bring change.

**AMERICA IN THE EARLY TWENTIETH CENTURY**

Events in the early twentieth century—World Wars I and II and the Great Depression—brought tremendous change to all aspects of U.S. society. The wars had important repercussions for America's wildlife policy, primarily because the country faced a vastly increased need for food, owing to the collapse of food production in Europe. The collapse occurred because European economies were forced to emphasize war production over agriculture and to send much of their agricultural labor force to the military. This resulted in food shortages and soaring prices as America tried to feed both itself and its allies. Americans were accustomed to cheap and abundant food. In response to the threat of food shortages and higher prices, Americans' concern for livestock waxed and their concern for wildlife waned (Feldman 1986).

Another significant change in wildlife management in the early 20th century was technology driven. Chemistry was in its heyday, spurred by the realization during

World War I that new chemical discoveries (e.g., poisonous gases) could contribute to the war effort. The U.S. federal agency responsible for predator control, the Bureau of Biological Survey, took advantage of these new chemical developments and introduced poisons as a tool to control coyotes (Belanger 1988, Dunlap 1988, Feldman 1996).

This Bureau, established by the Department of Agriculture during the Progressive Era, initially was formed to serve "as an information center for state bounty systems, circulating booklets, and conducting demonstrations on control techniques." But, as Feldman observes, "By 1915, under pressure from western ranching interests, the government for the first time hired professional hunters, and Congress allocated $125,000 to deal with predatory animals" (Anderson 1991). The Bureau, justifying these actions on economic grounds, met little opposition (Dunlap 1988, Feldman 1996).

**MODERN AMERICA**

Following World War II, Americans became more interested in the nation's wildlife. The country had entered a period of prosperity that gave Americans more money and leisure time, which they increasingly spent outdoors. By 1960, there were 30 million hunters and fishermen, who spent nearly $4 billion in pursuit of wildlife. Better highways and more affordable cars gave more Americans the opportunity to travel to the nation's many national parks. The government expressed concern for these developments through the establishment of an Outdoor Recreation Resources Review Commission in 1958. One of its actions was the creation of the Land and Water Conservation Fund (enacted in 1964), which aimed to preserve, develop, and provide public assess to outdoor recreation resources. A resulting trend observed by the mid-1960s was the increasing enjoyment of fish and wildlife by non-anglers and non-hunters (Belanger 1988). By 1970, 128 million people participated in outdoor recreation—not just hunting and fishing, but nature walking, bird watching, and wildlife photographing. Clearly, the wildlife conservation movement was drawing an "increasingly diverse clientele" (Belanger 1988).

A new invention—television—also elevated interest in wildlife as people all across the country could watch, and marvel at, the beauty of the nation's wildlife resource without having to leave their living rooms. Television produced a national constituency for wildlife. No longer were wildlife problems just a local issue. Now, people in New York City could follow and care about the fate of a wildlife population a thousand miles away. Now, local concerns about how wildlife should be managed had to be balanced with the concerns of distant citizens.

But, with an increasingly diverse clientele, tensions began to mount concerning wildlife management. Opinions often differed between the expanding urban population and the declining rural one. Most publicized was the constant struggle between local commodity interests in the West and national environmental interests. Those who espoused the "commodity point of view" included representatives of the western livestock industry and the mining, oil and gas, and timber interests. Supporting the opposing viewpoint, or environmental interests, were the Friends of the Earth, the National Wildlife Federation, the Natural Resources Defense Council, the Sierra Club, and the Wilderness Society (Satchell 1990, Reiger 1992, Cawley 1993).

Battle lines also were drawn between hunters, non-hunters, and anti-hunters. Although the major conservation organizations—National Audubon Society, Wilderness Society, Wildlife Society, American Forestry Association, Sierra

Club, National Wildlife Federation—still considered sport hunting legitimate action and a valid tool of wildlife management, the American public opinion seemed to be shifting against hunting. The media helped fuel these flames (Belanger 1988, Dunlap 1988). An early example of this occurred in November 1969, when NBC TV aired a program, "The Wolf Man," which showed the slaughter of wolves by bounty hunters in Alaska. Thousands of TV watchers sent letters of protest to the Interior Department concerning the grisly scenes. More TV programs would follow that raised the question of whether hunting should be tolerated (Feldman 1996).

A climax in the media's "feeding frenzy" came in 1982, when the news media found "a hot story" in the fate of 5,500 deer in the Florida Everglades whose habitat was being flooded. With a deer die-off apparently imminent, the Florida state game commission recommended an emergency hunt. But animal rights groups, led by the Fund for Animals, filed an injunction to prevent the hunt. They contended that shooting the deer was inhumane, that deer had "rights." At one point, more than 150 television reporters had converged on the scene. Finally, a compromise was reached; the hunt took place in the northern section of the area, while animal rights groups tried to rescue deer in the southern section. In the long run, the wildlife managers' approach of hunting the excess population proved to be more "humane" and allowed more deer to survive than in the non-hunted area (Belanger 1988).

Polarization also increased beginning in the 1960's when some, but not all, Americans experienced a paradigm shift in how they perceived the environment and their role in it. The new view was that the environment was fragile, with many interconnected features, and that changes brought about by man could have serious and unexpected consequences. Helping to lead the change was Rachel Carson's *Silent Spring*, which promoted the adoption of an "ecologist" mind-set. The spread throughout the country of this mind-set led to the establishment of events such as "Earth Day" in 1970 (Feldman 1996, Norton et al. 1996).

Still, this new environmental consciousness was not accepted universally. Throughout U.S. history, rural folk continued to hold more "utilitarian perspectives" than urban residents. Rural residents relied more directly on the land than urban residents, and they traditionally worked in more "extractive occupations" (e.g., farming, logging, trapping) than did urbanites. Given their dependence on natural resources, many rural Americans maintained the traditional perspective of their pioneer ancestors (Conover and Decker 1991, Conover 1998).

The result of all of these contentious issues was the polarization of American society (local versus nation interests, urban versus rural residents, hunters versus anti-hunters, "ecologists" versus "utilitarians"). Americans' perception of society also changed. No longer did people value consensus and uniformity, but instead embraced the notion of diversity. Citizens learned how to use the media and the political process to make their voice heard. This polarization of society made wildlife management decisions controversial because no action could please everyone.
Society and public perceptions were not the only changes since World War II. The passage of game laws that protected wildlife from over-exploitation by humans and the adoption of science-based management practices had their intended result: populations of game species (e.g., deer, elk, turkey, geese) and many fur-bearers (e.g., beaver) increased to levels not seen since colonial days. Likewise, predator populations, freed from

unrestricted killing, recovered. However, these increasing wildlife populations produced some unforeseen negative consequences for society. Wildlife damage to crops and livestock increased (Conover and Decker 1991). In the 1990s, estimates of wildlife damage to U.S. agricultural producers range from $500 million (Wywialowski 1990, Conover 1994, Conover et al. 1995) to $2 billion (Conover 1998). Wildlife attacks on humans also increased as predator-human confrontations became more common, owing both to soaring predator populations and a growing enthusiasm for outdoor recreation. Furthermore, some wild animals were losing their fear of humans. Illustrative of this trend was the increased frequency of alligator attacks on humans. From 1948-1970, when alligators were persecuted by human poachers, <1 human was attacked yearly by alligators in U.S. (Conover and DuBow 1997). From 1990-1995, as alligators and humans increasingly shared the same habitat, a mean of 22 humans were attacked annually by alligators (Conover and DuBow 1997).

Another new trend was the establishment of urban wildlife populations. Many wildlife species (e.g., deer, Canada geese [*Branta canadensis*], foxes, turkeys), which used to be found only in remote areas, moved into many U.S. metropolitan areas. Initially, these urban wildlife populations were encouraged by local residents. But, as wildlife populations increased, some metropolitan residents became concerned with some of the negative consequences of high wildlife populations (Conover and Chasko 1985, Conover 1997a). A recent survey of American metropolitan residents found that they suffered $3.8 billion in damages caused by wildlife, despite spending $1.9 billion and 268 million hours trying to solve or prevent these problems (Conover 1997b). Furthermore, deer-car collisions in the U.S. became more common until, by the 1990's, they exceeded 1 million annually (Conover et al. 1995). Other problems included an increase in zoonoses, such as rabies, hantavirus, and Lyme disease, which were virtually unknown in the U.S. a few decades ago (Conover et al. 1995). For instance, there were >12,000 human cases of Lyme disease in 1992 (Conover et al. 1995).

**AMERICA IN THE TWENTY-FIRST CENTURY: WHAT NOW?**

So, as the second millennium approaches, will the pendulum continue to oscillate? Perhaps, for in the words of Mark Twain, "history may not repeat itself, but it does rhyme."

Future Americans could have a sense of déja vu with regard to their encounters with wildlife. From the days of the Puritans until today, Americans have encroached upon wildlife habitat. Such trends will continue in the future as human populations increase, although this movement is counter-balanced with a movement of wildlife into urban human habitats. In the words of Anthony Brandt (1997):

> "By moving into their habitat, by eliminating their predators, we have caused the explosion of deer and geese and beavers and moose and coyotes on what we persist in thinking is our property. We are the stewards of the world; we hold it in sacred trust. But the world isn't 'out there' any longer, somewhere in Montana or the rain forest of the Amazon basin. The world is staring at us with big soulful brown eyes where our azaleas used to be."

Future generations of Americans may experience threats to their property, health, and even lives, in ways that their colonial ancestors could appreciate (Kellert and Berry 1980, Kellert and Westervelt 1982, Kellert 1985). A 1997 survey

indicated that 65% of the families in North Haven, New York, on Long Island, had experienced Lyme disease (nearly 30% of the households there suffered 3 or more cases). Brandt (1997) suggested that "this level of infection can only be described as a plague."

As this study suggests, "progress" has been made in terms of saving wildlife. Will this progress continue in the next century? History has demonstrated that society will sacrifice wildlife resources for food resources when its food supply is threatened. Hence, the future of wildlife will be tied to our ability to increase our food productivity faster than the increase in the human population. Will this happen? Time will tell, but we are optimists. Despite Malthus's grim predictions in the 1700's about increasing populations causing famines, civilization has thus far been able to cope.

As we have seen, disagreements about how wildlife should be managed have occurred since colonial times, and the divisions have become deeper since World War II as interest in wildlife has increased (Van-Putten 1997). This polarization of American society has made the wildlife manager's job of obtaining consensus about how wildlife should be managed almost impossible. It will not become easier in the future.

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# DO YOU HAVE YOUR SKATES ON?

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It is an honor to keynote this conference as we think about our profession in the next century. Jim asked me to predict what the future of wildlife damage management might look like in the year 2020. I explained to him that I have not been actively engaged in doing wildlife damage work for almost 9 years and I had been in an administrative role. Jim knew that I am going back to a faculty position in the next several months. He thought it was great for a person coming out of retirement to predict the future.

Since I left my active work with ADC in 1989, many things have changed in our profession and it looks as if there will be many new concepts and tools on the horizon. However, to look to the future and speculate on what could be or might be is a daunting challenge. I knew I needed help! I immediately went to the administrator's practical guide for long range strategic planning concepts. I consulted the all knowing Swami, the great Carnac, and that never fail tool—the Ouija Board. I also consulted private practitioners, researchers, and biologists and asked them to star gaze with me. This talk is a mixture of all of the above—part fact, fantasy, fiction and fatalism.

First, I must commend the planners of the conference for soliciting the Humane Society to sponsor part of this conference; yet, I have already heard the question "Why are they here?" I listened to the same questions when I asked Tom Regan, who wrote *The Case for Animal Rights*, to be on a panel speculating about the future of animal damage control in the early 1980s. While we might not agree in philosophy with each other, there are many areas of animal welfare where we all share common ground. We must engage everyone in productive dialogue, if we are to be successful. We will need to work together to manage our wildlife resources and their shrinking habitats if they are to be part of our world in 2020.

In the next 20+ years, opportunities for wildlife damage management work will continue to grow, especially in the urban environment. Private companies are forecasting a 10- to 20-year growth pattern. As cities and counties look to control costs while continuing to provide municipal services to their taxpayers, they are contracting with private companies to gain needed expertise without hiring more employees. In the past, an animal control officer dealt primarily with domestic animals; in the future, many calls will relate to wildlife species. A contract with a private company provides the community with a professional who will answer all types of animal calls 24 hours a day, 7 days a week. City fathers will not have responsibility for a truck, liability insurance, benefits, overtime or training. Yet, they will be able to provide their constituents with a reasonable and professional service.

We have had a stable to improving economy for the last several years and the outlook for continued prosperity is reasonably good. New home starts are up and our population, while not growing very fast, is spreading out on the landscape. In Pennsylvania, the sleepy borough of State College, home of Penn State University, will become the fourth most populated area in the state in the next 20 years. With an improving quality

of life, there seems to be a desire in homeowners to see and enjoy wildlife on their property.

Once it was a rare occurrence to see a black bear outside of the woods; today, they can be found in suburban yards raiding bird feeders and garbage cans. Wildlife enforcement officers in Pennsylvania have gone on television to recommend that bird feeders should be removed during certain times of the year to keep unwanted visitors out of the yard. Yet, many individuals often do not heed warnings that these critters can be dangerous. Communities will continue to encroach on agricultural lands, hobby farmers and ranchers who do not need to make a living from their land will experience negative interactions with wildlife at an even faster rate.

In Mesa Verde National Park, Colorado, a 4-year old boy was waving to his parents when a cougar attacked and pulled him off into the brush. The cougar was shot and the child survived. However, several days later in Rocky Mountain National Park, Colorado, a 10-year old boy died from a cougar attack. In 1991, an 18-year old Colorado jogger lost his life to a cougar. In 150 years of Colorado's written history, these were the only 2 recorded fatalities.

In a recent article from the New York Times on the cougar attacks, James Brooke quotes Gary Lane, a resident of Parker, Colorado, "The female lion represented the future of her species, which I believe has an equal right to exist on this planet." Although that cougar returned to the spot of the kill and then attacked an investigating ranger, Lane concluded, "The lioness deserved better treatment from the rangers." Many individuals have moved into the foothills of the Rockies and built a green oasis of food and water for herbivores in that semi-desert ecosystem. Predators will follow their prey even into downtown Boulder, Colorado.

Children feed scraps of bread to ducks and geese in many city parks across the nation; just as home owners along many southern water ways encourage alligators into their yards by feeding them chicken necks and animal parts. Reduced hunting and free lunches have made these once timid reptiles rather aggressive. Numerous alligator attacks have been documented, including several human fatalities. These incidents did not happen in remote wild areas. They occurred on city jogging paths, in community swimming holes, and next to water hazards of exclusive golf course communities.

As biologists, we have done a good job of restoring many wildlife populations to historic levels. Deer, giant Canada geese, and snow geese are doing very well, as are predator populations of coyote, cougar, raccoon, and fox. Because of reduced mortality factors and an increase in food and shelter opportunities, raccoon populations often can grow faster in urban areas than in rural areas, as reported in a paper entitled *Raccoon Population Demographics Along an Urban Rural Gradient* by S. Hatten, S. Gehrt and E. P. Wiggers.

Coyote populations continue to expand into the East. In the West, where predator control is most intense, God's dogs seem to breed longer, reach sexual maturity earlier, and have more young per litter. The dramatic increase in rabies that often follows expanding wildlife populations will continue to support research in the area of human and wildlife disease interactions. Recently, in North Carolina, 3 beavers were found to be rabid. One attacked a camp counselor as he was swimming with a group of youngsters in a lake close to Raleigh, NC. More recreational time and a desire to be closer to nature will increase the opportunities for negative consequences in the next 20 years.

Due to successful wildlife management programs, white goose populations have

risen to a point where they may threaten their own nesting grounds. Lyme disease continues to be of concern as the number of vectors for transmission increases and deer populations expand. In some communities, resident Canada geese have become so abundant that they are rounded up for slaughter. Goose dinners are being provided to food pantries and homeless shelters. This points to a greater need for us to understand the links between wildlife populations, disease concerns, and man's interactions with these populations.

Michael Conover, in his paper *Monetary and Intangible Valuation of Deer in the United States*, notes that deer damage to agricultural crops is estimated at $500 million a year. There are more than 1.5 million deer-car interactions every year in our country. Using an average cost of repair of $1,500, the bill is over a billion dollars. In the Allegheny hardwood forests of Pennsylvania, Diefenbach, Palmer, and Shope estimate deer cause $367 million of losses annually. These costs will continue to escalate in many states because there will be fewer hunters and a desire by some clientele to oppose active management of their deer herds. The pressure is likely to continue unless funding sources and public education improve.

Currently, about 80% of our citizens live in urban communities and many families are several generations removed from the land. Fewer homeowners are comfortable with the idea of killing an animal in defense of their life or property. Recreational hunting and trapping will decline. Nevertheless, the need for hunting and trapping will expand as control of nuisance wildlife will become a major concern of wildlife management agencies and the private sector.

Reflecting the public's desire for non-lethal and more humane methods of control, manufacturers will improve existing technologies and research new methods for controlling problem wildlife. Registering new chemicals will be harder as we gain greater knowledge of chemical hazards. New products will be more target specific. Additional species will be added to existing labels that have a well-scrutinized history. Agencies and manufacturers will broadly survey public attitudes and customer service will improve as practitioners become more business-like and professional.

Companies will stress service and want long-term contracts. Managers will be as concerned about on-the-job accidents as they are with trapping, exclusion methods, and home repairs. Consultants and home designers will build and landscape to protect property from wildlife damage. Local ordinances and building codes will require construction techniques that exclude wildlife from homes and buildings.

Competition between private sector providers will be more intense. No longer will a person with a few traps, a ladder, a catch pole, and a pickup truck with a magnetic sign on the side be competitive. Those companies will go the way of the teenage lawn care entrepreneur. Today, university extension programs provide information on methods to protect property from wildlife damage. This service will be challenged by professionals because many homeowners will not have the tools or the knowledge to carry out even a simple control program. An electrical engineer in North Carolina wired his gutters to repel a flicker that was waking him up in the morning. He did repel the bird; but also managed to burn down the second story of his house. The skill level of the average homeowner in wildlife related matters will continue to dwindle as the next century dawns.

In the next century, to gain employment in this field, you will be certified as a wildlife professional. Biologists will participate in a life-long learning process to continue to be current in their profession. Public sector damage control practitioners will be

certified by their own ranks and wildlife agencies will require them to pass a rigid exam before they approve wildlife capture and control permits. A professional code of ethics will be a clause in all contracts and practitioners who use illegal products and do not obey wildlife agency laws should not be certified or tolerated by an educated public.

Robert H. Schmidt, Department of Fisheries and Wildlife at Utah State University, has developed, with help of others, a draft code of ethics for wildlife damage management professionals. It is part of his home page and he is asking for input. It is a common sense set of statements that encompass professionalism, honesty, and a minimum knowledge base for practitioners. Wildlife damage management in the year 2020 will be a significant aspect of all agency management plans in rural and urban settings. Several state wildlife agency directors have seen this trend coming and are planning appropriately.

In many parts of our country, animal damage control programs are coming under greater scrutiny and, as a result, the policies and philosophies of individuals and agencies are changing. The "gopher choker" is no longer a popular image of ADC specialists. Human dimensions aspects are being given more consideration as new management programs are designed. Expanding urban wildlife populations and public concerns for health, safety, and the humane treatment of animals are pushing science to find new answers to age old questions.

Ten years ago, when individuals talked about neutering wildlife populations rather than killing them to achieve population control, few biologists gave it much hope. Invariably, the story of the old trapper at a meeting of sheep ranchers out West who was talking to an animal rights person who wanted to sterilize coyotes comes to mind. He explained that the coyotes came to visit the sheep pens for a far more sinister purpose. Today, sterilization is being given consideration as a viable control method. Bruce Gill, of the Colorado Division of Wildlife, is looking at a contraceptive for cougars. Using a biodegradable bullet, this hormone toxin will sterilize the animal for life.

In Australia, researchers are investigating the delivery of immunocontraceptives by altering a microbe that will infect the target animal. Specific offending animals can now be identified by the genetic markers in DNA collected from their salvia on trees or kills. Whales are being marked using DNA collected through small bits of tissue recovered from a bio-dart or from their skin that is normally sloughed off as they swim through the ocean for a mark and recapture model. When President John Kennedy said that we would land individuals on the moon, I never thought of measuring deer damage to corn crops or apple trees from satellites 250 miles above the earth. Science has changed dramatically and will continue to change as basic science unlocks the complex systems that impact our application-based profession. The science fiction of 10 years ago is fast becoming a reality of today's science.

As with any field of scientific endeavor, progress in wildlife damage management comes by fits and starts. Therefore, it is difficult to predict exactly what our tools will look like in 20 years. We can be sure that research institutions will put greater emphasis on finding answers to questions about relocation, immunocontraception, repellents, population limits, habitat destruction, oral vaccines, euthanasia, and zoonosis.

There will be no one silver bullet, cellulose or otherwise, that will answer all of our needs. Old tools will be modified to be more acceptable; new technology will come from other fields of science, such as genetics, aerospace engineering, botany,

animal physiology, and medicine. We must investigate all leads, options, and alternatives for improving the methods and tools for control. As professionals, we will be held accountable for our actions and our techniques by a public who will be more sensitive to the human dimension aspects of management. They will expect more and better answers from us before they support our endeavors.

Wildlife damage management will continue to be a major component of agricultural systems, endangered species management, natural resource policy, ecosystem management, and, most of all, politics. Now, if all of these predictions do not give you a feeling of job security, I am not sure what will.

I would like to close with a quotation from that famous wildlife damage control specialist, Wayne Gretzky . . . "I skate to where the puck is going to be, not where it has been." Do you have you skates on? Will you get there in time?

Thank you.

# THE MASS MEDIA AND STAKEHOLDERS' BELIEFS ABOUT SUBURBAN WILDLIFE

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Abstract—This study examines how suburban audiences obtain information about 3 species in New York State (whitetail deer [*Odocoileus virginianus*], beaver [*Castor canadensis*], and Canada goose [*Branta canadensis*]). Respondents in 3 suburban areas were surveyed on concerns and interests about a particular species in their area. Respondents also were surveyed about preferred sources for species information and actual source use. Finally, respondents were surveyed about general media use. "Uses-and-gratifications" theory was used to characterize respondents' information behavior for species information. Specific recommendations for communication planning are offered.

Key Words: beaver, *Branta canadensis*, Canada goose, *Castor canadensis*, mass media, New York, *Odocoileus virginianus*, stakeholders, survey, white-tailed deer

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## INTRODUCTION

Over 25 years ago, Gilbert (1971) emphasized the importance of effective public communication for natural resource management. He recognized that natural resource managers, experts in fields such as wildlife, forestry, and fisheries, typically lacked a comprehensive understanding of the users of these resources or of ways to communicate effectively with them. Decker (1985) found communication with the public to be the least positive element of wildlife agency image among a variety of populations studied. Lautenschlager and Bowyer (1985) suggested that wildlife professionals need to develop good communication practices or risk the long-term survival of the profession. More recently, Gray (1993:206) emphasized—perhaps overstated—the continuing difficulty that wildlife managers have had regarding public communication:

> "Failure to communicate effectively with the general public seems to be a problem with wildlife personnel at all levels, from technicians to administrators. Yet the success of many wildlife agency initiatives absolutely depends on the ability of wildlife professionals to successfully communicate with their specialized publics and with the citizenry at large."

Agency communication efforts targeted at residents of suburban areas especially may be challenging due to (1) the diversity of beliefs and attitudes regarding wildlife that exist among residents in these areas (Decker and Richmond 1993) and (2) the lack of longstanding relationships between agencies and suburban residents (Schaefer

1987). Fortunately, wildlife agencies generally recognize the importance of understanding beliefs, attitudes, and experiences of stakeholders (Decker et al. 1992), but they may not be incorporating such understanding into communication planning. In addition to the challenge of understanding beliefs and attitudes and using that understanding in communication, wildlife professionals must learn how to develop communication strategies that fit the needs and desires of suburban residents.

Still, wildlife professionals often tend to see communication simply as "persuasive" activities with various stakeholder audiences, particularly regarding agency programs and controversial wildlife policies. For instance, wildlife professionals sometimes suggest that communication efforts are necessary to help "educate" suburban residents who might not understand the "facts" of a given management situation (Decker and Gavin 1985, DeBruyckere and Garr 1991, Hadidian 1992). In such cases, the goal of agency communication with suburban residents tends to be support for specific programs or management actions that wildlife management agencies recommend (Schaefer 1987).

Most of this kind of communicative activity occurs within a relatively short time period. We argue that successful communication strategies involve more than the short-term, campaign-oriented approaches that typically are followed. Indeed, short-term, persuasive communication strategies likely will be unsuccessful if intended audiences do not have values, beliefs, or experiences in common with the communicator. Lacking such commonality, improving understanding of factual information in the short term necessarily will not change attitudes or behaviors (National Research Council 1989) and could even lead to unintended backlash effects.

One reason that short-term campaigns rarely succeed is that stakeholder audiences form beliefs over long time spans, and they generally acquire knowledge that relates to beliefs and attitudes from a variety of sources. One of the most important sources is the mass media, which cultivate beliefs about a variety of types of environmental information (Shanahan, et al., 1997). If wildlife professionals do not understand the dynamics of mass communication processes, which have the power to cultivate audience members consistently and cumulatively with bits of information about wildlife management, they likely will mount unsuccessful specific short-term communication campaigns.

Although mass media processes never will be fully under the control of wildlife professionals, agency personnel should obtain better understanding of how these processes work. In this paper, we examine concepts from the "uses-and-gratifications" approach to mass communication research to help understand suburban residents' motivations to seek particular types of information regarding 3 problem-causing species, sources of information they have used to gain information about those species, and their general use of media. In addition, relationships between residents' information-seeking motivations and their attitudes, interests, concerns, and acceptance of management actions for problem species are examined. Finally, we provide policy recommendations on how wildlife professionals can best use information on mass media use to achieve their goals.

Media and Wildlife

We believe the media "uses-and-gratifications" approach has potential to yield information that can be used to facilitate on-going, proactive communication strategies for wildlife species that cause problems in suburban areas. Suburban wildlife problems

generate particular media issues, given that suburban residents rarely have direct knowledge of or experience with wildlife behavior and thus they rely on the media for impressions about problem species. Three species that cause widespread problems in suburban areas of many Eastern states are white-tailed deer (*Odocoileus virginianus*), beaver (*Castor canadensis*) and Canada geese (*Branta canadensis*). New York State is no exception, with all 3 identified by the New York State Department of Conservation's (DEC) Bureau of Wildlife (BOW) as creating problems for residents in suburban areas. Problems commonly associated with deer include motor vehicle accidents, damage to gardens and shrubs, and the transmission of Lyme disease to humans (Decker and Gavin 1985, Curtis et al. 1993). Beavers plug culverts, flood highways and residential subdivisions, and destroy trees and shrubs valued for economic, aesthetic, and other attributes (Ermer 1988, Harbrecht 1991). Canada geese damage or diminish aesthetic attributes of lawns, docks, swimming pools, and golf courses (Cleary 1983).

Because diverse viewpoints exist among suburban residents (Decker and Richmond 1993), controversy often emerges regarding human-wildlife interactions and the types of wildlife management actions taken to ameliorate problems. Controversy invariably attracts and is magnified by media attention, which means the media often get to play a significant role in constructing perceptions of suburban wildlife problems. Therefore, increasing public understanding of complex suburban wildlife situations and minimizing public contention can be a daunting challenge for wildlife professionals. Determining the public's informational needs regarding wildlife and filling these needs via planned, continual, and comprehensive communication and research is an essential step toward meeting this challenge.

Media Uses and Gratifications

"Uses-and gratifications" is an approach that seeks to increase understanding of both *how* and *why* people use particular media (Infante, 1993). In "uses-and-gratifications" research, *how* questions deal with specific uses of the media: what media, when, or how long, whereas *why* questions deal with people's gratifications: what do people "get out of" the particular media to which they attend? Overall, "uses-and-gratifications" research assesses how media use "gratifies" individual needs, desires, and proclivities. It "…attempts to explain the uses and functions of the media for individuals, groups, and society in general" (Infante 1993:405).

Descriptive knowledge of audience intentions in using mass media helps guide effective media and communication strategies. Thus, research into audience uses of media often is recommended during the development phase of communication plans (Severin and Tankard 1992). During the initial formation of communication plans, this descriptive information helps predict the ways in which (and ideally why) audiences turn to specific media. Thus, we chose this approach because it provides a practical and straightforward way for wildlife professionals to understand and analyze public informational needs regarding wildlife and how these needs can be met through media sources and channels.

Applying aspects of the "uses-and-gratifications" approach, we categorized suburban residents along dimensions of information-seeking motivation and media use to answer the question of how citizens get information about wildlife. We examined relationships between these dimensions and other factors, such as attitudes and concerns about a given species, to see why they might use such sources. Finally, we looked at relationships between information-seeking motivations and particular media use to

show how wildlife agencies can think about appropriate channels for wildlife information. For example, a wildlife agency might want to know what type of information suburban residents who have serious concerns about wildlife-related damage would seek, if any, and then compare that to the information the agency actually provides. Also, using the information provided by such a study, the agency then could select appropriate channels for disseminating its persuasive messages. Insights about information-seeking motivations and general media use of target audiences can be used as part of a comprehensive plan to improve communication with the public about wildlife issues. As we will argue, the "uses-and-gratifications" approach offers a practical tool of a type not yet used systematically in communication planning regarding wildlife.

> The "uses-and-gratifications" approach provides important information for wildlife managers who deal with problem species in suburban areas by addressing 2 key issues:

1. What information-seeking motivations regarding the referent species exist for suburban residents with particular characteristics (e.g., interest in seeing the referent species; concern about damage caused by the referent species)?

2. What are the best ways to reach those residents who desire information regarding the referent species (i.e., what sources have they used to obtain information regarding the referent species? how often do they use various types of media?)?

**METHODS**

A literature review and qualitative interviews were conducted to improve understanding of the human dimensions of suburban wildlife situations. Interviews were conducted with BOW staff ($n$ = 33) and other stakeholders (e.g., residents affected by the species of interest, community leaders; $n$ = 32) in the management of deer, beaver, and Canada geese in suburban areas. Three groups of BOW staff were selected for interviews: the staff of the BOW's Communication Unit; program leaders for deer, beaver, and Canada geese; regional managers and staff most familiar with the three species. Input from the interviews was used to develop a mail-survey instrument. The instrument was reviewed by Cornell University survey research specialists and pre-tested in 3 suburban areas (different from those selected for the final survey).

Survey Sampling, Inc., a private firm, was hired to provide a random sample of residents who lived within the geographic parameters chosen in the 3 geographic areas designated by BOW as having a history of or potential problems with deer, beaver, of Canada geese. The goal was to contact residents who likely had some experience with or were aware that the species existed in their area, so the sample was drawn from census tracts (each containing approximately 3,000 people) and census block areas (each containing approximately 1,000 people) where such experience was likely. Names, addresses, and telephone numbers for people who lived within the specified areas were selected randomly from a telephone directory database. The person listed in the telephone directory was the person whom we requested to complete the questionnaire.

<u>Study Areas</u>

Residents who lived within specified census tracts or census block groups in 3 areas were questioned regarding their attitudes about the relevant problem species in their area: deer in the eastern portion of the Town of Amherst, beaver in

the City of Oneonta, and geese in the Merritts Pond area of the City of Riverhead, respectively. Based on 1990 Census Bureau information, the population of the Amherst census tracts was approximately 41,621 and primarily caucasian. The median age of the adult (>18 years of age) population was 46.5 years, and slightly more females than males lived in the study area. A majority (70%) of the population >25 years of age had received at least some college education. The population of census tracts that corresponded to the City of Oneonta was 9,123 and also predominantly caucasian. The median age of the adult population was 37 years. Slightly more females than males lived in this area (5,034 vs. 4,089). A majority (52.5%) of the population >25 years of age had received some college education. Finally, the population of census block groups in Riverhead (Merritts Pond area) was 3,030 and primarily caucasian. The median age of this population was 46 years, and a small majority was female. Approximately one-third (32.4%) of residents >25 years of age had received some college education.

Measures

Three measures were developed to obtain information about residents': (1) motivation to seek specific types of information regarding the species of interest; (2) information sources residents actually used to obtain information about the species; and (3) residents' general media use. We wanted to determine the likelihood that residents would seek specific types of information regarding the referent species. We asked respondents to tell us how likely they would be to seek information about the following topics:

1. Population biology and habitat of the referent species.
2. Prevention of damage to property from the referent species.
3. Hunting/trapping of the referent species.
4. Viewing and photographing the referent species.
5. Animal rights.
6. Contraception for the referent species.
7. State management programs for the referent species.

These data were used in a principal-components factor analysis (Bollen 1989) to identify broader types of information-seeking behavior.

The next measure focused on the frequency with which people, in their daily lives, used various media channels and types. Residents were asked to report how often they did the following activities:

1. Watch television programs (hours/day)
2. Watch local television news programs (days/week)
3. Read the local daily paper (name of paper inserted--days/week)
4. Read the local weekly paper (name of paper inserted--days/month)
5. Read news magazines (number/month)
6. Read wildlife or nature magazines (number/month)
7. Read hunting magazines (number/month)
8. Read animal rights magazines (number/month)
9. Listen to the radio (hours/day)
10. Watch video cassettes (number/week)

Again, we used principal-components factor analysis to group the above items into factors that represent categories of media use.

The third measure focused on the specific sources that residents actually used to obtain information about referent species. We asked residents to indicate, from a predetermined list of sources identified in the interview phase of the study, which resources they had used to gather

information about referent species. The 15 sources we identified were:

1. Local newspapers
2. Family members
3. New York State Department of Environmental Conservation (DEC) publications
4. Animal rights group publications
5. Friends/neighbors
6. Local television news
7. Personal observations
8. Hunting group publications
9. Local governmental reports
10. Magazine articles
11. Environmental/conservation groups
12. E-mail
13. Videotapes
14. Informational meetings
15. Radio news reports

We also measured respondents' attitudes, interests, and concerns about the species, using techniques developed in Loker (1995).

Survey Implementation

The self-administered, mail-back questionnaire was sent to 500 residents in each of the 3 areas (total $n = 1500$) using methods outlined in Dillman (1978) and Brown et al. (1989). Response rates for the surveys regarding deer, beaver, and Canada geese were 63.1%, 54.5%, and 50.7%, respectively. Telephone interviews were conducted with non-respondents to determine whether respondents differed from non-respondents on key issues such as concerns about problems with wildlife.

## RESULTS AND DISCUSSION

We found significant differences between respondents and non-respondents for variables that related to residents' concerns and experiences regarding the 3 species. The differences between respondents and non-respondents indicate that each sample may have been biased toward people who had seen or were at least aware that deer, beaver, or Canada geese existed in their area or who had formulated attitudes regarding these species. Because the goal of the sampling scheme was to select people who had experience or familiarity with the species of interest in each study area, no adjustments were made to the data. However, caution should be used when making inferences from our data to those who have no attitude regarding the referent species.

Analysis of Measures

*Information-seeking Motivation*—Factor analysis revealed some similarities and differences in information motivation between respondents from Amherst, Oneonta, and Riverhead (Table 1). We found 3 information-seeking motivation factors in Amherst: *pragmatic* motivations, *nature/rights* interests, and *hunting* interests/concerns (Table 1). Factors were similar in structure for Oneonta and Riverhead, with the exception of the *hunting* factor. Trapping beaver and hunting Canada geese fell under the *pragmatic* factor for Oneonta and Riverhead, respectively. The *pragmatic* factor for each area included items related to minimizing problems caused by the referent species (e.g., information on prevention of damage, contraception, and state management programs). While some variation existed for the *nature/rights* factor, most items that comprised this factor (e.g., information regarding animal rights and viewing/photographing the referent species) were consistent for the 3 areas. For Amherst, information-seeking regarding deer hunting comprised a separate factor. Still, little variation existed among the 3 areas as far as the structure of information interest was concerned. Across the 3 areas, the 2 important factors are the *pragmatic* factor and the *nature/rights* factor, reflecting the fact that a general dichotomy in public opinion on wildlife issues tends to drive 2 different types of information-seeking

behavior. We argue that wildlife professionals can rely on this dichotomy regardless of geographic area.

Relationships were examined between residents' information-seeking motivation factors and their: (1) attitudes toward the referent species, (2) interests in activities associated with the referent species, (3) concerns about problems caused by the referent species, and (4) acceptance of management actions used to minimize problems with the referent species. Residents were asked about their degree of interest in activities (e.g., watching wildlife, photography, hunting associated with species in their area). Response options ranged from "not at all interested" to "greatly interested." In addition, residents were asked to report their level of concern about various problems (e.g., vehicular accidents, property damage) regarding the referent species. Response options ranged from "not at all concerned" to "greatly concerned." Table 2 illustrates associations between information-seeking tendencies and these variables for the Merritt's Pond area (similar relationships existed within each area). Riverhead residents who were interested in *pragmatic* or *hunting* information (e.g., how to prevent damage to property, health/sanitation problems) regarding Canada geese possessed more negative attitudes about geese. In addition, these residents were more concerned about nuisance, damage, and health/safety issues associated with Canada geese than residents who would not seek such information. Conversely, residents interested in information regarding viewing/photographing geese or animal rights displayed less concern about this species in their areas.

Thus, information-seeking motivation can be seen as a reliable and consistent indicator of concern about the species. The disparity between *pragmatic* information-seekers and *nature/rights* information-seekers was consistent across the 3 study areas. In general, *pragmatic* information-seekers were concerned about problems associated with the referent species, whereas *nature/rights* information seekers were interested in activities associated with the referent species, with the exception of hunting.

For the Riverhead area, significant negative correlations were found between the *pragmatic/hunting* factor and acceptance of "letting nature take its course" without human interference or feeding Canada geese, but significant positive correlations existed between the *nature/rights* factor and these management actions. Residents who were interested in practical or hunting information were more likely to accept invasive management actions than those who desired information regarding viewing/photographing geese or animal rights. These residents were more likely to accept lethal methods as practical means to solve problems caused by wildlife. As would be expected, residents interested in *nature/rights* information were less likely to accept lethal methods. Significant, negative correlations existed between information-seeking about *nature/rights* topics and acceptance of lethal methods in all 3 areas.

Sources

We were interested in the relationship between residents' information motivations and sources they used to obtain specific information about deer, beaver, or Canada geese. Although no patterns were apparent across all 3 areas, some similarities were found. In Amherst and Riverhead, significant correlations ($p \leq 0.05$) existed between: (1) *pragmatic* information seeking and frequency of local newspaper reading, and (2) *nature/rights* information seeking and frequency of magazine reading. For Amherst and Oneonta, significant correlations existed between *pragmatic* information-seeking

and attention to New York State DEC publications. No similarities existed between Oneonta and Riverhead. Thus, residents of the 3 areas were similar in terms of some, but not all, of their information-seeking motivations. This may be due partially to the fact that respondents cannot reliably remember or estimate where they get species-specific information. If such is the case, then more general media use must be scrutinized to help the planner. That is, in cases such as this where sources of species-specific information are not very predictive, then planners still can turn to information about general media use because that will be better than having *no* information.

Media Use

In addition to understanding people's desire for specific types of information and specific sources that have been used to obtain information about a species, we were interested in people's general media usage. This information facilitates communication with the public by identifying appropriate sources and channels through which they may be reached.

First, the communication planner must describe the media market within which he/she is working. We found significant differences among the 3 areas for 2 media-use variables, local television news watching and daily newspaper reading. On average, Amherst residents used local television news (Amherst [A] = 4.56 hours/day, Oneonta [O] = 2.85, Riverhead [RH] = 3.69; $p < 0.05$) and the local daily newspaper (A = 5.91 days/week, O = 4.88, RH = 3.86; $p < 0.05$) more often. News use normally is correlated positively with socioeconomic status, income, and education, so these differences probably reflect demographic variation across the sample sites. Significant differences ($p < 0.05$) existed between Amherst and Riverhead for the mean number of hours of general television viewing per day (A = 2.60, RH = 3.17) and the number of wildlife/nature magazines read per month (A = 0.60, RH = 1.03). In addition, significant differences were found between Amherst and Oneonta for the mean number of hunting magazines read per month (A=0.15, O=0.91) and the number of video cassettes watched per week (A = 0.78, O = 1.18). These findings reflect differences specific to the characteristics of the 2 media markets: Oneonta significantly is more rural than Amherst.

We found 4 primary media-use factors for each area (Table 3). Only 1 factor remained constant (i.e., was comprised of the same items) for each of the areas. This factor, which was labeled *environmental/wildlife media*, included the use of wildlife, nature, and animal rights magazines. Hunting magazines were included in this factor for Amherst and Oneonta, but factored alone for Riverhead. Other media fell under different factors for each area and reflects underlying differences in media use (and in the nature of the media markets) among the areas.

Correlation analysis revealed relationships between information-seeking motivation factors and media-use factors (Tables 4-6). For each of the 3 areas, significant associations were apparent between *nature/rights* information-seeking and *environmental/ wildlife* media use. In Amherst, deer *hunting* information-seeking also correlated significantly with *environmental/wildlife* media use. Significant correlations also were found between the *nature/rights* and *hunting* information-seeking factors and *entertainment/misc.* (e.g., video tapes) media use. For Amherst, *pragmatic* information-seeking was related to use of mainstream news. However, in Oneonta, *pragmatic* information-seeking was related negatively to general TV/local news watching. No significant relationship existed between *pragmatic* information-seeking and any of the media use factors

for Riverhead.

Thus, it is difficult to generalize across markets about media usage of particular types of information seekers. This may arise because media markets (particularly those in this study) differ across many characteristics (and each study addresses different species, thus information-seeking characteristics logically will differ). Larger media markets (e.g., Amherst) offer options that differ from those in smaller cities (e.g., Oneonta), whereas markets near large cities (e.g., Riverhead) have still more options. This suggests that studies of media use should be conducted on an area-by-area basis to maximize reliability of results and efficiency and effectiveness of information dissemination.

## CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

It is difficult to generalize across differing media markets because the problems experienced and the species involved differ in each area. However, some conclusions can be reached. In Amherst, for instance, on the issue of deer, both of the major information-seeking types use environmental/wildlife sources. This presents both an opportunity and a problem. The opportunity is that typically "opposing" groups can be reached in the same medium. Thus, an agency could opt to concentrate its communication in this medium to put both groups on the same playing field and to maximize its investment of resources. However, the problem is that opposing groups often interpret messages differently. Thus, the agency may wish to keep especially controversial news items out of such media, where the opportunity for polarization especially is prominent.

- *Recommendation: over the long term, place stories on cooperation between nature/rights and pragmatic types in environmental/wildlife publications. Avoid controversial issues in these publications, if possible.*

In Riverhead, the data show that those interested in aesthetic/animal rights issues are, in general, much heavier consumers of the local newspaper. The agency professional in this area therefore needs to pay special attention to the role this paper plays. He/she must determine whether the newspaper leans toward the aesthetic/rights viewpoint (which is possible given the high correlation), or whether the newspaper simply incites attention through controversial coverage. The local newspaper likely played a primary role in constructing public attention on the goose controversy. Further research (content analysis, for instance) could show the nature of this construction. In any case, the agency communication planner should develop close professional relationships with this medium, given its self-evident importance.

- *Recommendation: develop a strong working relationship with local newspaper personnel to help educate writers and editors on goose management issues. Try to present alternatives to highly inflammatory or controversial coverage.*

Further, Riverhead residents who had concerns or negative attitudes about Canada geese were more interested in pragmatic or economic information regarding Canada geese than were residents who were interested in or had positive attitudes about geese (as would be expected). Loker (1995) found that interests in and concerns about deer, beaver, and Canada geese by suburban residents influenced their attitudes toward these species. Concerns and negative attitudes toward Canada geese may have motivated pragmatic information-seeking in some residents (i.e., pragmatically-oriented Riverhead residents "gratify" their need for information by using news

media).

- *Recommendation: communication that intends to minimize concern should be directed toward residents with pragmatic information needs whereas communication that intends to increase interest in a particular species should be directed toward nature/rights information seekers. Both types of communication may produce more positive attitudes toward a problem species and increase agency responsiveness to public information needs.*

In Oneonta, where a particular species has not yet caused many problems but may in the future, residents may not be motivated to seek any information about that species. If the species becomes recognized as an issue in a community through the media or other communication sources, residents will begin to form attitudes about it and thus be more likely to seek information or at least form an opinion based on information provided to them. It may behoove wildlife agencies to implement proactive communication (e.g., build relationships with the media, community leaders) in these areas and allow residents to build trust in wildlife agency staff as an information source. The agency should embrace such opportunities to develop successful mass communication strategies before an urgent need to do so is thrust upon them.

- *Recommendation: a planned and periodic release of information to the various media that highlights positive aspects of beaver management could cultivate wider public acceptance of more invasive techniques when or if the need arises.*

Those interested in pragmatic information also tend to support "traditional" management options more frequently. Moreover, in 2 of the 3 study areas, these groups rely on newspapers for their data on wildlife issues. Nature/rights supporters, conversely, use magazines, specialized publications, and entertainment sources more frequently. Magazines often present information in narrative-structured packages, whereas newspapers focus more on providing information. This suggests that pragmatic information-seekers may be "informed" about wildlife issues, whereas nature/rights information seekers are motivated by stories, narratives, and images about wildlife problems. Wildlife managers should interpret these as evidence of the gratifications different audiences seek in their use of media resources.

Here, specific recommendations depend on the goals developed in a communication plan. If the agency has the goal of reconciling conflict between opposed groups, then messages need to be targeted at the types of media those groups use most frequently, and in a format they are accustomed to using. Thus, pragmatic information-seekers will be influenced more by messages targeted at informational media that present factual reasons for reconciling positions with nature-rights supporters. Conversely, nature/rights supporters will be motivated more by narratives that show how cooperation leads to better outcomes for wildlife. These narratives should be targeted at magazines preferred by this audience.

On the other hand, the agency's goal may be to strengthen a specific audience. Such a strategy tends toward manipulation and probably would not be adopted by most agencies today, but could be legitimate if the agency decided that a particular course of action substantively was better for wildlife. In that case, the agency should address communication unilaterally to the public to be supported, and in the specific media used most frequently by that public.

In Amherst, for instance, a strategy that supported the pragmatic group ought to focus on the "mainstream" news media preferred by that group. A strategy for strengthening the nature/rights group should focus on environmental media.

Although similarities in residents' information-seeking motivations do exist for the 3 areas, their use of the general media differed. The *environmental/ wildlife* factor was the only consistent media use factor throughout the 3 areas. Variability in media use between Amherst, Oneonta, and Riverhead reflects differences in demographic characteristics (e.g., age, education) and the relative proximity of each to a major metropolitan area. Thus, general assumptions about media use should be made cautiously for suburban areas, which can differ widely in demographic makeup. It cannot be assumed that people with similar information needs regarding wildlife will use the same sources and channels to gain that information. For example, it was difficult to discern a general media-use pattern for *pragmatic* information-seekers in each area. Effective communication on problem-causing species therefore requires, at a minimum, routine monitoring of information about local media use.

- *Recommendation: examine media use patterns of wildlife publics every 3 years to monitor and detect changes in the media and opinion landscape.*

Effective communication begins by recognizing audiences as active participants in the communication process. The "uses and gratifications" approach emphasizes the information-seeking motivations and media use of the public and therefore may be a helpful tool for wildlife agencies interested in meeting public needs regarding problem-causing wildlife. Agencies that move toward a more tailored, audience-oriented approach to communication will build better relationships and minimize contention between themselves and their publics.

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**Table 1. Factor solutions for: types of information that residents would seek regarding the referent species in Amherst, Oneonta and Riverhead.**

| AMHERST (deer): | ONEONTA (beaver): | M. POND (geese): |
|---|---|---|
| *Pragmatic* | *Pragmatic* | *Pragmatic/hunting* |
| ? Prevention of deer-car accidents | ? Prevention of damage to trees | ? Goose biology and habitat |
| ? Prevention of deer damage to property | ? Prevention of damage to land | ? Prevention of damage to property |
| ? Deer contraception | ? Beaver trapping | ? Health/sanitation problems caused by geese |
| ? State deer management programs | ? Beaver contraception | ? Goose hunting |
| | ? State beaver management programs | ? Goose contraception |
| | | ? State goose management programs |
| *Nature/rights* | *Nature/rights* | *Nature/rights* |
| ? Deer biology/habitat | ? Beaver biology/habitat | ? Viewing/photo-graphing geese |
| ? Viewing /photographing deer | ? Viewing/photo-graphing beaver | ? Animal rights |
| ? Animal rights | ? Animal rights | |
| *Hunting* | | |
| ? Deer hunting | | |

| **Table 2. Relationships between information seeking motivation and concerns, attitudes and views about management actions** | | |
|---|---|---|
| Variable | Factors | |
| | *Pragmatic* | *Nature/rights* |
| **Attitude toward Canada geese**[1] | -0.31* | 0.30* |
| **Interests**:[2]<br>Watching Canada geese near home | -0.03 | 0.47* |
| Photographing Canada geese | 0.00 | 0.49* |
| Hunting Canada geese | 0.25* | 0.02 |
| Feeding Canada geese near Merritts Pond | -0.14 | 0.38* |
| Seeing Canada geese near your home | -0.09 | 0.34* |
| Hearing the sounds Canada geese make as they fly overhead | -0.08 | 0.32* |
| **Concerns**:[3]<br>Canada geese disturbing you with their calls | 0.15* | -0.15* |
| Canada goose droppings in parks | 0.33* | -0.28* |
| Canada goose droppings on your lawn or other property | 0.33* | -0.21* |
| Losing control of your vehicle when trying to miss Canada geese on the road | 0.13 | -0.14 |
| Health and sanitation problems caused by Canada goose droppings | 0.39* | -0.21* |
| Canada geese chasing or threatening you | 0.07 | -0.17* |
| Canada geese polluting Merritts Pond with their droppings | 0.42* | -0.19* |
| **Concerns**:<br>Damage to lawns from Canada geese | 0.45* | -0.18* |

| Variable | Factors | |
|---|---|---|
| | *Pragmatic* | *Nature/rights* |
| Canada goose droppings on golf courses | 0.29* | -0.14 |
| **Management Actions**:[4] Scarecrows to keep Canada geese away from property | -0.13 | 0.00 |
| Birth control/sterilization | 0.32* | -0.08 |
| Feed Canada geese during the winter | -0.38* | 0.22* |
| Nonharmful chemical repellents | 0.29* | -0.18* |
| Trap and transfer Canada geese to another location | 0.22* | -0.24* |
| Sharpshooters to shoot Canada geese and give meat to foodbanks | 0.27* | -0.24* |
| Treat some Canada goose eggs so they do not hatch | 0.28* | -0.29* |
| Regulated hunting by licensed hunters | 0.24* | -0.21* |
| Reintroduce natural predators of Canada geese | 0.24* | -0.20* |
| Remove Canada goose eggs from nests and destroy them | 0.25* | -0.28* |
| Trap Canada geese and kill them with lethal injections | 0.16* | -0.16* |
| Let nature take its course | -0.46* | 0.29* |
| Use balloons or flags on floating boards to keep Canada geese away from Merritts Pond | 0.07 | -0.20* |
| **Management Actions**: Prohibit people from feeding Canada geese | 0.26* | -0.14 |

| | | |
|---|---|---|
| Dogs to scare Canada geese away from property | 0.07 | -0.13 |
| Variable | Factors | |
| | *Pragmatic* | *Nature/rights* |
| Fences or other barriers to keep Canada geese away from Merritts Pond | 0.05 | -0.19* |

*Correlation is significant at $p \leq 0.05$.

[1]Response options were 1=do not enjoy Canada geese and regard them as nuisances; 2=enjoy presence of Canada geese but worry about problems they cause; 3=enjoy presence of Canada geese unequivocally.

[2]Response options ranged from 1=not at all interested to 5=greatly interested.

[3]Response options ranged from 1=not at all concerned to 5=greatly concerned.

[4]Response options ranged from 1=not at all acceptable to 4=very acceptable.

**Table 3 Media-use factors.**

AMHERST:

| | |
|---|---|
| *Environmental/wildlife*: | Use of media that focus specifically on environmental issues such as nature or wildlife (e.g., wildlife or hunting magazines). |
| *Local newspapers:* | Use of daily and/or local newspapers (e.g., *Amherst Bee*). |
| *News magazines:* | Use of national news magazines. |
| *Entertainment:* | Use of entertainment media (e.g., video cassettes). |

ONEONTA:

| | |
|---|---|
| *Environmental/wildlife*: | Use of media that focus specifically on environmental issues such as nature or wildlife (e.g., wildlife or hunting magazines). |
| *Television:* | Use of television generally and television news programs. |
| *Written news media:* | Use of written news media (e.g., local news papers, national news magazines). |
| *Miscellaneous:* | No logical pattern existed within this factor. |

RIVERHEAD:

| | |
|---|---|
| *Environmental/wildlife*: | Use of media that focus specifically on environmental issues such as nature or wildlife (e.g., wildlife or hunting magazines). |
| *Local newspapers:* | Use of daily and/or local newspapers (e.g., *Newsday*). |
| *Random new media:* | Use of a variety of sources of news media (e.g., radio news programs, television, news). |
| *Hunting magazines:* | Use of hunting magazines. |

**Table 4. Correlations between media use and information-seeking motivation factor scores for Amherst.**

| Information Motivation Factors | Media Use Factors | | | |
|---|---|---|---|---|
| | *Envir./ wildlife* | *Mainstream news* | *News magazines .* | *Entertain./ misc.* |
| *Pragmatic* | 0.08 | 0.16* | -0.05 | -0.08 |
| *Nature/rights* | 0.41* | -0.03 | 0.06 | 0.17* |
| *Hunting* | 0.22* | -0.02 | -0.03 | 0.13* |

*Correlation significant at $p < 0.05$.

**Table 5. Correlations between media use and information-seeking motivation factor scores for Oneonta.**

| Information Motivation Factors | Media Use Factors | | | |
|---|---|---|---|---|
| | *Envir./wild-life* | *Television* | *Written news media* | *Misc.* |
| *Pragmatic* | 0.05 | -0.18* | -0.01 | 0.02 |
| *Nature/rights* | 0.21* | -0.05 | -0.01 | 0.10 |

*Correlation significant at $p < 0.05$.

| **Table 6. Correlations between media use and information-seeking motivation factor scores for Riverhead.** | | | | |
|---|---|---|---|---|
| Information Motivation Factors | Media Use Factors | | | |
| | *Envir./wild-life* | *Local newspaper* | *Random* | *Hunting mags.* |
| *Pragmatic/sci./hunting* | 0.12 | 0.13 | -0.04 | 0.01 |
| *Aesthetic/rights* | 0.02 | 0.39* | -0.06 | 0.05 |
| *Correlation significant at $p < 0.05$. | | | | |

# ALDO LEOPOLD'S LAND ETHIC: IMPLICATIONS FOR PREDATOR MANAGEMENT

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Abstract: The golden rule of Aldo Leopold's land ethic clearly supports active management of predators that harm populations of rare animal species. In the early part of his career, while working as a forester in the American Southwest, Leopold advocated exterminating large predators like gray wolves (*Canis lupus lupus*) and grizzly bears (*Ursus arctos horribilis*) from the region, but he later changed his mind when he realized that native predators help maintain ecosystem integrity. Philosophically, Leopold's changing views on predators exemplifies John Dewey's customary and reflective morality. But Leopold's dramatic narrative in *A Sand County Almanac* about his regret for helping kill a female wolf with pups on the Apache National Forest in 1909 should not be misinterpreted to mean he condemned all predator management as environmentally wrong. On the contrary, today, in some situations, the ecosystem integrity Leopold valued actually may be dependent upon active management of certain predator species. And, in some cases, lethal control may be the best option. I examine situations involving rare species that are harmed by predators in which the land ethic's golden rule (i.e., "A thing is right only when it tends to preserve the integrity, stability, and beauty of the community, and the community includes the soil, waters, fauna and flora, as well as people") mandates predator management. I explain why "letting nature take its course" is not a desirable option, and maintain that, in such cases, the predator management polemic should be focused on how management should proceed rather than on whether it should proceed.

Key Words: Aldo Leopold, ecosystem integrity, land ethic, predator control, predator management

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# PRIVATE NUISANCE WILDLIFE CONTROL: IS THERE A FUTURE IN KANSAS?

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Abstract: The private industry involvement in nuisance animal damage control is increasing in Kansas. Improved oversight of that industry is needed and the Kansas Department of Wildlife and Parks (KDWP) plans to implement a mandatory education and certification program beginning in 1998. KDWP currently issues permits to individuals who wish to trap or control nuisance animals outside of normal harvest seasons. Individuals who have held these permits to conduct nuisance animal damage control were surveyed in 1995 to better understand the status and needs of that industry in Kansas. A 3-page mail survey was sent to all 93 permit holders. Raccoons (*Procyon lotor*), beaver (*Castor Canadensis*), and skunks (*Mephitis mephitis*) were the species most often involved in complaints. Most damage control was conducted from March to June and occurred in both urban and rural areas. About 42% of the individuals doing nuisance animal damage control work did not receive monetary compensation for their services. Most respondents believed there was competition for control services from KDWP, Cooperative Extension Service, and the USDA-Animal and Plant Health Inspection Service-Animal Damage Control program. There was strong support for a mandatory training and certification program. About half of all respondents indicated there is potential or strong potential for new private nuisance animal damage control businesses. Private animal damage control appears to have a future in Kansas. That future should include continuing cooperation and coordination between public natural resource management agencies and private damage control operators.

Key Words: animal damage control, certification program, Kansas, private nuisance control operators, survey

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# VERTEBRATE DAMAGE MANAGEMENT: THE FUTURE OF AN EVOLVING PROFESSION

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Abstract: The author argues that an objective of a new group of people taking a systems approach to large wild animal problems should be to manage damage as a cost-reducing role within a total, profitable, long-term system, not necessarily to control the "pest." The needs are for well-grounded financial analyses both for customers, the public, the resources, and the well-being of the profession. A point of view is advanced for the need for evolving pest-related operations into a new, unique profession that is involved in a profound way as an element of a cost-effective total land and human resource production system.

Key Words: damage management, financial analyses, pest, resource production system, systems approach, vertebrate

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## INTRODUCTION

Over my career I have backed into things. Not in my car, but in the woods! I backed into maple thickets in Oregon, blackberry bushes in the Virginia Piedmont, "laurel" (rhododendron) in North Carolina, and who knows what collection of awful things in Florida. I expect you understand very well the term "backing in." I want to back into some ideas in this paper. I have advocated to my classes in Systems Ecology that they back into their analyses. I also say "start at the end." By this I mean think about the desired end conditions, the history you wish you could read, or what you expect in some final evaluation report, and then work backwards, *up* the flow chart, to be sure that the desired final condition happens. We need now to look into an analysis of vertebrate damage management for the future.

## PRACTICAL MEMORY

Ray Hilborn (1992), a fisheries scientist, complained that fisheries, as a field of work, has no *institutional memory*. As we think about the vertebrate damage management system for the future, we need to be sure we have a memory that

prevents us from making that claim and the same mistakes. We cannot avoid making mistakes (for reasons too many to discuss here). We usually can avoid making the same mistake. Hilborn (1992) observed that there are few places where the need for institutional learning has occurred (March 1988), but there is evidence that it can occur and it is intuitive that it is needed.

There have been amazing changes in technology and in society, and some people will argue that history has little meaning today. I only argue that many good ideas have failed because of a poor presentation or because they were presented at the wrong time or place, or to the wrong person. The past system context for an idea may have been wrong; failure was not necessarily due to the quality of the idea. To document the reason for the failure may allow the efficiencies of the idea to be gained later. History does cost, but so does any mistake or past inefficiency. We need a cost-effective memory, one that is brief, practical, and oriented to a high probability of retrieval. We need one with

a mechanism for being moved into current decision making.

In order to develop a practical memory, I suggest:

1. Periodic staff debriefing (twice a year reviews; the recent history).
2. A computer question-and-answer system designed to prompt people (once-a-year use) for answers and comments that may be useful later. This is a growing computer file of expert commentary.
3. Old-timer seminars (suggested by Hilborn 1992).
4. Memoirs of retirees commissioned by the collective profession and written (as needed) with paid assistance.
5. New staff requirements (that they at least read important components and abstracts of the various historical media).

The history needs to be practical. I assume that much learning is built into policies. These tend to suggest limits and things to avoid and often emerge from past problems. Most people in the audience have heard: "Get rid of the massive policy manual!" However, at least the grounds for the policy manual need to be remembered. Policy doesn't emerge on its own.

I assume that techniques will be improved and thus embodied within each of them is a form of institutional learning. I am more concerned about remembering what did not work and why it was changed. I am even more concerned that the reason why the technique was first used may have changed. This is called "displacement of the objective" and it brings me to my next topic.

**OBJECTIVES**

By "starting at the end," I mean that we need a clear statement of a destination. That is the only way we can tell when we have arrived (the clarity of the logic exceeds the clarity of the map to the destination). What will be the "good" in this history that we create for ourselves? We have to be sure that our work on improved traps, trapping, devices, and repellents does not displace the objective. Why were we doing the work in the first place? Perhaps the objective was *improved profit*. If so, the evaluation of our work in the net income column should not be displaced by trap effectiveness, number of traps, area covered, or animals taken. There can be *big* differences between the two.

I have studied objectives and objective setting for years (Giles 1981) and with students (Buffington 1972, Cowles and Giles 1982, Lee 1972, Lobdell 1972, Ritter 1975, Waldon 1987). It is a topic as discussable as UFOs and, based on the evidence that I now have, just about as meaningful. Over many years I have argued for stating a large *set* of objectives (because we have many), estimating the *amounts* of each product or service that we need, assigning relative *importance* to each (because I know they are not of equal importance), assigning a *probability* of success or failure (because nature, weather, etc., will have its way no matter what our objectives may be), and then stating what we will *substitute* for some of those things we "demand." This all gets very complicated, but it is readily handled by computer. At least the equation and the relations described in it can help people understand and explain why some people are so sympathetic and other people have such disagreements. The chance of two people having equal objectives is almost zero.

Vertebrate damage management specialists (managers) are perceived (at least by me) as working at all parts of the system to achieve a high score using these concepts within a computer. The score improves as they reduce losses, achieve demand, modify values, make expectations realistic, encourage substitutions, and

reduce costs and losses.

Now, however, I give up! I've fought the good fight and failed. I give up on trying to get people to work with such objectives. I suggest that the objective for our field be

> *to assist (public and private) land and property owners maximize profits partially by minimizing system costs (and equivalent actual or perceived losses) to vertebrate wild and semi-domestic animals, all subject to legal, ecological, economic, esthetic, and energetic constraints; all within* a *10% zone* of *performance; and all counted over a dynamic 100-year planning period.*

That is it. That is all. Just do it, any way possible. The scientists can work on the basic processes; the economists can work on the algorithms; the foresters and agronomists can worry about whether "yield" means wood, tomatoes, or profit; the nay-sayers can debate profit-motives, the free-market, and entrepreneurial systems. The ecologists can struggle with what "relations" really mean and search for true "interactions;" and the vertebrate damage managers can work with them all.

**VDM**

I do not approve of the word "integrated" in IPM (integrated pest management) (ct. Giles 1980). If I am managing, I am integrating, I am working with everything all at once. The modern person working in our field is working with a whole complex system. Such people are attempting to manage (or assist in managing) a whole system. Not to *integrate* things as a manager is silly, without meaning. I am opposed to the idea of managing pests. I want to manage their effect or perceived effect (e.g., a bat flying through bakery). I may have to kill or move an animal or increase its predators, but I can use barriers. I can use metal containers. When I exclude mice from grain, am I managing pests? Poisoning them, yes; excluding them, I think not. Of course I am managing their effects. When I prevent damage, I rarely do anything to the animals themselves. When I change knowledge of a cute animal into a disease vector, have I managed the pest? I think not; only the perception of the animal problem. I think we should manage perceived damage and reduce it at reasonable costs, not just manage pests.

I have no option but to hold on to the word vertebrate. As a person advocating a total system view, I see no way to separate high quality work on reducing costs and losses from wild animals -- whether they are vertebrates or invertebrates is a matter of their bones, not my practice. When I think of mosquitoes, I am thinking of tree holes and birds and flying squirrels. When I think of mice, I think of fleas, plague, and hanta virus. When I recommend "sanitation," I am as involved in reducing invertebrates as with vertebrates. When I work with moles, I am actively involved (or believe I should be) with invertebrates, the creatures in the soil. I give up! Use "vertebrate;" draw another line, restrict our work and thoughts; but let us realize what we have done. Let us see these divisions that we have made as a regional line created for efficiency, employment, and for teaching and not as ground to be fought over as if by territorial squawking birds.

We are not wildlife managers because they cannot decide who they are. They cannot decide and neither can we. They call themselves "biologists," but rarely do they talk about botany, require little botany in their education, spend 80% of their professional time working with groups of plants (which they call "habitat"), and cannot recognize a professional society take-over by an emerging bunch with the non-name of "conservation biology." "Teaming with Wildlife," a national tax proposal, if successful, will unleash massive new pest problems. Agencies have

struggled with names and proper "homes" for vertebrate damage management work for years. The U.S. Fish and Wildlife Service, with its own identity crises over many years (in the very name itself), allowed damage work to move to the U.S. Department of Agriculture. Amazed observers note that moves within Departments are common; between Departments, rare.

We are regulators; we are "Extension;" we are emergency services; we are public health workers; members of the agroforestry and agro-silvo-pastoral efforts. We are very diverse and scattered unequally throughout health fields, agriculture, military, product suppliers, inventors, and livestock people. As customs workers, we stand guard to prevent invasions; as students, we follow those creatures already having invaded. My view is that the demands for effective vertebrate damage management are profound. They encompass all of the concepts, techniques, and work of the field once called game management, now called imprecisely and inaccurately wildlife management. They demand breadth of knowledge of ecology (more than classical wildlife management), and simultaneously they require use of the extra knowledge domains of economics, esthetics, and energetics . . . all within the envelope of enforcement systems. This will not be embraced by any agency, any university. We need total systems people. What person recommends costly population controls to a person otherwise going into bankruptcy? What person accepts costs of operations far greater than the benefits likely to be received? What more than the most simple economics requires that we discount treatment costs over the life of a program if we are going to do reasonable financial analyses? More than "biologists" are needed!

I am now convinced that more good for humanity can be done over the next 20 years for the expanding world of 5.7 billion people by those people in the vertebrate damage management area than by all advances in agricultural research (Huffaker et al. 1976). We can reduce *losses* of the total production by 10% or more; agriculturists are not likely to increase net *production* by that much. Vertebrate damage management is an essential in modern society. It is an essential for survival. The population is expanding. We shall not bring it under control. It will double in 50 years at our present rate. It has already doubled since I've been on Earth. I feel crowded, stressed; things are half as sweet, we are more than twice as "bad off."

We have to see ourselves, clearly, to be very, very important for ourselves, our natural resources, and for our children. Who are we for the future? Vertebrate damage managers? I once defined wildlife management using the phrase "the science and art" (Giles 1971). I now reject that. Wildlife management just means deciding and manipulating populations, habitats, and people.[1] There is science and some art, but much more. It is just doing it. "Science" crept into my thought and that of U.S. society with Sputnik. If anything was scientific, it was good. That premise secretly slipped into "it is only good if it is scientific." Now we can step back and realize that there are many ways to know things. Science (typically induction/deduction) is only one. We need a new way to proceed. Science can help, but it is only one of many ways to know—to know how to manage vertebrate damage.

## THE KNOWLEDGE BASE

[1]My current recommendation is: Wildlife management is making decisions and taking action to manipulate the structure, dynamics, and relations of wild animal (and plant) populations, faunal space, and people to achieve specific, stated human objectives by means of the wild fauna resource.

We have to use the power of the geographic information system (Jones 1976, deSteiger and Giles 1981, Giles and Nielsen 1991) to understand what animals are involved where; what people are involved; what the estimated real losses are and how those will match with the estimated costs of control, enforcement, applications, and inspections. We now have wildlife information systems in >20 states; we have demonstrated we can "do ecology" at the level of areas about 1/3 the size of a football field. We've moved past speculation and dreams of Giles (1973) and into the world of monthly advances in relevant applications heralded in trade magazines (e.g., GIS World).

I have spent 30 years modeling natural resource systems and advocating use of systems analyses and computer decision aids (Giles 1979). I now finally realize that every model I attempted to create requires more data, more inputs, than I could *ever* get (e.g., Gruen 1993, Wajda 1993). I attributed my lack of success to *someone else's* failure to get and hold data for me. A simple vertebrate population model with any practical meaning requires a minimum of 34 pieces of information. I now realize that these data rarely are available for *any* population, even those most intensively studied! It is interesting to think about them, program them, simulate what would happen *if* certain numbers existed, but we now know that the numbers do not exist and the funds for getting them do not exist, and the time required to get and process them is too great for them to be of timely use. I once thought funny the statement "We can use a computer to predict exactly the next day's weather . . . but it takes a week to run it!" Just last year a forest model was reported to take 3 weeks to run on today's fast PCs! The situation is no longer funny. Timely approximations from feasible-to-run programs remain needed. We need powerful alternatives, one of which is a growing knowledge base with emphasis on ranges and medians, not means and deviation. We need all of the aspects of the rationally robust paradigm (Giles 1979, Giles et al. 1993).

## THE RATIONALLY ROBUST PARADIGM

There are 10 components of the paradigm that I propose (Giles et al. 1993) as a replacement paradigm for the pseudo-scientific, crisis-response, agency-bound, predominantly socialistic policies under which much vertebrate damage management work is now done. All of these, I assert, for the future are too concentrate on profit (within constraints) as defined above. They are:

1. Use site-specific knowledge, typically in a GIS, acknowledging that every site is unique.
2. Acknowledge the limits and consistency of financial support, minimizing costs and accepting the unlikelihood of long-term studies.
3. Accept lower confidence levels for (statistical) sampling and reaching conclusions.
4. Use estimates of median values (to replace the mean).
5. Use knowledge of range limits of ecological factors.
6. Study the general system's phenomenon of equifinality and its consequences.
7. De-emphasize time in system analyses, replacing it with other phenomena such as cumulative energy received.
8. Use regression techniques, simultaneously using factors that operate in many models (e.g., precipitation).
9. Use regression and modeling techniques to accommodate the non-linear nature of most economic, aesthetic, and ecological systems.
10. Operate as if in a clinical milieu, with conservative changes made rapidly with feedback.

## CONSTRAINED PROFIT

Years ago, state operated soil-testing labs

were privatized. Free (tax-paid) soil tests were inappropriate in an entrepreneurial system. Only when an open market existed did private soil labs become possible. By analogy, and for other more compelling reasons, I hold that vertebrate damage management can and should exist in an open market environment. The public is served inadequately by the budget-strapped, often inefficient agency. Needs are increasing; the tax base is not increasing; the customer is changing rapidly to the urbanite or to the agribusiness person. The power of the current knowledge of the field is not being used and developments for the future remain in the hands of a tax-limited few people in public agencies seeking to placate strongly-different, politically-weighted demands.

I believe studies should be done and techniques developed by companies to achieve a competitive edge. Superior students who will work will be recruited by well-paying companies. Effective practices will be used to achieve highest success for lowest cost as in any open-market system. Prevention contracts will be seen to be as valuable as fire insurance. Rapid-response units will form as collectives from within often-competing companies. Of course, there will remain regulation, the enforcement of which is the rightful role of agencies, but beyond this, there is the need for vital companies working to help landowners make profit, reducing inappropriate regulation and control costs, and either adding gains or reducing losses from vertebrates. A deer (for example) in a regulated environment is at once an urban pet, a crop destroyer, an aesthetic entity, and a potential trophy game animal. It destroys endangered plants, changes forest structure, contributes to improving forest site index, is a highway hazard, and is one vector of ticks transmitting Lyme disease. There is no "solution" for the deer problem. It is called by one analyst a "wicked problem" for which there is no solution, only the needs for management to blunt the extreme conditions for separate groups. The professional vertebrate damage manager is needed. Such people can deal with such large, complex, multi-faceted problems. How will they (or society or customers) know when they succeed when there is not a solution? By the measure of constrained profit. The constraints are ecological (do not extirpate; do not diminish an endangered species; work for desired natural productivity of forests, waters, and rangelands). The constraints also are economic or monetary (limited staff, equipment, budgets, cash flow, time, required profit, and discount rate). The constraints also are energetic (energy conservation and preparedness for looming fossil-energy shortages). They are aesthetic (subject to group and individual sensibilities relative to humane tactics, animal care, and animal removals). Except for major public constraints (laws, regulations, and policies), moving professional work to the private sector allows an objective to be decided and progress to be made. Without such clarification, damage/or pest-related agencies are adrift. Their performance is recited in calls that are made by the public, counts of animals moved, and other numbers unrelated to their real objective—presumably the health, safety, welfare, economic well-being, and quality of life of citizens (Giles 1982). No one yet has a measure for the collective "social good" (except the scoring procedure suggested above) and I do not recommend waiting for one to be used. In our modern society, I recommend working toward constrained profit in a free enterprise system.

**PROFIT VS YIELD**

In creating a model of tomato disease, I discovered that the effect of disease on profit was not known. Must 100% crop loss always be assumed? Perhaps birds cause loss of grade in a fruit, but what is the total loss in profit for the year, given the current complex of supports, tariffs, and transportation cost? What was the

tolerable loss for a landowner before the minimum profit threshold was passed?

I once suggested to an agency that my models of a boll weevil control program could suggest very effective control, so effective that it would increase cotton supplies and cause the price of cotton to drop, perhaps below a profit margin. I was encouraged not to pursue ***that*** line of analysis.

"Sustained yield" is required of the U.S. Forest Service. Often debated, it is very important that yield be interpreted as profit, not cubic yards of wood. Neither in forestry nor elsewhere is biological yield the end result needed. Sustained productivity of products in a deflated economy can lead to bankruptcy.

The point of these examples is that there is a need, a glowing opportunity for a modern profession of vertebrate damage management to step into the forestry-agricultural and the expanded residential-urban realm to help customers see clearly their monetary or financial situation and to engage in cost-effective analyses of their enterprise and the role that rational vertebrate damage management can play.

Critics for years have claimed that no one can quantify the worth of a duck or the beauty of a sunset. I advocate not trying, agreeing. My hypothesis is that "money talks"; that when financial concerns clearly are incorporated into a 100-year profit-making enterprise with all the needed societal constraints, then all of those extra, said to be non-quantifiable, needs will be amply accommodated—ducks and sunsets.

**THE VDM SYSTEM**

The professional manager is not yet being produced in the University. It is unlikely this will occur soon for reasons I am embarrassed to discuss, so I recommend and believe a high-intensity educational program can emerge. Created by one company or a collective, ***education for profit*** can emerge.

Research needs to be company specific, but a company also is likely to find that a research and development group may be useful. "Basic research" rarely will be tolerated; use of existing knowledge, synthesis, and modeling to help find the sensitive areas that can be manipulated will be the task of this group, which itself, can be financially self-sufficient.

The "pest control operator" has already had many tools removed from the arsenal of managerial tactics. The new profession needs to regain these, to overcome the reasons for past removals, and to exercise skillful, site-specific, timely, cost-effective field work ***after*** the computer-aided analysis has been made of expected financial returns in the context of the customer's needs (and society's constraints). [I find this free-market concept analogous to the freedom to go anywhere in the U.S., as long as you follow the rules of the road.]

We in vertebrate damage management have to achieve (at least in some place) a level of expertise, competence, and image that will allow us to do the work needed. I have in mind an image of a Mayo Clinic, a Rand Corporation. I have in mind military special forces—Rangers or Seals. There are pieces of an image, one or more centers of exceptional capability in analyzing, designing, and implementing a vertebrate damage management system.

I am convinced that with increasing college costs, shrinking class hours, grade inflation, professors without experience, a persuasive reductionist research paradigm (which will not change soon), and narrow college departmentalism, there will be no graduates to hire for these imagined centers of excellence. Therefore, I see the need to privatize an educational center for the vertebrate damage management system. I do not believe we can count on any university. One or two modified

curricula locked within the present-day university cannot handle the task or overcome the contextual inertia for the tasks ahead. Vertebrate damage managers need their own "special force" educational center, one that recruits special people, educates them (and continues to do so) to deal with the total production system for society, and then does it.

Along with the people of such a center there will be needed complex staff work to implement the selective, unique tasks usually needed. Usually average solutions are suboptimal. Suboptimum is the enemy. There is need for the injunction, the subvention, the emergency procedure—in carefully analyzed situations. The law is right for the average, everyday case; the law can be a messenger of policy and limits. The growing daily needs, however, are for the equivalent of laser surgery, and the military strike. We have a long way to go and we'll not achieve the perceived possible and needed changes in 50 state offices, several national offices, or several agency offices. We'll not achieve society's respect by defining ourselves as PCOs or as wildlifers with an emphasis, or as entomologists that apply their knowledge to large animals, or as health officers more interested in the virus than the vectors, and with a slogan of the question "but what can you do?"

Let me assure you that I am very serious. Do not dismiss the message today as that of an after-thought. We have within our grasp a profound need—safety, health, food, forests, rangeland, and quality urban spaces. We can have that only when a vital system of vertebrate damage management is operated. The need is too great and the solution too large and complex to be designed and managed by the average "grade-C" university graduate of a non-descript, small curriculum full of electives. It will not be handled well by a biologist never having a course in economics. The molecular biologist will not master "all ecology" in one watered-down, over-extended, and case history-infused course on that topic. With only 3% of the U.S. population now living on farms, the vocabulary of the field is no longer known by the person on the street. Without the words, there can be no understanding!

I do not like very much where my thoughts have taken me. Perhaps I should back track. Maybe "backing in" has been very bad. "Backing in" can be dangerous if you don't know where you are going. I know where vertebrate damage management must end up—a vital field of work serving all society, working to achieve the most profound of social, ecological, and esthetic objectives—working at purposefully achieving profitable partnerships in human health, safety, foods, welfare, recreation, and defense.

We are too important; we know too much; people suffer too much damage. We must develop a bold new strategy and then take action to create the vertebrate damage management so badly needed for the future.

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# DEVELOPMENT OF THE VIRGINIA COOPERATIVE COYOTE CONTROL PROGRAM TO PROTECT LIVESTOCK

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Abstract: The Virginia Cooperative Coyote Control Program was created in 1990 to address increasing livestock losses to coyotes and the inability of producers to solve such problems themselves. The eastern coyote arrived in Virginia in the late 1970s or early 1980s. Lobbying efforts of agricultural groups, such as the Virginia Sheep Federation, helped create a cost-share program administered by the Virginia Department of Agriculture and Consumer Services (VDACS) and U.S. Department of Agriculture-Animal and Plant Health Inspection Service-Wildlife Services (USDA-APHIS-WS). The objective of the program was to educate producers about control methods and to alleviate damage by removing offending coyotes where damage was chronic or economically harmful. The Cooperative Coyote Control Program has focused on educating producers about livestock husbandry practices that reduce coyote predation and developing an integrated direct control program to remove offending coyotes. Initially, only trapping and shooting during daylight hours were legal methods to remove offending coyotes. VDACS and USDA-APHIS-WS worked with the Virginia Department of Game and Inland Fisheries, animal welfare interests, and other affected stakeholders to broaden the methods available to remove coyotes that were killing livestock. In 1997, the integrated coyote control program used traps, shooting, calling and shooting at night, snares, M-44s, denning, and Livestock Protection Collars to remove offending coyotes and stop predation. M-44s and Livestock Protection Collars were restricted to use only by USDA-APHIS-WS personnel. The strategy of alleviating livestock losses in Virginia shifted from primarily corrective control to preventive and corrective control as more effective means to reduce livestock losses. A record-keeping system was implemented to track livestock losses and management responses as means to evaluate the program.

Key Words: *Canis latrans*, Cooperative Control Program, coyote, livestock depredation, Virginia

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## INTRODUCTION

Coyotes (*Canis latrans*) are native to North America and historically inhabited the deserts and short grass prairies of the West until Europeans colonized North America (Parker 1995). The extirpation of gray wolves (*Canis lupus)* and habitat modification by humans are believed to be contributing factors in the immigration of coyotes into eastern North America (Parker 1995). Across the western United States, coyotes have been a primary predator of domestic livestock (Terrill 1975).

The eastern coyote arrived in Virginia in the late 1970s. Livestock losses to coyotes first were reported to the Virginia Department of Agriculture and Consumer Services (VDACS) in the early 1980s.

According to Virginia Department of Game and Inland Fisheries (VDGIF) and U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services (APHIS) records, 522 sheep and 7 calves were reported killed or injured by coyotes in 6 western counties from the early 1980s through 1987 (Tomsa 1991). The National Agricultural Statistics Service (NASS) reported 4,100 sheep and 700 calves killed by coyotes in Virginia in 1990 and 1991, respectively (NASS 1991, 1992). Sheep and calves reported killed by coyotes in these two surveys were valued at $366,500 (NASS 1991, 1992). The Virginia Sheep Federation, a state-wide umbrella organization comprised of the 7 wool pools in Virginia, and other agri-business groups lobbied the legislature to establish a program to assist livestock producers with coyote depredation. The Virginia Cooperative Coyote Damage Control Program (VCCDCP), a 50:50 cost-share program between VDACS and APHIS, was created in 1990 to address the increasing predation problem that producers were unable to alleviate themselves.

VDACS negotiated with APHIS to establish a 50:50 cost-share program to fund a wildlife biologist position devoted solely to assisting producers. The objective of the program was to educate producers about coyote control methods and to alleviate damage by removing offending coyotes where damage was chronic or economically harmful. Later, the Virginia Sheep Industry Board was created by referendum in 1995 and a "head tax" collection program was imposed for each sheep sold as a means to fund predator control and marketing. Funds from the Sheep Industry Board were used to support a technician position within APHIS.

Nationally, APHIS has been the lead federal agency in managing wildlife damage and conflicts to protect agriculture, human health and safety, natural resources, and property (USDA 1994). APHIS has been providing service since the late 1800s to reduce depredation to livestock. In Virginia, VDACS has been the lead state agency directed by law to protect agriculture, human health and safety, and property from damage associated with wildlife. Both agencies have provided technical assistance, loaned equipment, and provided direct control services to alleviate wildlife damage or conflicts.

Wildlife damage management is defined as the alleviation of damage or other problems caused by or related to the presence of wildlife. It is an integral component of wildlife management (Leopold 1933, The Wildlife Society 1990, Berryman 1991). APHIS and VDACS use an Integrated Wildlife Damage Management (IWDM) approach (sometimes referred to as Integrated Pest Management, or IPM) in which a combination of methods may be used or recommended to reduce wildlife damage. IWDM is described in Chapter 1, 1-7 of the Animal Damage Control Program Final Environmental Impact Statement (USDA 1994). Prior to August 1, 1997, Wildlife Services was named Animal Damage Control.

In this report, we discuss the development and efficacy of the Virginia Cooperative Coyote Damage Control Program.

## DEVELOPMENT OF THE COOPERATIVE COYOTE CON-TROL PROGRAM

The VCCDCP, an integrated wildlife damage management program, uses non-lethal and lethal methods (Table 1). The integrated program has used any and all practical methods to alleviate damage while minimizing environmental impacts. Initially, APHIS had few methods

available to remove offending coyotes. Therefore, a strategic plan was developed to identify and prioritize potential management methods suitable for use where the objective was to reduce livestock predation to the lowest levels possible. Reducing predation on sheep was viewed by APHIS and VDACS as critical because the sheep industry in Virginia was in decline, as measured by a reduction in sheep numbers from 165,000 sheep in 1990 to 88,000 sheep in 1997. Two of the reasons commonly given by sheep producers for going out of business were coyote predation and the interaction of coyote predation and low lamb prices in 1993 and 1994.

Educating People about Coyotes and Providing Technical Assistance

Education, technical assistance, and the dissemination of information have been the primary emphases of the VCCDCP. This approach has allowed the VCCDCP to provide assistance to >180 different producers in 31 counties and to educate the public about impacts coyotes have on livestock production.

*Educational Programs*—APHIS conducted annual educational programs for people directly involved in livestock production to inform them of current methods of coyote damage management and how these methods could be incorporated into current livestock production practices. Animal Control officers were involved because of their role related to an existing compensation program for dog predation on livestock. State wildlife biologists were provided information about coyote predation and control methods. The education program focused on 1) identification of coyotes and coyote sign, 2) distinguishing between coyote and dog depredation, 3) methods producers can use to help themselves, and 4) methods available to alleviate coyote predation on livestock. APHIS conducted 5-14 educational programs per year to 2,983 people between June 1990 and July 1997.

*Fencing*—Predators of large domestic animals have been absent from Virginia for >100 years. The condition of woven wire fence (4-6 inch stays), the standard fence used by sheep producers in Virginia, was in a general state of disrepair statewide in 1990 (Tomsa 1991). Initial non-lethal recommendations emphasized the need for producers to improve, repair, and/or replace ineffective fencing.

*Guard Dogs*—Initial efforts to use guard dogs as a method to alleviate sheep depredation were ineffective, primarily because breeders were selling dogs that had not been trained properly to guard; these dogs were not reared with livestock to establish necessary bonding. As a consequence, guard dogs were viewed by livestock producers as being ineffective, based on past personal experience or shared perceptions of other producers. APHIS facilitated the placement of 12 working guard dogs to create credibility among livestock producers. The success of these dogs has increased the popularity of guard dogs in Virginia. APHIS continues to assist sheep and goat producers in locating, training, and using suitable livestock guard dogs.

*Snare Cooperative*—Snares are an important, cost-effective tool that allows producers to help themselves. APHIS assisted sheep producers in Highland County set up a snare cooperative. Funds from the Highland County Wool Pool, Predator Committee, were used to purchase snare components recommended by APHIS. Then, producers were trained by APHIS personnel to create their own snares and how them to catch coyotes. Producers paid a replacement cost for snare components that allowed the cooperative to be self-supporting.

*Media*—The VCCDCP was staffed by 1 wildlife biologist responsible for educating livestock producers about alleviating coyote predation in 31 counties in western Virginia. Because the number of producers who could be served effectively by 1 biologist was limited, the media, especially newspapers, was seen as an important potential conduit of information. Information on protecting livestock from coyote predation was disseminated through local newspapers (e.g., *Highland Recorder*), regional newspapers (e.g., *The Roanoke Times*), and statewide news sources (e.g., Associated Press). APHIS conducted 3-12 newspaper interviews and 1-3 radio spots per year. Additionally, APHIS cultivated relationships with the media by working with county agents, public affairs specialists with state agencies, and livestock interest groups.

Coyote Control Tools Available In Virginia

When the VCCDCP started in 1990, only trapping and calling/shooting during the daylight hours were legal techniques in Virginia. An assessment of available coyote control methods was made and efforts were started to obtain additional methods (Table 1). Tools or methods identified in the strategic plan as being suitable and necessary included calling/shooting at night, snares, gas cartridge, M-44s, and Livestock Protection Collars.

Calling/shooting at night with night-vision goggles or spotlights was allowed when permitted by VDGIF in 1990. This method proved to be time consuming and costly in terms of personnel and equipment. Therefore, APHIS has made only limited use of this method.

Snares were identified by APHIS and VDACS as a critical tool that would allow livestock producers to catch depredating coyotes themselves. The use of snares was made available by permit from VDGIF in 1990. In 1991, VDGIF, with support from APHIS and the Virginia Trappers Association, modified the existing snare regulation to allow the use of locking snares.

The gas cartridge is registered for use on coyotes under a Federal Insecticide, Fungicide, and Rodenticide Act, Section 3, registration by the Environmental Protection Agency. The gas cartridge was registered in Virginia as a means to fumigate coyote pups in the den, which has been shown to be an effective means of stopping predation on livestock (Till and Knowlton 1983). However, this option has been used only sparingly in Virginia because coyote dens are so difficult to find.

M-44s and Livestock Protection Collars are restricted-use pesticides that are regulated stringently by the Environmental Protection Agency. However, the use of these tools was viewed as being an essential element of an integrated program and, in certain situations, provides cost-effective coyote control. M-44s and Livestock Protection Collars can operate in wet or severe winter weather that would disable most traps and snares. Additionally, M-44s and Livestock Protection Collars require only a 7-day check (Lowney 1996), whereas snares and traps, by state regulation, must be checked daily. It took 3 years to garner support from VDGIF, VDACS, and animal welfare advocates, and to write a training manual before M-44s were registered for use in 1994. The same process took 5 years before Livestock Protection Collars were registered (1996) and first used in Virginia (1997).

M-44s and Livestock Protection Collars allowed APHIS to serve more sheep, cattle, and goat producers than would have been served if only traps, snares, and shooting were used (Table 2). Just as importantly, M-44's and Livestock Protection Collars

allowed APHIS to implement a more efficient strategy of predation management.

Strategies and Methods to Alleviate Coyote Predation

As additional methods became available (Table 2), the strategies for addressing coyote predation by the VCCDCP changed. In 1990, when the VCCDCP first opened, emphasis was placed on removing offending coyotes after a livestock depredation had occurred because data on the extent, location, and seasonality of coyote predation on livestock in Virginia was lacking. We called this strategy "corrective" control. In 1994, the VCCDCP made 2 management changes: 1) "preventative" control efforts were initiated in areas characterized by historic livestock losses to coyotes, and 2) the use of leghold traps replaced calling/shooting as the primary lethal method of coyote removal (Table 2). "Preventative" control was defined as removal of coyotes from farms with a history of livestock predation before any lambs, kid goats, or calves were released onto spring pastures for grazing. Preventative control occurred primarily from January through mid-April; after that, APHIS shifted to corrective control strategies to respond to new, emerging or current predation problems.

Preventative control efforts focused on removing adult coyote pairs during late winter/early spring and prior to denning in areas adjacent to farms that had a history of depredations; coyote predation on livestock could be reduced or prevented for the upcoming lambing/kidding/calving season. Producer requests for assistance were more evenly distributed and handled in the spring when preventative control occurred, whereas under corrective control prior to 1994, APHIS received a deluge of requests for assistance in the spring between April and June, which prevented the sole biologist from serving all requests in a reasonable time frame. Because preventative control was hampered by the daily requirement to check traps and snares, APHIS relied more on M-44s. To some extent, daily trap and snare checks were compensated for by having livestock producers check equipment while tending livestock. However, this often resulted in traps and snares being placed in areas convenient to the producer rather than in locations optimal to catching coyotes. Equipment was not set if livestock producers were unable to check traps and snares daily.

Since 1996, preventative control has shifted from the use of traps and snares to the use of M-44s. This shift increased the efficiency of the VCCDCP. Most importantly, the requirement that these devices be checked weekly, rather than daily, allowed wildlife biologists more time to provide services to more livestock producers. Less reliance is placed on producers having to perform daily checks. M-44s require less maintenance than traps or snares that can be rendered ineffective during inclement weather. When non-target wildlife (e.g., opossum, raccoon, skunk, fox) are captured in a snare or trap, it becomes unavailable for coyotes. Because M-44s are more species-specific for coyotes, the VCCDCP has become more efficient.

The corrective control strategy has been used primarily from mid-April through August and uses a combination of methods: snares, M-44s, traps, and Livestock Protection Collars. The use of Livestock Protection Collars further improved program efficiency by providing an additional tool for situations where other lethal methods were deemed inappropriate or ineffective. Traps and snares were used more often during summer months when M-44s became less effective in taking coyotes. M-44s were not used from September through the second Saturday in

January due to concerns about killing hunting dogs.

## EFFECTIVENESS OF THE VIRGINIA COYOTE CONTROL PROGRAM

APHIS in Virginia developed a feedback system to monitor program effectiveness and provide accountability to producers, VDACS, and the Virginia Sheep Industry Board, all of whom fund the VCCDCP. A report of program accomplishments has been prepared annually and distributed to these groups. In addition to the annual report, producers receive a summary report of activities on their property. Also, strategies and methods have been evaluated continuously and, where necessary, changed to fulfill the goal of reducing livestock losses to the lowest possible level (Table 2).

Methods to measure program effectiveness have been agreed upon by APHIS, VDACS, and the Virginia Sheep Industry Board. These included determining the rate of reduction in sheep depredations statewide and on individual farms. APHIS personnel also continue to evaluate the benefits of new strategies and the incorporation of new, innovative methods into the existing integrated wildlife damage management program.

### Statewide Reduction Of Coyote Predation On Sheep

The National Agricultural Statistics Service (NASS) has conducted statistical sampling of sheep producers to measure loss to predators (NASS 1991, 1995). NASS (1991) estimated 4,100 sheep were killed by coyotes in Virginia during 1990. The latest NASS survey of sheep losses to predators estimated 1,125 sheep were killed by coyotes during 1994. This represents a 72% reduction in depredations on sheep by coyotes in the first 5 years of the VCCDCP. The reduction in depredation rate on sheep may be due in part to the coyote predation problem becoming more manageable as fewer sheep producers had to be served by the one biologist.

NASS also conducted surveys of cattle losses to predators (NASS 1992, 1996). The NASS survey of Virginia cattle producers estimated 700 calves were killed by coyotes in 1991. A NASS survey in 1996 indicated 900 cattle (calves and cows) had been killed by coyotes (NASS 1996). This represents a 22% increase in cattle depredations by coyotes. The increased rate of coyote depredation on cattle is attributed to increased coyote abundance in southwest Virginia and a lack of funding for a wildlife specialist to assist cattle producers.

### Individual Farm Reduction Of Coyote Predation On Livestock

APHIS documents livestock losses reported by livestock producers through a Management Information System. This information allows for the calculation of the number of sheep killed per farm. The sheep killed per farm ratio has declined since 1994, reaching its lowest value in 1997 (Table 2). We attribute these reductions in sheep depredation to the implementation of the preventative control strategy in 1994 and increased integration of methods during the last 4 years (Table 2).

Without actions to alleviate predation, losses to predators can be as high as 8.4% of ewes and 29.3% of lambs in the flock (O'Gara et al. 1983). Conversely, losses of sheep and lamb to predators are much lower where wildlife damage management is applied (Nass 1977, Tigner and Larson 1977, Howard and Shaw 1978, Howard and Booth 1981).

### Benefits Of A New Strategy And Methods

The number of lambs lost to coyotes declined as additional lethal control methods were made available and

emphasis on those methods increased (Table 2). We believe the implementation of preventative control in 1994 reduced coyote predation on sheep by 49% from the previous 2 years. Use of M-44s in 1995 further reduced depredations on sheep. When Livestock Protection Collars were added in 1997, depredations on sheep declined 38% from the previous 3 years (Table 2).

## SUMMARY

The development of the VCCDCP has demonstrated several components for success for states and livestock commodity groups needing to implement coyote damage abatement programs. First, educational programs were emphasized to maximize dissemination of information and gain public acceptance; providing technical assistance to individual producers also was extremely important. Secondly, direct control services, both preventive and corrective, were important in reducing sheep losses. Many producers have little time or expertise to resolve predation problems themselves. Finally, an integrated program that uses all available control methods provides the most effective reduction of livestock losses.

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Table 1. Non-lethal and lethal methods available in the United States to manage coyote predation on livestock. Availability of methods may be reduced by state law, regulation, or applicability.

| Non-lethal Methods | Lethal Methods |
|---|---|
| Change pasture being grazed | Leghold traps |
| Shift lambing, calving, or kidding period | Snares |
| Select less vulnerable livestock | Callings/shooting |
| Herder | Dogs (denning and calling/shooting) |
| Night-penning | Denning |
| Shed-lambing, calving, or kidding. | M-44 |
| Guard animals (dogs, donkeys, llamas) | Livestock Protection Collar |
| Electronic guard (sirens and lights) | Aerial gunning |
| Electric fencing | |
| Woven-wire fencing | |

Table 2. Mean number of sheep killed by coyotes on farms in Virginia in relation to changing emphasis on lethal and non-lethal methods and strategies implemented.

| | YEAR | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
| Mean # of Sheep Killed/Farm | 12.6 | 11.4 | 17.8 | 16.8 | 8.8 | 6.8 | 7.2 | 5.1 |
| # of Sheep Producers Assisted | 44 | 50 | 35 | 24 | 41 | 28 | 56 | 49 |
| Primary Control Methods (lethal) | SN SH | SN SH | SN SH | SN SH | TR SN | TR SN M-44 | TR SN M-44 | SN M-44 |
| Secondary Control Methods (lethal) | TR | TR | TR | TR | SH | SH | SH | TR LPC |
| Primary Control Methods (nonlethal) | FN HS | FN HS | FN HS | FN HS | FN GD | GD EG | GD EG | GD FN |
| Secondary Control Methods (nonlethal) | GD | GD | GD | GD EG | HS EG | FN HS | FN HS | HS |
| Strategies Used | DAM | DAM | DAM | DAM | PREV /DAM | PREV /DAM | PREV /DAM | PREV /DAM |

KEY: SN=snare, SH=calling/shooting, TR=trapping, M-44=self explanatory, LPC=Livestock Protection Collar, FN=fencing, HS=husbandry, GD=guard dog, EG=electronic guard, DAM=corrective control, PREV/DAM=preventative and corrective control.

# WILDLIFE-CAUSED LOSSES FOR CATFISH PRODUCERS IN 1996

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Abstract: In January 1997, the National Agricultural Statistics Service (NASS) surveyed catfish producers about wildlife-caused losses in 1996, Of the 1,465 catfish producers in 15 states surveyed, 1,008 (68.8%) agreed to complete the survey. Surveys were conducted primarily by telephone, but some producers received mail surveys. The response rated varied among states. The majority of catfish producers were in Mississippi (n=-300), followed by Alabama (n=163), and then Arkansas (n=117). The remaining states each had <100 respondents. Data were analyzed for 6 regions, each with a sample size of >100 respondents. Overall, 69% of catfish producers cited a wildlife-caused loss of catfish. Producers cited losses to wildlife most frequently in Mississippi (81%), followed by states adjoining the Mississippi River and Alabama. Birds were cited most frequently as a cause of the losses and double-crested cormorants (*Phalacrocorax auritus*) were cited most frequently (53%) as the primary species causing problems. The next most frequently cited birds were herons (48%) of which 42% were cited as great blue herons (*Ardea herodius*). Egrets (16%) were the third most frequently cited group of birds, followed by pelicans (8%). Muskrats (*Ondatra zibethica*) were the most frequently cited mammal (primarily for damaging roads and dikes). Other species cited by >2% of producers were otters, waterfowl, gulls, turtles, beaver, and raccoon. Other species or wildlife groups were cited by <2% of producers. Of those citing wildlife-caused losses, the main problem was feeding on catfish (96%). Wildlife also caused losses by injuring catfish (58%), disturbing feeding patterns of catfish (34%), and damaging roads and levees (23%). The total estimated cost of losses was $8.4 million, based on a simple sum of cited loss values. Producers spent a substantial amount of effort and money trying to prevent wildlife-caused losses of their catfish. Loss prevention methods most frequently cited were: shooting (57%), vehicle patrols (55%), frightening devices such as flagging or balloons (36%), roost dispersal (14%), modify pond management (10%), and other methods (8%). Producers <1 mile from a bird roost or refuge were more likely to cite losses than those not so located. Producers surveyed estimated that they spent $4.0 million protecting their operations from wildlife-caused losses. More catfish producers (44%) than other types of agricultural producers were familiar with the federal Animal Damage Control (ADC) program. Of producers familiar with ADC, 55% used information provided by ADC in attempting to reduce their losses, 51% had contacted ADC for assistance, and 40% received assistance from ADC in 1996.

Key Words: Animal Damage Control, *Ardea herodius*, catfish, cormorant, damage prevention, egret, heron, *Phalacrocorx auritus*, survey, wildlife-caused loss

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# DOUBLE-CRESTED CORMORANTS AND RING-BILLED GULL DAMAGE MANAGEMENT ON LAKE CHAMPLAIN: ARE BASIN-WIDE OBJECTIVES ACHEIVABLE?

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Abstract: Ring-billed gulls (*Larus delewarensis*) and double-crested cormorants (*Phalacrocorx auritus*) have nested on Lake Champlain since 1949 and 1982, respectively. Recent increases in cormorant nesting populations and pioneering activities of both species to previously uncolonized islands have resulted in impacts related to accumulation of bird guano and interspecific competition with less common species. Of primary concern are: decreases in wildlife and plant diversity on islands; reduced aesthetics and property values of island associated with the loss of trees; and predation or competition for nesting space with other species such as the state-endangered common tern (*Sterna hirundo*). In addition, public concerns have been raised over potential impacts to fish species by cormorants, as well as urban-suburban gull activity impacting human health and safety and property. Nine stakeholder meetings have been held since 1990, to consider prospective management strategies for gulls and cormorants on Lake Champlain, Vermont. Since 1994, limited site-specific control efforts have been conducted by USDA-APHIS-ADC (ADC) at the request of the Vermont Fish and Wildlife Department (VFWD) and private landowners who recently experienced damage from these species. A technique for the removal of cormorant nests in trees has been developed and tested by ADC using portable pumps to deliver pressurized water to remove the nests. This technique has proven successful in tree nests up to approximately 15 m. Also, an alternative method is being tested to selectively remove nesting cormorants from a great blue heron (*Ardea herodius*) rookery. Currently, a draft environmental assessment is being prepared cooperatively by VFWD and ADC that explores alternatives for future management over 5 years beginning in 1998. Extensive public involvement using a variety of approaches will occur during the summer of 1997. VFWD, in cooperation with ADC, will continue to approach damage management on Lake Champlain for these species on a site-specific basis while working toward a more comprehensive interstate and international agreement on goals for basin-wide population and ecosystem management.

Key Words: ADC, double-crested cormorant, Lake Champlain, *Larus delewarensis*, nest removal, *Phalacrocorax auritus*, ring-billed gull, stakeholders

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# NESTING POPULATIONS OF DOUBLE-CRESTED CORMORANTS, GREAT BLUE HERONS, AND GREAT EGRETS IN THE UNITED STATES AND CANADA: IMPLICATIONS FOR MANAGEMENT

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Abstract: Populations of piscivorous birds in North America are receiving increasing attention in the southeast United States because of depredations at aquaculture facilities. We obtained recent (most since 1994) estimates for the number of nesting double-crested cormorants (*Phalacrocorax auritus*), great blue herons (*Ardea herodias*), and great egrets (*Casmerodius albus*) in the United States (US) and Canada from published references and by conducting telephone interviews with state and provincial biologists. Using previously-published data, we also determined annual rates of change in the number of cormorants since about 1990. Estimates for minimum numbers of nesting pairs (minimum numbers of colonies) of double-crested cormorants, great blue herons, and great egrets were 356,000 (824), 133,000 (3,345), and 36,000 (421), respectively. Most cormorants and herons nested in the Interior Region (67% and 56%, respectively). In contrast, 74% of egrets nested in the Southeast Region. Overall, double-crested cormorants increased about 1.4% annually in the US and Canada during the early 1990s. The greatest decline (-7.9% annual change) was for the West Coast-Alaska Region. The greatest increase (5.8% annual change) was for the Interior Region. The increase in the Interior Region was a consequence primarily of a 23% annual increase in the number of nesting pairs of cormorants in states and provinces bordering the Great Lakes. These baseline population data are essential for monitoring trends in nesting populations and for developing informed management decisions. However, the completeness, quality, and timing of surveys varied substantially among jurisdictions; therefore, initial population figures and rates of population change are conservative estimates and should be used with caution. We recommend coordination of methodology and timing of future surveys among political jurisdictions (at least within regions) to improve accuracy of estimates and allow more meaningful comparisons of population status.

Based on these estimates, the <8,000 double-crested cormorants, <3,000 great blue herons, and <2,000 great egrets killed annually via depredation permits at aquaculture facilities in the southeast US conservatively represented <3% of the respective nesting populations (<1% of the total populations) in the US and Canada. Thus, the number of these species killed at southeast US aquaculture facilities has had minimal effect on continental or regional nesting populations. We recommend continued monitoring of nesting populations in relation to lethal control at aquaculture facilities to ensure that population viability of piscivorous birds is not adversely affected.

Key Words: annual increase, *Ardea herodias*, Canada, *Casmerodius albus*, double-crested cormorant, great egret, great blue heron, nesting, *Phalacrocorax auritus*, population, United States

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Piscivorous birds at aquaculture facilities in southeast United States (US) are of concern as their feeding activities may result in economic losses to producers (Mott 1978). Double-crested cormorants (*Phalacrocorax auritus*), great blue herons (*Ardea herodias*), and great egrets (*Casmerodius albus*) are species most frequently associated with depredations of fish at aquaculture facilities in this region (Mastrangelo et al. 1997). For example, 57% of Mississippi Delta catfish growers reported cormorants to be a problem on their farms (Stickley and Andrews 1989). Most depredation problems occur in winter when birds from northern US and Canada migrate to the southeast US (Dolbeer 1991).

The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services (WS) program is responsible for addressing depredations caused by migratory birds in the US (Acord 1995). Following on-site inspections of aquaculture facilities, WS personnel then recommend integrated damage management plans that emphasize non-lethal techniques (Mastrangelo et al. 1997). If non-lethal control is determined inadequate for reducing damage, management plans may be amended to include recommendations to the U.S. Fish and Wildlife Service (USFWS) for issuance of depredation permits to kill piscivorous birds.

Belant et al. (in press) determined that <8,000 double-crested cormorants, <3,000 great blue herons, and <2,000 great egrets were killed annually from 1987-1995 to protect aquaculture facilities in the southeast US (USFWS Region 4). Concerns have been expressed regarding the effects of lethal control of piscivorous birds using depredation permits at aquaculture facilities on local, regional, and national bird populations (Trapp et al. 1995). However, no study has addressed this fundamental issue. Our objectives were to (1) obtain the most recent population estimates for nesting double-crested cormorants, great blue herons, and great egrets, (2) determine the rate of change in populations of double-crested cormorant populations by region during the early 1990s, and (3) evaluate the effects of lethal control of these species at aquaculture facilities in the southeast US on respective nesting populations.

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## METHODS

Previous estimates (1975-1992) for the number of nesting double-crested cormorants were obtained from Hatch (1995). To obtain the most recent population estimates for cormorants, great blue herons, and great egrets, we conducted telephone interviews from May-

October 1996 with biologists from each state (excluding Hawaii), province, and territory in the US and Canada when publications or reports were unavailable. Information requested included the number of nesting pairs and colonies present and the survey technique used to obtain the estimate. As described by Hatch (1995), each estimate provided was placed in 1 of 4 categories of decreasing precision, ranging from a recent complete count to conjecture based on old or incomplete information. Population estimates for each species were grouped into 1 of 4 regions: 1) Interior, 2) Atlantic, 3) Southeast, and 4) West Coast-Alaska (Fig. 1) (modified from Hatch 1995).

For double-crested cormorants, we determined the mean percent annual change (MPAC) in the number of nesting pairs using the formula:

$$MPAC = (N_2/N_1)^{1/y} - 1$$

where $N_1$ is the number of nesting pairs observed during the first estimate (from Hatch 1995) and $N_2$ is the number of nesting pairs observed during the second estimate, $y$ years later.

## RESULTS

Double-crested Cormorants

Most (70%) of the 63 State/Provincial estimates were made in 1994-1996. The number of nesting double-crested cormorants in the US and Canada has increased about 1.4% annually from 1990-1994 (about 336,790 to 356,051 nesting pairs) (Table 1). Most birds occurred in the Interior (67%, 239,853 pairs), followed by the Atlantic (24%, 85,510 pairs), West Coast-Alaska (5%, 17,084 pairs), and Southeast (4%, 13,604 pairs) Regions.

The greatest regional decline (-7.9% annual change) occurred in the West Coast-Alaska. The greatest regional increase (5.8% annual change) occurred in the Interior. The increase in the Interior was a consequence primarily of a 23% annual increase in the number of nesting pairs of cormorants in states and provinces bordering the Great Lakes, particularly Ontario. Cormorants adjacent to the Great Lakes increased from about 41,540 pairs in 1992 to about 76,667 pairs in 1995 (Appendix 1). There were ≥824 double-crested cormorant nesting colonies (≥313 in the Atlantic, ≥253 in the Interior, 243 in the West Coast and Alaska, and ≥15 in the Southeast Regions).

Great Blue Herons

Seventy-two percent of the 61 State/Provincial estimates were made in 1994-1996. We conservatively estimated >133,034 nesting pairs of great blue herons in the US and Canada (Table 1). Most birds occurred in the Interior (56%, ≥75,052 pairs), followed by the Atlantic (25%, ≥33,046 pairs), Southeast (14%, ≥18,613 pairs), and West Coast-Alaska (5%, >6,323 pairs) Regions. There were ≥3,345 great blue heron colonies (≥1,736 in the Interior, ≥731 in the Atlantic, ≥577 in the West Coast-Alaska, and ≥301 in the Southeast Regions).

Great Egrets

Of the 61 State/Provincial estimates, 87% were made in 1994-1996. We conservatively estimated ≥35,908 nesting pairs of great egrets in the US and Canada (Table 1). Most birds occurred in the Southeast (74%, ≥26,424 pairs), followed by the Interior (19%, ≥6,954 pairs), Atlantic (4%, 1,377 pairs), and West Coast-Alaska (3%, ≥1,153 pairs) Regions. There were ≥421 great egret colonies (≥238 in the Southeast, ≥77 in the Interior, ≥60 in the Atlantic, and 46 in the West Coast-Alaska Regions).

## DISCUSSION

The number of double-crested cormorants increased rapidly from the 1970s to the early 1990s (Hatch 1995). For example, the number of cormorant nests bordering the Great Lakes increased from 89 in 1970 to 38,000 in 1991, an annual increase of 29% (Weseloh et al. 1995). The number of cormorants in the northeast US (Atlantic

population) increased from 17,100 to 34,200 nesting pairs from 1977 to the mid 1980s, then increased slightly to 37,600 pairs in the early 1990s (Krohn et al. 1995). Our most recent estimates of cormorant numbers suggest that the overall rate of growth in the US and Canada has declined substantially during the early 1990s.

Although the number of nesting pairs of double-crested cormorants in the US and Canada increased only slightly during the early 1990s, regional populations have varied more dramatically. We are uncertain of the causes for recent declines in nesting populations of double-crested cormorants in the Atlantic and West Coast-Alaska Regions. In the Atlantic population, reduced suitability of colony sites may have been responsible for recent population declines (Krohn et al. 1995). Local declines in the number of cormorants has occurred in the West Coast and Alaska from habitat loss, pollution, human disturbance, and introduced predators (Carter et al. 1995).

The continued increase of double-crested cormorants in the Interior population was a consequence primarily of dramatic population increases in states and provinces bordering the Great Lakes. The number of cormorants in this area has increased from 38,000 pairs in 1992 (Weseloh et al. 1995) to >76,000 pairs in 1995 (this study). Continued increases in nesting pairs of cormorants near the Great Lakes have been attributed to reductions in contaminant levels, low human persecution, high reproductive success, and increased availability of prey (e.g., alewife [*Alosa pseudoharengus*]) (Weseloh et al. 1995). Exploitation of catfish as a winter food in the southeast US, especially the Mississippi delta area, also may have enhanced survival of cormorants (Williams 1992), particularly cormorants arriving from Great Lakes populations. The majority of cormorants nesting around the Great Lakes winter in the southeast US (Dolbeer 1991).

The reported population estimates do not include subadult nor nonbreeding adult birds; thus, total populations of cormorants, herons, and egrets are greater. For example, 0.6 to 4.0 nonbreeding cormorants for every breeding pair have been estimated for several populations (McLeod & Bondar 1953, Price & Weseloh 1986, Watson et al. 1991). Therefore, we conservatively estimate the total number of cormorants in the US and Canada at 1 to 2 million individuals.

**MANAGEMENT IMPLICATIONS**

This report provides updated estimates for nesting populations of double-crested cormorants in the US and Canada and the first comparable estimates for great blue herons and great egrets. These baseline data are essential for monitoring future trends in nesting populations and for developing informed management decisions. However, the initial population estimates and rates of population change presented in this report should be used with caution. As with a similar study of laughing gulls (see Belant & Dolbeer 1993), disparity among jurisdictions in survey techniques, intensity of searches, observer differences, and the time at which surveys were conducted precluded statistical analyses of data. Comparisons of rates of change for double-crested cormorants also were confounded by different methods of data collection. We recommend coordination of survey methodology among political jurisdictions (at least among regions) to allow direct comparisons of population status and to reduce biases (see Erwin et al. 1984).

The <8,000 double-crested cormorants, <3,000 great blue herons, and <2,000 great egrets killed annually under depredation permits at aquaculture facilities in the southeast US (Belant et al., in press) conservatively represented <3% of the respective nesting populations in the US and Canada. When nonbreeding birds are included, the kill may represent <1% of the

US and Canadian populations. Also, numerous state and provincial populations of cormorants are increasing, particularly those adjacent to the Great Lakes that migrate to the southeast US (Dolbeer 1991). Therefore, we believe that the number of double-crested cormorants, great blue herons, and great egrets killed at aquaculture facilities in the Southeast from 1987 to 1995 has had minimal effect on continental or regional nesting populations. Additional information is necessary to determine if local populations have been affected. We recommend continued monitoring of nesting populations in relation to lethal control at aquaculture facilities to ensure that population viability of piscivorous birds is not affected adversely.

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Table 1. Regional estimates of nesting pairs of double-crested cormorants (DCCO), great blue herons (GTBH), and great egrets (GREG) in the United States and Canada, and estimated mean percent annual change in DCCO populations, about 1990-1994.

| | DCCO | | | GTBH | | GREG | |
|---|---|---|---|---|---|---|---|
| Region | Estimated # nesting pairs (# colonies) | Approx. year of estimate | Mean % annual change | Estimated # nesting pairs (# colonies) | Approx. year of estimate | Estimated # nesting pairs (# colonies) | Approx. year of estimate |
| Atlantic | ≥85,510 (≥313) | 1993 | 6.5 | ≥33,046 (731) | 1992 | 1,377 (≥60) | 1995 |
| Interior | ≥239,853 (≥253) | 1994 | 5.8 | ≥75,052 (≥1,736) | 1993 | ≥6,954 (≥77) | 1995 |
| Southeast | 13,604 (≥15) | 1994 | 2.6 | ≥18,613 (≥301) | 1994 | ≥26,424 (≥238) | 1994 |
| West Coast & Alaska | 17,084 (243) | 1993 | -7.9 | >6,323 (≥577) | 1993 | ≥1,153 (46) | 1995 |
| Total | ≥356,051 (≥824) | 1994 | 1.4 | ≥133,034 (≥3,345) | 1993 | ≥35,908 (≥421) | 1995 |

Appendix 1. State and Provincial estimates of nesting pairs of double-crested cormorants (DCCO), great blue herons (GTBH) and great egrets (GREG) in the United States and Canada, and estimated mean percent annual change in DCCO populations, about 1990-1994.

| | DCCO | | | | | GTBH | | GREG | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | estimated # nesting pairs (# colonies)[1] | | mean percent annual change | | estimated # nesting pairs (# colonies)[1] | | estimated # nesting pairs (# colonies)[1] | |
| Region | Year 1[2] | Year 2 | Year 1[2] | Year 2 | | Year | | Year | | Source |
| **1. Atlantic (Northeast Coast)** | | | | | | | | | | |
| Connecticut | 1992 | 1995 | 623[a] | 716 (11)[a] | 4.7 | 1995 | ?[3] | 1995 | 122(6)[a] | J. Victoria, Conn. Dep. Environ. Prot., unpubl. data |
| Maine | 1992 | 1994 | 28,004[b] | ≥20,692(117)[c] | -14.0 | 1994 | ≥606(15)[c] | 1994 | ≥2(1)[c] | B. Hoover, U.S. Geol. Surv., unpubl. data |
| Massachusetts | 1992 | 1994-95 | 7,000[b] | 7,274 (28)[a] | 1.3 - 1.9 | 1994-95 | 0(0) | 1994-95 | 77(7)[a] | B. Hoover, U.S. Geol. Surv., unpubl. data |
| New Brunswick | 1990 | 1990 | 7,800[b] | 7,800[b] | | 1990 | 1,400[b] | 1996 | 0 | Erskine (1992) |
| New Hampshire | 1992 | 1995 | 325[b] | ≥483 (1)[b] | 14.1 | 1983-92 | 1,353(123)[c] | 1993 | 0 | J. Kantor, N.H. Fish and Game Dep., unpubl. data (DCCO, GREG); Martin (1993) (GTBH) |
| New Jersey | 1992 | 1992 | 109[a] | 109 (≥1)[a] | | 1995 | 860(20)[c] | 1995 | 486(25)[c] | Hatch (1995) (DCCO); D. Jenkins, N.J. Div. Fish, Game, Wildl., pers. comm. (GTBH, GREG) |
| New York-Atlantic | 1992 | 1995 | 2,513[a] | ≥3,528 (8)[a] | 12.0 | 1996 | 0 | 1995 | 541(17)[a] | L. Sommers, N.Y. Dep. Environ. Conserv., unpubl. data (DCCO, GREG); B. Miller, N.Y. Dep. Environ. Conserv., pers. comm. (GTBH) |
| Newfoundland | 1975-89 | 1975-89 | 261[c] | 261[c] | | 1996 | 0 | 1996 | 0 | Hatch (1995) (DCCO), A.Smith (GTBH) and B. Turner (GREG) Can. Wildl. Serv., pers. comm. |
| Nova Scotia | 1992 | 1993 | 15,200[b] | 13,500 (67)[c] | -11.2 | 1980-88 | 2,027(59)[c] | 1996 | 0 | G. Milton, unpubl. data (DCCO); A. Smith, Can. Wildl. Serv., unpubl. data (GTBH); P. Mills, Can. Wildl. Serv., pers. comm. (GREG) |

Appendix 1 (continued)

| Region | DCCO Year 1[2] | DCCO Year 2 | DCCO estimated # nesting pairs (# colonies)[1] Year 1[2] | DCCO estimated # nesting pairs (# colonies)[1] Year 2 | mean percent annual change | GTBH Year | GTBH estimated # nesting pairs (# colonies)[1] | GREG Year | GREG estimated # nesting pairs (# colonies)[1] | Source |
|---|---|---|---|---|---|---|---|---|---|---|
| Prince Edward Island | 1990 | 1995 | 7,000[b] | 6,619(6)[c] | -1.1 | 1990 | 1,800(~14) | 1995 | 0 | A.McLennan, Prince Edward Isl. Environ. Resour., unpubl. data (DCCO, GREG); Erskine (1992), Smith (1980) (GTBH) |
| Quebec | 1992 | 1993-96 | 27,300[b] | 22,400(68)[a] | -4.8 to -17.9 | 1991-1995 | 25,000(500)[b] | 1994 | 12(1)[a] | M. LeBage, Minist. De La Environ., pers. comm. |
| Rhode Island | 1992 | 1994 | 1,700[a] | 2,082(5)[c] | 10.7 | 1994 | 0 | 1994 | 137(3)[c] | B. Hoover, U.S. Geol. Surv., unpubl. data |
| St. Pierre et Miquelon | 1987 | 1989 | 40[b] | 46(1)[b] | 7.2 | 1989 | 0 | 1989 | 0 | Cairns, et al. (1989) |
| **Subtotal** | **~1991** | **~1993** | **97,875** | **≥85,510(≥313)** | **-6.5** | **1992** | **≥33,046(≥731)** | **1995** | **~1,377(≥60)** | |
| 2. **Interior** | | | | | | | | | | |
| Alberta | 1992 | 1996 | 7,000[c] | ~7,000(~22)[c] | 0 | 1996 | ~1,500(~75)[c] | 1996 | 0 | S. Brecktel, Alta. Dep. Environ. Prot., pers. comm. (DCCO, GREG); Alta. Dep. Environ. Prot. Wildl. Manage. Div. (1996) (GTBH) |
| Arkansas | 1991 | 1991 | 15[a] | 15[a] | | | | | | Hatch (1995) (DCCO) |
| Colorado | 1990 | 1990 | 1,000[c] | 1,000(~13)[c] | | 1996 | 486(9)[a4] | 1996 | 10(1)[a4] | Hatch (1995), Andrews & Righter (1992) (DCCO); J. George, Colo. Div. Wildl., pers. comm. (GTBH, GREG) |
| Illinois | 1992 | 1995 | 355[c] | 675(6)[c] | 23.9 | 1995 | 9,800(54)[c] | 1995 | 1,855(21)[c] | V. Kleen, Ill. Dep. Nat. Resour., unpubl. data |

Appendix 1 (continued)

| Region | DCCO Year 1[2] | DCCO Year 2 | DCCO estimated # nesting pairs (# colonies)[1] Year 1[2] | DCCO estimated # nesting pairs (# colonies)[1] Year 2 | mean percent annual change | GTBH Year | GTBH estimated # nesting pairs (# colonies)[1] | GREG Year | GREG estimated # nesting pairs (# colonies)[1] | Source |
|---|---|---|---|---|---|---|---|---|---|---|
| Indiana | 1992 | 1996 | 0 | 0 | | 1993 | 6,320(78)[c] | 1996 | 0 | J. Castrale, Ind. Dep. Nat. Resour., pers. comm. (DCCO, GREG); Castrale (1994) (GTBH) |
| Iowa | 1992 | 1995 | 400[c] | 689(4)[c] | 19.9 | 1995 | 3,790(37)[c] | 1995 | 234(4)[c] | L. Hemesath, Ia. Dep. Nat. Resour., unpubl. data |
| Kansas | 1985 | 1996 | 20[c] | 100[d] | 15.8 | 1996 | 3,000(100)[d] | 1996 | 120[d] | B. Busby, Kans. Biol. Surv., pers. comm., (DCCO, GREG); S. Roth, pers. comm. (GTBH) |
| Kentucky | 1991 | 1994 | 0 | 0 | | 1994 | 1,750(24)[a] | 1994 | 25(2)[a] | Palmer-Ball & Wethington (1994) |
| Manitoba | 1992 | 1992 | 125,000[c] | 125,000[c] | | 1989 | 10,000[d5] | 1996 | 0 | Hatch (1995) (DCCO); R. Larche, Manit. Dep. Nat. Resour., unpubl. data (GTBH); R. Larche, pers. comm. (GREG) |
| Michigan | 1988-90 | 1988-90 | 7,975[b] | 7,975[b] | | 1987 | 1,064(32)[c] | 1987 | 31(3)[c] | Hatch (1995) (DCCO); Scharf (no date) (GTBH, GREG) |
| Minnesota | 1990 | 1991-95 | 7,970[c] | ≥6,439(≥37)[c] | -4.2 to -19.2 | 1991-95 | ≥10,850(≥221)[c] | 1991-95 | ≥1,811(≥24)[c] | M. Miller, Minn. Dep. Nat. Resour., unpubl. data |
| Missouri | 1992 | 1995 | 0 | 0 | | 1995 | ≥7,500(~250)[c] | 1995 | 144(5)[c] | J. Wilson, Mo. Dep. Conserv., pers. comm. |
| Montana | 1992 | 1988-95 | 850[c] | ~1,475(~17)[b] | | 1988-95 | ~2,411(~82)[c] | 1995 | 0 | K. Jurist, Mont. Nat. Her. Found., unpubl. data |
| Nebraska | 1992 | 1992 | 850[c] | 850[c] | | 1980-93 | ~970(~69)[c] | 1996 | 0 | Hatch (1995) (DCCO); J. Dinan, Nebr. Game and Parks Comm., unpubl. data (GTHE, GREG) |

Appendix 1 (continued)

| Region | DCCO Year 1[2] | DCCO Year 2 | DCCO estimated # nesting pairs (# colonies)[1] Year 1[2] | DCCO estimated # nesting pairs (# colonies)[1] Year 2 | DCCO mean percent annual change | GTBH Year | GTBH estimated # nesting pairs (# colonies)[1] | GREG Year | GREG estimated # nesting pairs (# colonies)[1] | Source |
|---|---|---|---|---|---|---|---|---|---|---|
| New Mexico | 1992 | 1996 | 730[b] | 730(5)[c] | 0 | 1996 | 150(10)[b] | 1996 | 10[b] | S. Williams, N. M. Dep. Game and Fish, unpubl. data |
| New York-Interior | 1992 | 1995 | 5,890[a] | ≥8,097(≥19)[a] | 11.2 | 1996 | >1,837(2)[d] | 1996 | 0 | L. Sommers, N.Y. Dep. Environ. Conserv., unpubl. data (DCCO, GREG); B. Miller, N.Y. Dep. Environ. Conserv., pers. comm. (GTBH) |
| North Dakota | 1992 | 1992 | 1,200[d] | >1,200[d] | | 1996 | <1,000[d] | 1996 | ~30[c] | G. Burkee, Minot State Univ., pers. comm. |
| Northwest Territories | | 1996 | | ?[3] | | 1996 | 0 | 1996 | 0 | B. Bromley, Northwest Territ. Dep. Renew. Resour., pers. comm. |
| Ohio | 1992 | 1995 | 180[a] | ~1,500(1)[c] | 102.7 | 1995 | ~2,280(3)[c] | 1995 | ~1,157(2)[c] | M. Shieldcastle and B. Buckingham, Ohio Dep. Nat. Resour., pers. comm. |
| Oklahoma | 1992 | 1995 | 0 | 46(1)[6] | | 1995 | ≥30(1)[6] | 1995 | 515(1)[6] | R. Shephard, U.S. Fish Wildl. Serv., pers. comm. |
| Ontario | 1992 | 1993-96 | 16,170[a,c] | ~43,981(~86)[a] | 28.4 to 172.0 | 1990-91 | ~9,121(~520)[b] | 1996 | 90(6)[d] | D. Weseloh, Can. Wildl. Serv., pers. comm. (DCCO, GREG); Collier et al. (1992) (GTBH) |
| Pennsylvania | 1991 | 1996 | 0 | 0 | | 1995 | 835(15)[c] | 1996 | 155(1)[c] | D. Brauning, Penn. Game Comm., pers. comm. (DCCO, GREG); Brauning (1996) (GTBH, GREG) |
| Saskatchewan | 1991 | 1991 | 19,547[c] | 19,547[c] | | | ?[3] | | | Hatch (1995) (DCCO); E. Wiltse, Sask. Environ. Resour. Manage., unpubl. data (GTBH) |

Appendix 1 (continued)

| Region | DCCO Year 1[2] | DCCO Year 2 | DCCO estimated # nesting pairs (# colonies)[1] Year 1[2] | DCCO estimated # nesting pairs (# colonies)[1] Year 2 | DCCO mean percent annual change | GTBH Year | GTBH estimated # nesting pairs (# colonies)[1] | GREG Year | GREG estimated # nesting pairs (# colonies)[1] | Source |
|---|---|---|---|---|---|---|---|---|---|---|
| South Dakota | 1992 | 1991 | 850[c] | >2,962(≥11)[c,7] | | 1991 | >106(>48)[c,7] | 1988-91 | >244(>6)[c] | Peterson (1995) |
| Tennessee | 1991 | 1996 | 10[c] | 11(1)[a] | 1.9 | 1993 | 2,477(24)[b] | 1991 | 100-200(>1)[d] | G. Lee, pers. comm. (DCCO); B. Hatcher, Tenn. Wildl. Resour. Agency, unpubl. data (GTBH); R. Wheat, U.S. Fish Wildl. Serv., pers. comm. (GTBH); B. Hatcher, pers. comm. (GREG) |
| Vermont | 1992 | 1995 | 555[a] | 2,211(5)[a] | 58.5 | 1985 | 491(30)[c] | 1996 | 0 | M. Ferguson, Vt. Dep. Fish and Wildl., pers. comm. |
| West Virginia | 1990 | 1996 | 0 | 0 | | 1995-96 | ≥284(≥6)[a] | 1996 | 0 | S. Butterworth, W. Va. Dep. Nat. Resour., pers. comm. |
| Wisconsin | 1992 | 1994 | 3,000[c] | 8,000[a] | 63.3 | 1996 | 1,000-2,000[d] | 1995 | ≥373[c] | S. Matteson, Wis. Dep. Nat. Resour., pers. comm. |
| Wyoming | 1986 | 1994 | 3,000[b] | ≥350(25)[d] | -23.6 | 1994 | >500(~46)[c] | 1996 | 0 | A. Cerovski, Wyo. Game and Fish Dep., unpubl. data |
| Yukon Territory | | 1996 | | 0 | | 1996 | 0 | 1996 | 0 | D. H. Mossop, Yukon Terr. Dep. Renew. Res., pers. comm. |
| **Subtotal** | **~1991** | **~1994** | 202,567 | **≥239,853(≥253)** | 5.8 | **1993** | **≥75,052(≥1,736)** | **1995** | **≥6,954(≥77)** | |
| **3. Southeast** | | | | | | | | | | |
| Alabama | 1992 | 1996 | 0 | 0 | | 1996 | ≥1,200[d] | 1996 | ≥600[d] | R. Clay, Ala. Dep. Conserv. and Nat. Resour., pers. comm. |
| Delaware | 1992 | 1996 | 0 | 0 | | 1996 | 530(6)[a] | 1996 | 842(2)[a] | B. Hoover, U.S.Geol. Surv., unpubl. data |

Appendix 1 (continued)

| Region | DCCO Year 1[2] | DCCO Year 2 | DCCO estimated # nesting pairs (# colonies)[1] Year 1[2] | DCCO estimated # nesting pairs (# colonies)[1] Year 2 | mean percent annual change | GTBH Year | GTBH estimated # nesting pairs (# colonies)[1] | GREG Year | GREG estimated # nesting pairs (# colonies)[1] | Source |
|---|---|---|---|---|---|---|---|---|---|---|
| Florida | 1986-89 | 1986-89 | 12,000[c] | 12,000[c] | | 1993 | >629[d] | 1993 | >4,268[d] | Hatch (1995) (DCCO); G. Reynolds, Fla. Game and Freshwater Fish Comm., unpubl. data, (GTBH, GREG) |
| Georgia | 1991 | 1996 | 3[d] | ?[3] | | 1996 | ?[3] | 1996 | ?[3] | T. Schneider, Ga. Dep. Nat. Resour., pers. comm. |
| Louisiana | 1990 | 1996 | 100[d] | <200[c] | <12.2 | 1996 | >893(≥28)[b] | 1990-95 | >4,608(64)[b] | W. Vermillion, La. Dep. Wildl. and Fish., unpubl. data |
| Maryland | 1992 | 1995 | 300[c] | 491(2)[a] | 17.8 | 1995 | 5,573(57)[a] | 1995 | 918(20)[a] | G. Therres, Md. Dep. Nat. Resour., unpubl. data |
| Mississippi | 1992 | 1993 | 0 | 0 | | 1994 | 843(10)[a] | 1994 | 1,533 (6)[a] | P. Mastrangelo, U.S. Dep. Agric., pers. comm. (DCCO); A. Mueller (1995) (GTBH, GREG) |
| North Carolina | 1992 | 1995 | 20[c] | 0 | | 1995 | 0 | 1995 | 2,018(22)[a] | B. Hoover, U.S. Geol. Surv., unpubl. data |
| South Carolina | 1990 | 1994 | 115[a] | 515(8)[a] | 45.5 | 1994 | 2,539(88)[a] | 1994 | 6,980(57)[a] | S.C. Dep. Nat. Resour., (1996) |
| Texas | 1990 | 1996 | 6[a] | ?[3] | | 1991-92 | 1,809(60)[a] | 1991-92 | 4,404(53)[a] | W. Roach, U.S. Fish Wildl. Serv., pers. comm. (DCCO); Tex. Park and Wildl. Dep. (1991-92) (GTBH, GREG) |
| Virginia | 1992 | 1993 | 50[a] | 398(5)[a] | 696.0 | 1991 | 4,597(52)[a] | 1991 | 253(14)[a] | G. Costanzo (DCCO) and D. Schwab (GTBH, GREG) Va. Dep. Game and Inland Fish, unpubl. data |
| **Subtotal** | **~1991** | **~1994** | **12,594** | **≥13,604(≥15)** | **2.6** | **1994** | **≥18,613(≥301)** | **1994** | **≥26,424(≥238)** | |

Appendix 1 (continued)

| Region | DCCO Year 1[2] | DCCO Year 2 | DCCO estimated # nesting pairs (# colonies)[1] Year 1[2] | DCCO estimated # nesting pairs (# colonies)[1] Year 2 | DCCO mean percent annual change | GTBH Year | GTBH estimated # nesting pairs (# colonies)[1] | GREG Year | GREG estimated # nesting pairs (# colonies)[1] | Source |
|---|---|---|---|---|---|---|---|---|---|---|
| **4. West Coast and Alaska** | | | | | | | | | | |
| Alaska | 1975-92 | 1996 | 2,924[c] | 2,935(120)[c] | | 1996 | ?[3] | 1996 | 0 | S. Stephensen, U.S. Fish Wildl. Serv., unpubl. data (DCCO); D. Groves (GTBH) and K. Wohl (GREG), U.S. Fish Wildl. Serv., pers. comm. |
| Arizona[8] | 1992 | 1996 | 750[c] | (<15-20) | | 1996 | (>50) | 1996 | (<5) | T. Corman, Ariz. Game and Fish Dep., pers. comm. |
| British Columbia | 1987-89 | 1988 | 1,753[b] | 2,032(15)[c] | | 1980-87 | >1,181(84)[b] | 1996 | 0 | Campbell et al. (1990) |
| California | 1989-91 | 1993-95 | 5,592[a,c] | 2,394(17)[c] | | 1995 | 369(59)[c,9] | 1995 | 628(21)[c,9] | Carter et al. (1996), S. Tappen, Audubon Canyon Ranch, pers. comm. (DCCO); J. Kelly, Audubon Canyon Ranch, unpubl. data (GTBH, GREG) |
| Idaho | 1984 | 1993 | 850[b] | ~1,288(11)[c] | 4.7 | 1994 | ≥341(50)[c] | 1993 | ~21(~5)[c] | Trost et al. (1994) |
| Nevada | 1992 | 1994 | 1,500[c] | ≥80(≥3)[c] | -76.9 | 1994 | ≥64(≥7)[c] | 1994 | ≥83(≥4)[c] | Herron (1994) |
| Oregon | 1988-92 | 1992 | 7,167[a,c] | 6,987(24)[a] | | 1994 | 2,500 | 1994 | ≥376(≥7)[c] | H. Carter et al. (1995) (DCCO); Gilligan et al. (1994) (GTBH); Marshall et al. (1996) (GREG) |
| Utah | 1987-92 | 1987-96 | 1,200[b] | 482(15)[d] | | 1988-96 | 668(32)[d] | 1996 | 0 | F. Howe, Utah Div. Wildl. Resour., unpubl. data |

Appendix 1 (continued)

| | | | DCCO | | | GTBH | | GREG | |
|---|---|---|---|---|---|---|---|---|---|
| | | | estimated # nesting pairs (# colonies)[1] | | mean percent annual | | estimated # nesting pairs | | estimated # nesting pairs |
| Region | Year 1[2] | Year 2 | Year 1[2] | Year 2 | change | Year | (# colonies)[1] | Year | (# colonies)[1] | Source |
| Washington | 1992 | 1995 | 2,018[a,c] | 886(21)[c] | -24.0 | 1996 | >1,200(295)[d,10] | 1996 | ≥45(4)[d] | U. Wilson, U.S. Fish Wildl. Serv., unpubl. data (DCCO); T. Owens, Wash. Dep. Fish and Wildl., pers. comm. (GTBH, GREG) |
| **Subtotal** | **~1989** | **~1993** | **23,754** | **≥17,084(243)** | **-7.9** | **1993** | **>6,323(≥577)** | **1995** | **≥1,153(≥46)** | |
| **Total** | **~1990** | **~1994** | **336,790** | **>356,051(>824)** | **1.4** | **1993** | **>133,034(>3,345)** | **1995** | **>35,908(>421)** | |

[1] Classifications for various population estimates: a = recent complete count; b = extrapolated older count or other informed estimate; c = estimate, often based on knowledge of most colonies but few counts of individuals; d = guess: only old, indirect, or incomplete recent knowledge available.
[2] From Hatch (1995).
[3] Species known to breed, recent data unavailable.
[4] Counts from Boulder area only.
[5] Total spring population count (adults and subadults).
[6] Number represents only 1 colony.
[7] Number represents counts from only 1 county in the state.
[8] Data provided for number of colonies only.
[9] Count from northern San Francisco Bay area only.
[10] Colony size estimates ranged from 4 - 400 nests. A conservative estimate of 4 was used to calculate number of nests.


Fig. 1. Geographic boundaries for regional populations of Double-crested Cormorants, Great Blue Herons, and Great Egrets in the United States and Canada (after Hatch 1995).

# DEVELOPMENT OF A DOUBLE-CRESTED CORMORANT DAMAGE MANAGEMENT PLAN FOR THE SOUTHEASTERN UNITED STATES

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Abstract: In response to needs within the aquaculture industry to alleviate increasing depredation by double-crested cormorants (*Phalacrocorax auritus*), the U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, in conjunction with Federal, State, and Canadian wildlife and fisheries agencies, the aquaculture industry, and other wildlife professionals, is developing the framework for a comprehensive cormorant damage management program that uses an integrated wildlife damage management approach. This cooperative effort will produce a meaningful, mutually beneficial program that will reduce the effects of cormorants on aquaculture and sport and commercial fisheries, improve understanding of cormorant biology, and avert existing, but often fragmented, attempts to control cormorant populations. Explicit techniques or control measures to be implemented may include resource (facility or fish stocks) management, exclusion methods, and cormorant population reduction methods (non-lethal and lethal) at aquaculture facilities, winter-roost sites, and/or breeding colonies. Given the dramatic increase in cormorant populations over the past 15 years, cormorant-human conflicts will not subside in the foreseeable future. Thus, the focus of management efforts should be on development of strategies to minimize, rather than eliminate, resource losses.

Key words: aquaculture, catfish, depredation, double-crested cormorant, *Phalacrocorax auritus*, roost

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# ELECTRIC FENCING REDUCES HERON PREDATION AT NORTHEASTERN TROUT HATCHERIES

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Abstract: Great blue herons (*Ardea herodius*) are the most common avian predator at commercial trout hatcheries in the northeastern United States. We evaluated a 2-strand electric fence for excluding this species from raceways at 2 commercial trout hatcheries in central Pennsylvania. Fences consisted of high density polyethylene 400-lb strength tape supported by fiberglass posts and energized by either a battery-powered or a solar-powered fence charger. Labor and material for constructing the fences at the 2 sites averaged $1.32/m of raceway. Bird visitation at the 2 sites initially declined, but returned to pre-installation levels. However, bird use of raceways declined ($P < 0.05$) at both sites compared to pre-installation levels for the duration of the study (49 - 62 days post-installation). Fences must be monitored to detect electrical shortages and to ensure that birds do not gain access to raceways under the bottom strand of the fence or forage between the fence and the shoreline. The 2-strand fence evaluated in this study is a cost-effective method for deterring heron predation at commercial trout hatcheries.

Key Words: *Ardea herodius*, depredation, deterrent, electric fencing, great blue heron, raceway

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Predation by birds is a significant problem at commercial trout hatcheries in the northeastern United States (Parkhurst et al. 1992, Pough 1941). According to a 1996 survey, 80% of aquaculture facilities in New Jersey, New York, and Pennsylvania sustained annual losses as high as $500,000 (Glahn 1997). At least 8 species of birds forage regularly at commercial fish farms in the northeastern U.S., including great blue herons (*Ardea herodias*), black-crowned night herons (*Nycticorax nycticorax*), green herons (*Butorides virescens*), mallards (*Anas platyrhynchos*), osprey (*Pandion haliaetus*), common grackles (*Quiscalus quiscula*), belted kingfishers (*Ceryle alcyon*). Great blue herons are the most ubiquitous and common predator (Glahn 1997).

Many methods are available for reducing bird predation at fish-rearing facilities (Mott 1978, Draulans 1987, Curtis et al. 1996), but few are both practical and effective. Many farmers harass birds to drive them away from their farms. However, such methods either are prohibitively labor-intensive or eventually lose their effectiveness because of habituation by birds. Farmers also can reduce local populations of depredating birds by shooting or trapping them. However, almost all species of birds are protected by state and federal laws and international treaties, and the required

regulatory permits sometimes are difficult to obtain. Physical barriers ranging from overhead wires to complete enclosures provide varying degrees of protection. The most elaborate enclosures potentially are 100% effective, but are prohibitively expensive for most commercial enterprises and may interfere with other farm operations.

Electric fencing may provide a less expensive deterrent that is easier to construct than conventional exclusion systems (McKillop and Sibly 1988). Ramsey et al. (1989) described a 5-strand electric barrier that excluded great egrets (*Ardea alba*) and snowy egrets (*Egretta thula*) from preying on mosquitofish (*Gambusia affinis*) in California. More recently, Mott and Flynt (1995) demonstrated the utility of a 2-strand electric fence for reducing wading bird predation at commercial catfish farms in Mississippi. We evaluated a similar 2-strand fence for reducing great blue heron predation at commercial trout farms in Pennsylvania.

D.S. Reinhold and C. Shershanovich assisted with the field work. R.M. Engeman advised on the statistical analyses. M.L. Avery, D.T. King, and R.G. McLean reviewed an earlier draft of the manuscript.

**METHODS**

We evaluated the fencing between August and November 1996 at 2 trout hatcheries owned and operated by Cedar Springs Hatchery in Clinton County, central Pennsylvania. Both facilities contained a variety of trout species (e.g., rainbow, *Salmo gairdneri*; brook, *Salvelinus fontinalis*; and brown, *Salmo trutta*) that ranged in length from 7 to 60 cm. One facility (Barn site) was located 3 km north of Lamar and contained 3 parallel earthen raceways that were 3 - 6 m wide and 400 - 550 m long. The Barn site was surrounded by rolling farmland and scattered patches of mature woods. The second facility (Salona site) was located 7 km northeast from Barn site and contained 4 parallel raceways that each were 3 - 6 m wide. Two raceways at Salona were 70 m long, and two were 45 m long. The Salona site was secluded, surrounded by mature woods and grass fields. All raceways at both sites were partitioned at 30-m intervals by wooden walkways. At both sites, human disturbance was limited to normal hatchery operations.

We erected an electric fence around each of 3 raceways at each site; 1 of the raceways at Salona was drained just prior to the start of this study. Each fence consisted of 2 strands of high density polyethylene 400-lb tensile strength tape (polytape) supported by fiberglass posts (1.2 m length and 1.5 cm diameter) positioned at 5 - 10-m intervals around the perimeter of the raceway. Posts were set in the water 15 - 30 cm from the edge of the water, depending on the configuration of the raceway and the depth of water. We cleared potentially intruding vegetation from the path of the fence before attaching the polytape to the posts with plastic insulators. The 2 strands of polytape were 15 - 30 cm apart, with the lower strand 15 - 30 cm above the surface of the water. The polytape was 1.65 cm wide and was interwoven with 7 tinned aluminum wires. Each fence was powered by a 12-volt battery or a solar fence charger. Each produced a high voltage pulse for 1/4,000 sec every second. We installed "gates" where workers could disconnect the polytape to enter the raceways.

We monitored heron use of raceways before and after installation of the fence at each site by conducting 4 bird counts during each of the weeks preceding and following installation, as well as additional counts up to 62 days after installation. Each bird count consisted of 2 paired 2-h

observation periods conducted within 2 h of sunrise and 2 h of sunset, respectively. The morning observation periods were initiated at first light (usually 10 - 15 min before sunrise), and the evening observation periods usually ended 10 - 30 min after sunset. During each 2-h observation period, we sat in a vehicle >50 m from the raceways and at 5-min intervals used binoculars to count the number of herons in the raceways as well as the total number of herons (inside and outside the raceways) at the facility.

We used Kruskal-Wallis 1-way analysis of variance and multiple comparison procedures (Hollander and Wolfe 1973) to detect differences over time in number of herons observed. We divided the study into discrete periods at each site for comparison. These periods encompassed 1-7 days before and 0-3, 12-19, and 41-47 days after installation of the fences at Salona and 4-7 days before and 0-8, 11-19, 27-34, and 55-62 days after installation at Barn site. We analyzed the 2 sites separately.

## RESULTS

Total number of birds observed at Salona varied among observation periods ($\chi^2$ = 9.78, d.f. = 3, $P$ = 0.02) and was greater ($P$ < 0.05) before installation of the fences than either 0 - 4 days or 12 - 19 days after installation (Fig. 1). By the final observation period (41 - 47 days post-installation), heron numbers increased ($P$ < 0.05) compared to the first post-installation period and were similar to pre-installation levels. Bird use of raceways at Salona also varied among observation periods ($\chi^2$ = 7.56, d.f. = 3, $P$ = 0.06) and declined from about 6 - 14 birds/hour/day before electric fences were installed to <3 birds/hour/day after installation (Fig. 1). We recorded fewer ($P$ < 0.05) herons in the raceways during all post-installation observation periods than during the pre-installation observation period.

Total number of herons visiting the Barn site fluctuated widely, but did not vary consistently among observation periods ($\chi^2$ = 2.34, d.f. = 4, $P$ = 0.67) (Fig. 2). However, heron use of raceways differed among observation periods ($\chi^2$ = 9.84, d.f. = 4, $P$ = 0.04) and was less ($P$ < 0.05) during all post-installation observation periods than during the pre-installation observation period (Fig. 2). Number of herons in the raceways declined from 76 - 159 herons/hour/day before installation of the fences to <58 herons/hour/day after installation. The slight increase on the third and fourth days after installation probably was due to the fence shorting out in several places. After we corrected the problem, bird use of raceways declined to <22 birds/hour/day (Fig. 2).

Costs for materials per meter of fence ranged from $1.24 at Barn site to $1.40 at Salona (Table 1). At the former site, we expended 6 person-hours closing gaps where we observed herons entering the raceways. At Barn site, we also installed extra posts near the crosswalks to prevent herons from penetrating under the bottom strand of the fence and added additional fencing to prevent herons from landing on and fishing from the crosswalks.

## DISCUSSION

Two-strand electric fences significantly reduced heron use of trout raceways. Birds that contacted a charged fence squawked and quickly retreated, and heron use of protected raceways declined throughout the post-installation observation periods. Besides a few birds flying over the fence to enter the raceways, we saw little evidence that herons habituated to or otherwise learned to circumvent the fence. The fencing may have hampered foraging even of herons that circumvented the barriers (Parkhurst 1989).

The immediate decline in numbers of herons visiting both sites during the first

morning after the fences were installed suggests an initial neophobic reaction to the fences. Bird numbers at both sites declined on the first day following installation of the fences even though no birds had contacted the fences or been shocked. Heron visitation subsequently increased at both farms, albeit more quickly at Barn site, and eventually returned to pre-installation levels. Even after heron visitation increased to pre-installation levels, heron foraging in the trout raceways remained depressed.

Fences must be monitored to ensure proper functioning. We used a hand-held voltage meter to detect electrical shortages caused by fluctuating water levels, encroaching vegetation, or sagging wires and to verify that fences were carrying an adequate charge of 3,000 volts. Fences around large raceways may require >1 fence charger and/or battery to maintain sufficient voltage. Birds should be observed periodically to determine whether they are gaining access under the fence or foraging between the fence and the shoreline.

Excluding birds from ponds or raceways often is more effective than lethal or scaring techniques for reducing predation on fish (Draulans 1987). Totally excluding birds with netting probably is the most effective method for reducing damage, but it also is costly and may interfere with other farming operations (Parkhurst 1989). Electric fences provide a cheaper alternative where wading birds are the primary concern (McKillop et al. 1988). The 2-strand electric fencing we evaluated is well-suited for protecting earthen trout raceways from predation by great blue herons and other wading birds. The "gates" allowed for easy access of workers into the raceways, and thus compatibility with other farm operations. The fencing was easy to install, non-lethal, and, most importantly, effective.

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Table 1. Average costs of materials to construct a 2-strand electric fence around each of 3 trout raceways at the Barn site of Cedar Springs Hatchery in Clinton County, central Pennsylvania, August 1997. The fencing protected 3 raceways with a combined perimeter of 2520 m.

| Item | Unit cost ($) | Quantity | Total cost ($) |
|---|---|---|---|
| Fence charger (6/12 volt) | 77.99 | 1 | 77.99 |
| Battery (12-volt) | 86.99 | 2 | 173.98 |
| Battery charger | 50.00 | 1 | 50.00 |
| Polywire (200 m) | 44.99 | 16 | 719.84 |
| Fence posts | 1.49 | 165 | 245.85 |
| Insulators (25) | 2.49 | 14 | 34.86 |
| Ground wire | 12.99 | 1 | 12.99 |
| Grounding rod | 24.99 | 1 | 24.99 |
| Gate handles | 1.99 | 10 | 19.90 |
| Labor (person-hours) | 7.00 | 18 | 126.00 |
| TOTAL | | | 1486.40 |

Table 2. Average costs of materials to construct a 2-strand electric fence around each of 3 trout raceways at Salona site of Cedar Springs Hatchery in Clinton County, central Pennsylvania, August 1997. The fencing protected 3 raceways with a combined perimeter of 1260 m.

| Item | Unit cost ($) | Quantity | Total cost ($) |
|---|---|---|---|
| Solar charger | 204.99 | 1 | 204.99 |
| Polywire (200 m) | 44.99 | 8 | 359.92 |
| Fence posts | 1.49 | 85 | 126.65 |
| Insulators (25) | 2.49 | 7 | 17.43 |
| Ground wire | 12.99 | 1 | 12.99 |
| Grounding rod | 24.99 | 1 | 24.99 |
| Gate handles | 1.99 | 6 | 11.94 |
| Labor (person-hours) | 7.00 | 12 | 84.00 |
| TOTAL | | | 842.91 |

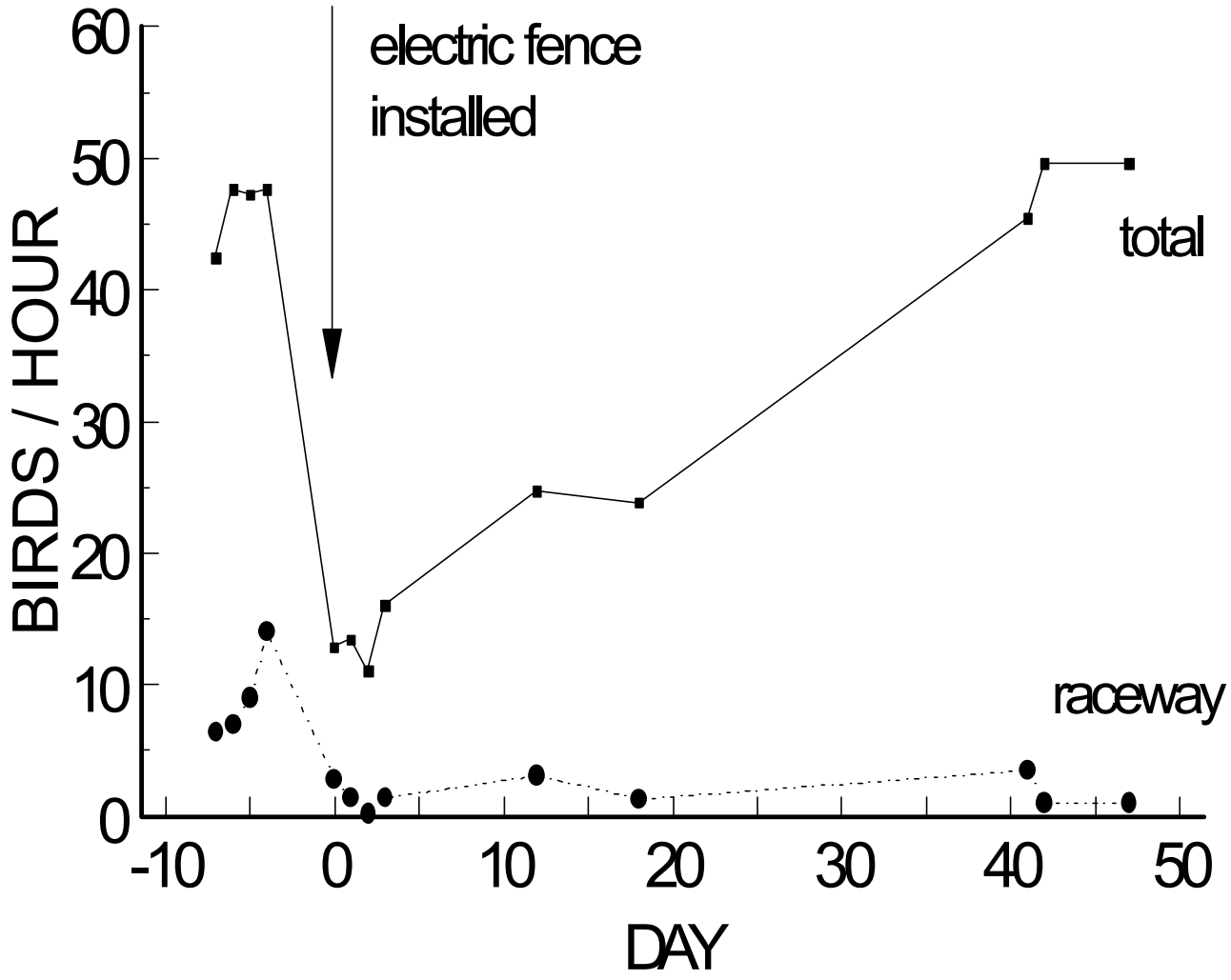


Fig. 1. Great blue heron activity in the vicinity of the site and in raceways before and after installation of 2-strand electric fences around fish raceways at Salona site of the Cedar Springs trout hatchery in central Pennsylvania, August and November 1996.

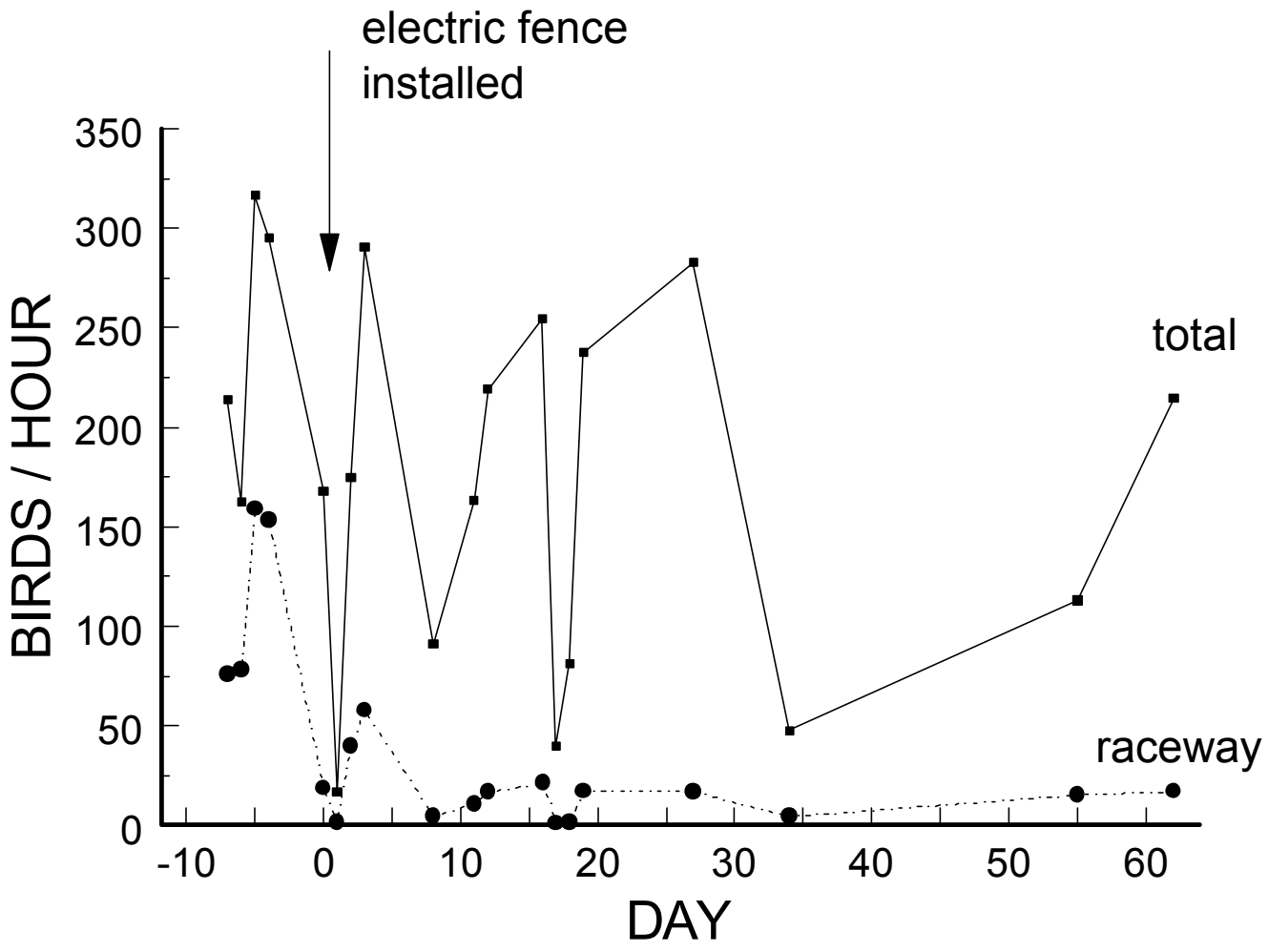


Fig. 2. Great blue heron activity in the vicinity of the site and in raceways before and after installation of 2-strand electric fences around fish raceways at Barn site of the Cedar Springs trout hatchery in central Pennsylvania, August and November 1996.

# THE LEGAL ROLES AND RESPONSIBILITIES OF A COMMUNITY CONCERNING CROP DEPREDATION BY WHITE-TAILED DEER

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Abstract: The interwoven issues of the legal roles and responsibilities that landowners (i.e., farmers, foresters, and hunters) and a state agency have to control deer densities in rural areas that directly affect crop depredation and various stakeholders will be addressed in this paper. Because unmanaged deer populations severely can damage agricultural crops, the financial cost of this deer damage is borne entirely by individual private landowners. The South Carolina Department of Natural Resources (SCDNR) is the regulatory state agency in South Carolina responsible for annually promulgating rules and regulations pertaining to white-tailed deer harvest by hunters. Even though deer are property of the state and SCDNR is responsible for establishing legal harvest limits and open seasons, it alone cannot manage deer densities. Common crop depredation problems, responsibilities, and solutions regarding deer in South Carolina are presented, based on our investigation of legal sources such as the South Carolina Code of Laws, U.S. Constitution, State Constitution of South Carolina, and Common Law. Suggestions are presented for rural landowners who want to manage natural resources and agriculture on their property. Landowners who hunt and/or allow hunting on their property are the key to successful management of deer as a public resource. The ability to effectively manage deer is up to individual landowners. However, because private landowners have no legal responsibility to manage wild deer populations, minimizing crop depredation through legal harvest remains an ancillary benefit of rural landowners' sport hunting objectives.

Key Words: agriculture, community, crop, depredation, farmers, hunters, landowners, legal, *Odocoileus virginianus*, responsibilities, South Carolina, white-tailed deer

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White-tailed deer (*Odocoileus virginianus*) and their population densities are viewed by various user groups of land resources in different ways. In some areas of South Carolina, high deer densities have caused friction among these user groups. For example, in Hampton and Jasper Counties, SC, many farmers are being affected economically by crop damage caused by deer. Some farmers consider deer as a public nuisance and believe that someone should be held accountable for deer depredation to agricultural crops (Smathers et al. 1994). Yet, other citizens in the same community can benefit economically and recreationally from having white-tailed deer in the area.

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This paper will address the interwoven issues of the legal roles and responsibilities that farmers, hunters, and foresters have to control deer densities that directly affect crop depredation in rural areas. These 3 land resource user groups represent common resource users of rural areas across the southeastern United States. Forestry, in much of the Southeast, is a special type of agriculture where "crop" rotations of pine trees typically occur every 2 to 3 decades. In 1993, 12,645,557acres were classified as forest lands in South Carolina (Conner 1993). That is an increase of 388,585 acres since 1986 (Conner 1993). Agricultural crops, such as soybeans, corn, and wheat, are grown by farmers throughout the Southeast and potentially can change the carrying capacity of an area for deer. In South Carolina in 1993, 6,579,403 acres of croplands and pasture existed (Conner 1993). Cropland alone decreased 521,862 acres since 1986 (Conner 1993). All agricultural and forestry practices are dynamic and affect food, water, and cover availability for white-tailed deer. These 3 factors are the habitat requirements deer depend upon to survive. Recreational deer hunting is the most efficient and effective means to control and determine annual deer densities in these areas.

White-tailed deer historically have been an important resource for hunters. Many people today benefit from deer hunting and often for slightly different reasons. Enjoying the outdoors and wildlife provides a means of relaxation and/or a break from the world of business and other social obligations. Hunting has been described as "the act of trying to find, seek, obtain, pursue, or diligently search for game" as defined by a court case ruling (***Prosser*** v. ***Parsons*** 141S.E.2d 342 1965). This does not explain why people hunt, but rather, how hunting is performed. A successful hunt can bring fond memories, several dozen pounds of venison, and, in some cases, a deer that the hunter may wish to mount and keep as a constant reminder of a hunting experience. Each of these rewards has a different degree of importance to individual hunters. Yet, all of them are considered benefits by hunters.

Another reason why white-tailed deer are considered a resource is because they can bring a great economic benefit to a community. Private landowners and timber companies that allow hunting on their property through leases have depended on white-tailed deer as an important source of revenue. There also is a tremendous amount of economic benefit that other community members can gain by expenditures from both local and non-resident hunters. For example, the total annual return in-county private land hunter expenditures in 1992 was >$6 million in Jasper County, SC (Richardson et al. 1992). Also, all South Carolina residents who plan to hunt deer must first purchase a big game permit in addition to a resident hunter's license (SC Code Ann. § 50-9-135 Supp. 1996).

Despite the numerous benefits deer can bring to a community, there are some negative impacts that uncontrolled and unmanaged deer populations also can bring to these same communities. If deer populations become too dense, deer-vehicle accidents can increase and cause physical harm and/or financial loss to individuals involved. For example, in 1990, 49 deer-vehicle collisions occurred in Hampton County, SC, alone (Shipes and Williams 1990). People involved in these accidents often have a continuous fear of colliding with another deer, especially while driving at night. The environment also can be impacted negatively by high deer densities. "Browse lines" can occur where deer have eaten most of the vegetation within their vertical reach in a given area. This can cause an impact on the regeneration of forests and habitat for

other species of wildlife. Pine and hardwood seedlings that foresters plant can be killed or stunted if deer eat the terminal buds. The depletion of all of these resources also can affect the health of deer.

Landowners who grow plants for personal consumption, aesthetics, and/or a livelihood often are affected to at least some degree in areas where deer densities are high. Thirty-six percent of South Carolina farmers surveyed reported that their crop damage was >5% of total crop production (Smathers et al 1994). Hampton and Jasper Counties are 2 of the 7 state counties where crop damage by deer has been classified as heavy (Smathers, Stratton, and Shipes 1994). Of all agricultural crops reported having been damaged by deer from the southeastern US, crops damaged most often have been soybeans in 11 states and corn in 9 states (Moore and Folk 1977).

**WHO IS RESPONSIBLE FOR CROP DEPREDATION BY WHITE-TAILED DEER IN SOUTH CAROLINA?**

Landowners and SCDNR ultimately are the 2 groups who potentially affect crop depredation by deer in SC. SCDNR is the state agency that has legal responsibility for coordinating biological information, such as deer harvest data, to develop broad management guidelines, most of which are enforceable by law (SC Code Ann. § 50-3-90 Supp. 1996). The federal government recognizes the state's privilege to manage wildlife on federal land and its right to manage state lands. The US Constitution retains police power as a source of law for states, thereby authorizing statutory control of deer.

White-tailed deer in South Carolina are among several species of wild animals which "are property of <the> state" (SC Code Ann. § 50-1-10 Supp. 1996). SCDNR is a state agency that is responsible for establishing management guidelines for deer through rules and regulations which, if violated, are punishable under criminal law (SC Code Ann. §§§ 50-1-120,-125,-130 Supp. 1996). SCDNR is bound by the South Carolina Code of Laws (SC Codes) to "continuously investigate the game and fish conditions of the state and the laws relating there to. It shall annually make report of its activities to the General Assembly and recommend legislation and other action by the General Assembly in its judgment conducive to the conservation of wildlife" (SC Code Ann. § 50-3-80 Supp. 1996). Because the state "owns" deer in South Carolina, it is responsible for establishing Rules and Regulations of game laws that can affect deer densities. The overall purpose of game laws is to avoid depletion of game to the point where harvest by hunters becomes too small or extinction occurs (74 A.L.R.2d 974).

Landowners constitute the other group that can affect deer densities. Unlike SCDNR, landowners have no legal obligation to manage for wild white-tailed deer on their property. Another difference between SCDNR and landowners is that landowners are the ones who decide whether deer hunting, which is the most practical and resourceful means for controlling deer in rural areas, will be allowed on their property. This is an important point because private landowners own the majority of land in South Carolina.

However, SCDNR is involved by restricting the means by which deer can be harvested and the quantity of deer that hunters can harvest. Landowners and hunters must follow these restrictions, which are printed in the annual Rules and Regulations as set forth by the SCDNR, if they choose to hunt deer on their property. This applies regardless of whether they are trying to manage the deer population on their lands. Virtually all land

management actions taken by landowners in rural areas have the potential to affect deer densities on adjacent landowners' properties. Even though some landowners believe there is a moral obligation by all to "appropriately" manage deer densities, landowners have no legal responsibility to do so.

We believe that this is the root of the problem, as described at the outset of this paper. Hypothetically, deer populations could become entirely unmanaged if hunters did not hunt. This would be unfortunate and potentially problematic because deer densities could increase greatly. Landowners, who allow deer hunting and farming on their property, and SCDNR must continue to work together in a cooperative manner if problems like this are to be resolved.

In 1896, the US Supreme Court decided that wildlife is state (public) property and declared that states are to hold the property "in the public trust" (*Geer v. Conn* 161US 519 1896). In that case, the Court decided that a state could limit interstate shipment of legally taken wildlife. The application of the public trust doctrine, unfortunately, does little to resolve liability for damage caused by wildlife.

Given the recognition of state or public ownership of wildlife, only a small step is required to find constitutional authorization for state control of this resource. It is found in the police power retained by the states as a source of law. This authorizes state legislatures to enact a wide array of regulations, including statutory regulations on wildlife. The Legislature of South Carolina has set broad management guidelines through legislation and has empowered SCDNR to enact detailed regulations essential for wildlife and game management (SC Code Ann. § 50-1-10 Supp. 1996). This moves the actual regulation from the legislature to an agency (SCDNR) and the rules are promulgated following the State's Administrative Procedure Act, with SCDNR acting in a quasi legislative function. The authority is the basis of the annual fish and game regulations that set seasons and bag limits.

Because one landowner's land management actions indirectly can affect an adjacent landowner's property (i.e., crop depredation) and because there are no specified legal obligations on either party, it should not be surprising that several court cases regarding such issues have occurred across the nation (93 A.L.R.2d 1366, 74 A.L.R.2d 974). These cases have examined deer damage to plants (e.g., lawn, cultivated crops, apple orchard trees, standing grain), and even shucked corn that was piled in a barn (*Commonwealth v. Bloom* 21Pa.D.2d 139 1959, *Commonwealth v. Riggles* 39Pa.D. 188 1940, *Commonwealth v. Gilbert* 5Pa.D. 443 1924, *State v. Ward* 152N.W. 501 1915). In the SC Codes (Title 50, Chapter 11[Protection of Game], Article 6 [Special depredation permits, collection permits, closing seasons, special seasons], section 50-11-1050), property owners can obtain a permit through SCDNR to remove wildlife that is destroying their property. This section cites the *American Law Report* (2nd edition), a secondary authority source, as a source for case law on point because no Appellate Court cases regarding this matter have occurred in South Carolina. Both the Constitution (Article 1, §3) and the 5th Amendment to the United States Constitution state the no person "…shall be deprived of life, liberty, or property without due process of law." However, some cases reviewed by *American Law Report* ruled that "...before a plea of justification for killing a protected wild animal may be asserted and heard it must be shown that all other remedies provided by law were first exhausted by the person

doing the killing" (93 A.L.R.2d 1366). So, intuitively, South Carolina landowners should consult SCDNR to obtain depredation permits if deer are damaging their property.

Clearly, game management is subject to the major sources of law: constitutional, statutes, and administrative. In addition, it has been affected by judicial elements in the form of court interpretations of statutes. In spite of the scope of this regulation, little firm law exists regarding state responsibility for deer damage, or game harm in general. Such law could come from common law claims of nuisance or trespass in which a private party would claim damage from the state caused by animals the state "owns." This has not been a markedly successful effort in most states, including South Carolina, because state law limits this type of lawsuit.
Although decisions from other states do not bind the actions of courts in South Carolina, at least they provide grounds for persuasive logical arguments. The pattern is not absolute, but cases from at least 12 states (AL, CT, GA, IA, KY, ME, MT, NH, NY, OH, PA, SD) suggest at least some right of landowners to kill deer to protect their property. Rather than pursuing legal action, the best solution seems to remain using existing laws that allow for permits to control deer and work with SCDNR to achieve reasonable interpretations of this law.

**WHAT SCDNR DOES TO EASE THE PROBLEM**

SCDNR publishes Rules and Regulations that are updated annually to reflect changes in law. South Carolina has one of the most liberal deer hunting seasons in the United States. In Hampton and Jasper Counties, the 1993-1994 rules/regulations and section 50-11-310 allowed hunting of deer by properly licensed hunters to begin on 14 August and end on 1 January. On private lands in these 2 counties, there are no limits on the number of bucks that can be harvested, as long as bucks have a 2-inch minimum antler height (SC Code Ann. § 50-11-335 Supp. 1996). There is a limit of 2 does/day on any of the 16 either-sex days, unless a hunt club chooses to use the antlerless-deer quota program. Legal hunting hours on designated days begin ½-hour before sunrise until ½-hour after sunset.

Hunters in Game Zone 11 must chose between either-sex days or antlerless deer quotas. Antlerless deer quota tags are issued to landowners or lessees who submit a completed application with a $50 fee prior to 1 September. Regional and local wildlife biologists will decide on the number of tags to issue each landowner each year. If landowners and biologists cooperate, the South Carolina antlerless-deer quota program potentially can offer a means of managing deer densities. But, as mentioned earlier, landowners do not have a legal obligation to harvest a minimum number of deer each year.

Because SCDNR currently divides the state into 11 Game Zones, wildlife biologists potentially are better able to manage specific wildlife populations of game to meet needs of local wildlife, wildlife habitat, and people. Each of these game zones have different rules and regulations, which are investigated annually by biologists (SC Code Ann. § 50-1-60 Supp. 1996). Biologists who deal with white-tailed deer in South Carolina help compile and examine harvest records from throughout the state. The annual South Carolina Deer Harvest Summary report includes statewide information concerning the deer harvest structure. Information that can indicate health trends of deer is taken from animals harvested. Deer weight, age, sex ratio, lactation dates of does, total hunter harvest, and harvest rates for a given area are examples of

biological statistics that biologists, in each game zone, can use to alter rules and regulations yearly.

South Carolina statutory law establishes a means by which a landowner may use depredation permits to remove white-tailed deer that are destroying their property, "...the department has the authority during any season of the year to permit the taking of any game animal and prescribe the method by which they may be taken when they become so numerous that they cause excessive damage to crops and property. Any animal taken under these conditions is under the supervision of the department. Any deer killed under these conditions must be given to eleemosynary institutions" (50-11-1090 SC Code). Section 50-11-1050 states a similar law, "...where wildlife is destroying property, the department, upon the request of the property owner, may issue a permit authorizing the property owner, under the supervision of the department, to take action necessary to remove the destructive wildlife from his property." Even though these laws allow landowners to obtain depredation permits to remove destructive deer, problems with agricultural depredation by deer still persist in some areas of South Carolina. Survey results, discussion with respondents, researchers, and deer biologists agree that landowners do not have the time or skill to control deer damage to their crops using depredation permits (Smathers et al. 1994). To some farmers, especially those who cultivate large acreage, crop depredation permits are not an efficient means for controlling deer densities.

There are many factors that can influence the reformation of rules other than sound biological statistics. Any individual landowner in America is likely to have numerous interests in how and when they want to legally utilize their land. For example, imagine a hypothetical case where 2 adjacent landowners use their land in different, but legal, manners: one landowner may leave the entire property, which is forested with a mature hardwood stand, alone for as long as it is owned, whereas someone else, who has just purchased adjacent and similar property, may cut and sell all of the timber at once and begin farming immediately as an economic means for livelihood. Both of these private land management practices are legal. However they both affect deer populations and their movements throughout the year. Who should be responsible for crop depredation by deer that this farmer may experience? SCDNR may make decisions about rules and regulations that favor and oppose different people. The politics of aesthetic, economic, recreational, and resource conservation issues are of concern to many landowners and they should be of concern to SCDNR. Because these public concerns are ever changing, SCDNR has the potential to reform the Rules and Regulations which may address these issues annually.

**WHAT CAN LANDOWNERS DO TO HELP EASE THE PROBLEM**?

The first thing a landowner must do to solve crop depredation is to become knowledgeable of the problem. An understanding of basic ecology as it pertains to white-tailed deer manage-ment, agriculture, forestry, and hunting are some subjects that a rural land manager should be aware of to make sound decisions. Before a landowner makes any decisions, he/she should establish a prioritized list of objectives for his land. Factors to be considered might include economic income from agricul-ture, forestry, and hunting; personal and ethical obligations to adjacent land-owners' property; management affects on white-tailed deer health; and personal use opportunities from hunting and gardening.

Once a prioritized list of objectives for land

use has been developed by a landowner, leasing the property to farmers and hunters may become a great benefit. If a landowner leases to conscientious people, he/she can benefit by financial profit and/or desired land management. By pre-writing a hunting lease that contains all of the expectations of a landowner, such as an annual quota of deer to be harvested, the owner can more effectively "shop" for a hunt club that will fulfill the stated objectives. The prospective hunting club should be respectful of the landowners expressed interests.

Similarly, when landowners lease to farmers, the same concept above could apply. Other means of crop depredation control, such as fencing, repellents, or scaring devices, could be incorporated into an agricultural lease if desired. If landowners who farm do not allow hunting on their property, then they should realize that they may 1) suffer the opportunity cost associated with leasing and 2) economically suffer from crop depredation by deer, especially where deer densities are unusually high.

**SUMMARY**

SCDNR is the regulatory state agency in South Carolina responsible for annually promulgating rules and regulations pertaining to white-tailed deer harvest by hunters. Hunting is the most efficient and effective legal means to control potentially damaging deer densities in rural areas. Unchecked deer populations severely can damage agricultural crops on private property. The financial cost of deer damage is borne entirely by private landowners. Even though SCDNR "owns" deer and is responsible for establishing legal harvest limits and open seasons, it alone cannot manage deer densities. Landowners who hunt and/or allow hunting on their property are the key to successful management of white-tailed deer. The ability to effectively manage deer is up to individual landowners. But, because private landowners have no legal responsibilities to manage wild deer populations, minimizing crop depredation through legal harvest remains an ancillary benefit of landowners' sport hunting objectives.

> *There is much confusion between land and country. Land is the place where corn, gullies, and mortgages grow. Country is the personality of the land, the collective harmony of its soil, life, and weather. Country knows no mortgages, no alphabetical agencies, no tobacco road; it is calmly aloof to these petty exigencies of its alleged owners.*"
>
> Aldo Leopold, "Country" in *A Sand County Almanac*

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# WILDLIFE DAMAGE TO AGRICULTURAL CROPS IN PENNSYLVANIA: THE FARMERS' PERSPECTIVE

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Abstract: Agricultural damage by wildlife is a major concern for both agricultural and wildlife agencies at the state and federal level. Our objective was to estimate wildlife damage to agricultural crops on a statewide basis. We sent questionnaires to 4,958 farmers and 1,003 were returned after 2 mailings. Twenty-five percent of farmers responding to our survey rated the level of wildlife damage to their crops as severe or very severe, 46% as moderate, and 29% had none or very little. Mean levels of crop loss to wildlife ranged from 6% for wheat to 10% for corn grain, and white-tailed deer (*Odocoileus virginianus*) were the most commonly reported cause of damage for all crops except soybeans. Farmers estimated the economic value of damage caused by wildlife to 6 crops (corn grain, silage, alfalfa, soybeans, oats, and wheat) as > $70 million. Ninety-one percent of Pennsylvania farmers allowed deer hunting on their farms, but 62% of the farms were bordered at least partially by land that was posted (no hunting or limited hunting). Fifty-six percent of farmers whose land was bordered by posted land believed adjacent posted land made it difficult for them to control deer numbers and damage on the land they farmed. Thirty-one percent of farmers responding to the questionnaire reported that they had changed farming practices (i.e., no longer farmed a particular field or raised a particular crop) as a consequence of deer damage. Additional methods used to control deer damage included shooting (28%), chasing (13%), fencing (9.3%), repellents (7%), and noise devices (5%). Fencing and shooting were the only methods rated as being at least moderately effective.

Key words: agricultural damage, *Odocoileus virginianus*, Pennsylvania, white-tailed deer, wildlife

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Agricultural damage by wildlife is a major concern for both agricultural and wildlife agencies at the state and federal level. In a survey of state wildlife agencies, state agricultural departments, wildlife extension specialists, U. S. Department of Agriculture Animal Damage Control state directors, and state Farm Bureau officials, respondents from many states indicated damage caused by wildlife had increased in the last 30 years and that deer were their worst problem (Conover and Decker 1991). Although deer apparently were responsible for the most damage on a national level, 27 different wildlife species were listed by respondents as causing the worst problem in their respective states. Conover and Decker (1991) suggested 2 factors caused the increase in wildlife damage: changes in agricultural practices (i.e., plowing practices, irrigation, and use of dwarf and semi-dwarf species in

orchards) and increasing wildlife populations. White-tailed deer (*Odocoileus virginianus*) populations have increased in the past 50 years in much of the Midwest and Mid-Atlantic states (Gladfelter 1984, Palmer et al. 1985). Unfortunately, updated national estimates of the extent and distribution of corn or other crop losses due to deer damage have been rare (Conover and Decker 1991, but see Wywialowski 1996).

As on the national level, white-tailed deer are thought to cause the most crop damage in Pennsylvania (Wingard et al. 1981, Anon. 1989). Some growers report that farming is no longer profitable because of deer damage, but debate exists regarding the severity and distribution of damage across the state. Disagreement over damage severity arises because estimates of crop losses to deer vary from year to year, with respect to adjacent land uses or habitat types, and with respect to sampling methods (Korschgen 1962, Murphy et al. 1985).

Two methods can be employed to evaluate wildlife damage: 1) indirect, in the form of postal or telephone surveys; and 2) direct, in the form of on-the-ground sampling. Given the magnitude of measuring and documenting wildlife damage on a large scale (state, regional, or national), agriculture and wildlife professionals often rely on surveys administered to farmers to estimate loss (e.g., Wywialowski 1996). Postal question-naires have been used to evaluate perceptions and estimates of damage, knowledge of wildlife species, and preferred wildlife management options (Craven et al. 1992). The first national survey on wildlife damage was conducted by McDowell and Pillsbury (1959). Conover and Decker (1991) attempted to re-evaluate issues of wildlife damage in 1987 with a similar survey. Since that time, many states or individual agencies have conducted their own surveys to evaluate the magnitude of damage, species responsible, economic impacts, and landowner tolerance to damage without extensive labor costs for field sampling (Craven et al. 1992). We used a questionnaire to estimate the extent, value, and causes of crop damage in Pennsylvania.

This project was funded by the Pennsylvania Department of Agriculture. M. Eckhaus and J. Rotz of The Pennsylvania Farm Bureau (formerly Association) provided support, contacts, mailing lists, and personnel to mail the questionnaire. M. B. Forgy entered the questionnaire data, and J. N. Bosco word-processed the final report. We appreciate the cooperation of Pennsylvania farmers who responded to our questionnaire.

## Methods

In Pennsylvania, there are approximately 50,000 farms (Anon. 1996) and, in 1993, 535,013 ha of corn were planted (Anon 1995). We used a comprehensive list of farmers maintained by the Pennsylvania Farm Bureau (PFB), which has 20,097 members distributed across the state, to select farmers who would receive the questionnaire. We identified 4,958 randomly chosen farmers and, to maintain the confidentiality of their list, the PFB mailed our questionnaire to them in April 1995. We allocated sampling among counties proportional to the amount of cropland within each county; the number of questionnaires mailed per county ranged from 31 to 119, except Philadelphia county, which received none.

In August 1995, a second mailing was made to a random sample of 1,000 farmers who did not respond to the initial mailing. Individuals were asked to base their answers on crops they grew during 1994.

Farmers were asked to estimate the amount of wildlife damage to each crop grown in 1994, the species perceived to be causing the damage, and the time of year

damage occurred. In addition, respondents were asked the type and size of farm operated, percent income earned from farming, percentage of posted land surrounding their farm, and their perceived trend in white-tailed deer numbers on the land they farm. We also asked farmers to describe abatement methods they used, rank their effectiveness in controlling white-tailed deer and other wildlife damage to crops, and describe level of hunting pressure on their land.

We asked the PFB to randomly select 4 names from each county from the list of farmers who did not respond to either mailing. From that list we randomly selected 2 farmers from each of 61 counties. During August 1996, we attempted to telephone 122 farmers to ask if they recalled receiving the questionnaire, and if they believed wildlife damage was a major problem in their farm operation. In addition, farmers were asked why they did not return the questionnaire and to estimate the percentage of their corn crop that was lost to wildlife damage.

We compared responses from the first mailing with those of the second to gain insight about expected responses from non-respondents (Fowler 1993). All statistical comparisons were done with Statistical Analysis System (SAS Inst. Inc. 1989) and Minitab (Minitab 1993) at the $\alpha$-level = 0.05.

# RESULTS

Response Rate

Pennsylvania farmers returned 870 usable questionnaires from the initial mailing. Seventy questionnaires were returned by farmers who were no longer actively farming. These were deducted from the total number of questionnaires mailed. One-hundred thirty-three farmers returned usable questionnaires from the second mailing. Our overall return rates for the first and second mailings were 17.8% and 13.3%, respectively. Subsequently, the two mailings were combined yielding 1,003 usable questionnaires, which yielded overall response rate of 20.5%. In the telephone survey, we successfully contacted 105 farmers.

General Information

Pennsylvania farmers ($n$ = 868) had an average of 31 $\pm$ 0.52 (SE) years farming experience. Fifty-seven percent of the respondents derived > 75% of their income from farming; 25% derived < 25%. Farmers ($n$ = 877) described their primary farm operation as being dairy (41%), grain (18%), beef (16%), other (11%), vegetable (5%), fruit (5%), swine (3%), and poultry (1%). Average farm size ($\bar{x}$ $\pm$ SE) for Pennsylvania farmers who owned the land they farmed ($n$ = 890) was 94 $\pm$ 3.7 ha with an average of 56 $\pm$ 2.4 ha in cropland, 17 $\pm$ 1.1 ha in pasture, 31 $\pm$ 3.6 ha in woodland. Fifty-six percent of farmers ($n$ = 1,003) leased land. Average amount of land leased was 75 $\pm$ 4.1 ha (68 $\pm$ 4.0 ha in cropland, 19 $\pm$ 1.8 ha in pasture).

Perceived Trends in Deer Numbers and Hunting Pressure

Pennsylvania farmers ($n$ = 982) believed that the number of white-tailed deer over the past 5 years had decreased greatly (6%), decreased (15%), had not changed (32%), increased (36%) or increased greatly (11%). Farmers ($n$ = 823) perceived that hunting for white-tailed deer hunting over the past 5 years had increased greatly (5%), increased (24%), had not changed (47%), decreased (20%), or decreased greatly (4%). Responses between the first and second mailings differed for perceived trend in white-tailed deer numbers ($\chi^2$ = 15.41, $p$ = 0.004), but did not differ in perceived trend in white-tailed deer hunting pressure ($\chi^2$ = 1.91, $p$ = 0.7523). Forty-eight percent of respondents to the first mailing ($n$ = 853) thought deer numbers had increased over the past 5 years, whereas only 37% of those

responding to the second mailing ($n$ = 129) believed deer numbers had increased.

Hunting Pressure on Adjacent Land and on Farmland

Sixty-two percent of the individuals who owned land and 63% of the individuals who leased land ($n$ = 923) farmed areas that bordered lands that were posted. There was no difference between first and second mailings in the number of farmers who owned ($\chi^2 = 0.58$, $p > 0.4$) or leased land ($\chi^2 = 2.28$, $p = 0.13$) bordered by posted land. Fifty-six percent of farmers ($n$ = 646) whose land was bordered by posted land believed that posting made it difficult to control white-tailed deer numbers on land they farmed. Perceptions about the effect of adjacent land posting on control of deer numbers differed between first and second mailings ($\chi^2 = 5.08$, $p = 0.024$). Fifty-eight percent of respondents to the first mailing believed adjacent posted land made it difficult for them to control deer numbers, whereas 46% of second mailing respondents believed similarly.

Among farmers who owned their farmland, 49% indicated that their land was bordered by private land where hunting was permitted, 36% by private land that was posted, 12% by public land where hunting was permitted, and 3% by public land where hunting was not permitted. For leased farm land, the respective percentages were 50%, 36%, 10%, and 4%.

Ninety-one percent of Pennsylvania farmers allowed deer hunting on their farms. Respondents to the first mailing were more likely ($\chi^2 = 5.21$, $p = 0.02$) to allow deer hunting (92%) than respondents to the second mailing (85%). Pennsylvania farmers ($n$ = 725) reported the level of hunting for antlered deer on owned farmland was very light (11%), light (17%), moderate (36%), heavy (27%), or very heavy (9%). For farmers who leased farmland ($n$ = 395), the respective percentages were 13%, 23%, 38%, 19%, or 7%. Response ($n$ = 711) regarding level of hunting for antlerless deer on owned farmland was very light (25%), light (3%), moderate (50%), heavy (3%), or very heavy (19%). For farmers who leased farmland ($n$ = 383), the respective percentages were 24%, 8%, 50%, 2%, or 15%. There was no difference between the first and second mailing responses for the level of antlered deer hunting on owned land ($\chi^2 = 0.44$, $p$ = 0.50) or on leased land ($\chi^2 = 3.0$, $p = 0.25$). Likewise, difference was not detected between first and second mailing responses for the level of antlerless deer hunting on owned land ($\chi^2 = 4.3$, $p$ = 0.367) and on leased land ($\chi^2 = 3.7$, $p$ = 0.448).

Wildlife Damage Estimates

Farmers rated damage to crops by wildlife as none (5%), very little (24%), moderate (46%), severe (19%), or very severe (6%). Farmers perceptions about level of damage differed between the first and second mailings ($\chi^2 = 9.5$, $p = 0.05$). Twenty-seven percent of respondents to the first mailing estimated damage as severe or very severe, whereas only 17% of respondents to the second mailing ranked damage levels this high.

In addition to providing an overall estimate of damage, farmers were asked to report specific crops grown, to estimate the percentage of each crop lost to wildlife damage, and to identify the species causing the damage and time of year that damage occurred. Farmers were asked to list any wildlife species that caused damage and the primary species causing damage. For seven crops, we had sufficient responses to calculate mean area (ha) planted (Table 1) and to examine attributes of damage.

The mean percent crop loss due to wildlife damage ranged from 6% for wheat to 10% for corn grain (Table 1). In all cases except

for soybeans, respondents to the first mailing reported higher levels of damage, but these differences were not significant.

White-tailed deer were most commonly reported as the cause of damage in all crops except soybeans, where the woodchuck (*Marmota monax*) was reported most frequently. For all crops, white-tailed deer were most frequently reported as the primary wildlife species causing damage. Pennsylvania farmers reported white-tailed deer damage to all crops was heaviest from June through September. Most farmers (70.5%) reported woodchucks caused the most damage to soybeans. Woodchucks were the second most often reported cause of damage to alfalfa (39.7%) and other forage (32.2%). Raccoon (*Procyon lotor*) and blackbirds were the second and third most reported cause of damage to corn grain and corn silage. Blackbirds were the second most reported cause of damage to oats. Of Pennsylvania farmers who reported damage to corn grain and corn silage, 11% and 13.5%, respectively, blamed black bears (*Ursus americanus*). Twelve percent of Pennsylvania farmers who reported damage to wheat attributed that damage to Canada geese (*Branta canadensis*).

Fifty-five percent of farmers ($n$ = 105) contacted by telephone were actively farming. Sixty-two percent of them ($n$ = 58) believed wildlife damage was not a major problem in their farming operation and estimated that only 4.5% of their corn crop was lost to wildlife. Thirty-eight percent ($n$ = 58) believed wildlife damage was a major problem and estimated that 12.9% of their corn crop was lost to wildlife. Farmers who believed wildlife damage was a major problem had higher average loss (%) estimates than farmers who believed wildlife damage was not a major problem ($t$ = 3.56, $p$ < 0.0005).

The economic cost of wildlife damage to 6 crops was estimated based on farmers' average loss (%) estimates and crop values for 1994 (Anon. 1995). The estimated value of loss to corn (grain and silage combined) and alfalfa was $40,348,000 and $25,582,000, respectively. The total estimated value of loss for the 6 crops was $74,509,000 (Table 2).

Methods Used to Control Wildlife Damage

Thirty-one percent of respondents ($n$ = 978) changed farming practices as a result of white-tailed deer damage. Responses differed between the first and second mailing ($\chi^2$ = 7.67, $p$ = 0.006). Thirty-three percent of respondents to the first mailing changed farming practices as a result of deer damage, whereas only 20% of respondents to the second mailing reported making a change.

Farmers were asked what methods they used to control white-tailed deer and other wildlife damage to crops and to rate the effectiveness of each method (where 1 = very effective to 5 = not effective). Twenty-eight percent of farmers ($n$ = 1,003) used shooting to control crop damage by white-tailed deer. Farmers who reported shooting deer ($n$=282) believed shooting was moderately effective ($\bar{x}$ rating = 2.80). Only 7% of farmers used chemical repellents to control crop damage by deer, which was rated as being somewhat effective ($\bar{x}$ rating = 3.74). Nine percent of farmers constructed fences to exclude deer from their fields, and rated this method as being moderately effective ($\bar{x}$ rating = 2.85). Five percent of farmers used noise devices to deter deer from their fields, whereas 13% physically chased deer from their fields. These methods were rated as being somewhat to not effective ($\bar{x}$ rating = 4.09 and 4.29, respectively).

Thirty-three percent of farmers ($n$ = 1,003) used shooting to control crop damage by wildlife other than white-tailed deer and rated it moderately effective ($\bar{x}$ = 2.92). Eight percent of farmers used chemical repellents, stating that they were moderately effective ($\bar{x}$ = 3.10). Only 5%

of farmers constructed fences to keep wildlife from their fields, but this practice was rated as only moderately effective ($\bar{x}$ = 2.85). Six percent of farmers used noise devices and 8% physically chased wildlife from their fields, both of which was rated somewhat effective ($\bar{x}$ = 3.68, 3.97, respectively). Eleven percent of farmers reported that they enrolled in the Pennsylvania Game Commission's (PGC) "hot spot" program.

## DISCUSSION

Surveys are useful for documenting the extent of a suspected wildlife damage problem, the timing of the problem, and, in some cases, the particular species responsible for the problem (Craven et al. 1992). They also can be used to compare trends among geographic regions or between time periods. In our study, 95% of farmers reported some level of wildlife damage, a value higher than ones reported from other states (e.g., Conover 1994, Wywialowski 1994). Consistent with reports from other states, the white-tailed deer was the primary cause of damage (Conover and Decker 1991, Conover 1997).

The PFB estimated that 74% of all farmers incurred damage to farm crops from white-tailed deer, which amounted to $96,530,000 in losses during 1988 (Anon. 1989). Wingard et al. (1981) reported that 42% of respondents had deer-caused damage on their Pennsylvania farms. When asked to specify the amount ($) of damage caused by deer to all crops on their farms, respondents (62%) placed that loss, when extrapolated to a state-wide basis, at $30,683,879. Losses to all wildlife for 6 crops in 1994, as estimated by farmers, totaled $74,042,000. Wingard et al. (1981) reported perceived trends in white-tailed deer numbers over the past years as decreased (18%), no change (51%), and increased (31%). Thirteen years later, respective percentages from our questionnaire were 22%, 30%, and 48%.

Surveys also are useful to detect changes in tolerance to wildlife damage (Pomerantz et al. 1986, Craven et at. 1992). We did not measure farmers' tolerance to deer and other wildlife damage directly, but instead asked farmers to rank damage on a scale from none to very severe. In an indirect way, this also serves as a measure of tolerance. Most farmers ranked damage as moderate to very little, suggesting that they have accepted the current level of damage as one of the costs of raising crops. However, a third of all respondents altered their farming practices as a result of damage.

Surveys can be used to identify current methods used to control wildlife damage and to design management programs that address stakeholder needs (Craven et al. 1992). In our study, over 90% of farmers allowed deer hunting on their farms, which is one of the primary methods available to them to control deer numbers. However, over 60% of the farms were bordered at least partially by posted lands (i.e., no hunting or limited hunting), a practice which many farmers believed contributed to their difficulty in controlling deer. This is an extremely difficult problem because agencies have no control over the posting of private lands adjacent to farmlands.

Results from surveys on wildlife damage are useful in developing management plans that will be acceptable to farmers and address their problems and concerns (Craven et al. 1992). In Pennsylvania, in addition to hunting, the primary avenues available to farmers to reduce deer damage include shooting permits, financial assistance with fencing, and the "hot spot" program. Participation in most of these programs generally is low. Although shooting deer outside the hunting season was reported to be moderately effective in reducing damage, less than one-third of farmers reported using this method. It is possible that use of this method was under-

reported, but research from other parts of the country suggest that farmers are reluctant to shoot deer for crop damage, possibly because of negative social consequences or desirability (Craven et al. 1992).

Fencing was rated moderately effective in controlling wildlife damage, but was used by <10% of the participants even though financial assistance was available to them through the PGC. We did not directly question farmers as to why they did not use the method, but conversations with farmers suggest that fencing is not desirable because it is time consuming to install and maintain and needs to be moved on a regular basis when crops are rotated.

The PGC initiated the "hot spot" program in the early 1990s. The program allowed farmers with documented damage from deer to open their land to hunters for a special additional hunting season in early January. The low percentage of farmers participating in this program suggests that it is not an effective form of assistance and, in fact, was highly modified in 1996 in response to farmer concerns. Lack of publicity may have hampered initial efforts to get individuals signed up in the program. However, the perceived or real problem of adjacent posted lands still was a deterrent to some farmers. They commented that deer left the farm when hunters arrived and returned when hunters departed.

Postal surveys have been widely used to estimate damage because they enable researchers to sample a large number of individuals at a relatively low cost. However, there are several disadvantages to using postal questionnaires. For example, accuracy and precision of survey results often are questioned because surveys are not conducted using statistically valid sampling methods, and non-response bias can cloud interpretation of results (Filion 1981, Fowler 1993).
Most wildlife damage surveys have had very high response rates (>70%) (Craven et al. 1992), attributed in part to the great personal interest respondents have in the topic. We do not think the low response rate in our survey reflected a low interest in the topic. A variety of factors have been shown to influence response rates (Heberlein and Baumgartner 1978). In our case, we think the low response rate resulted from (1) a mailing list that included many individuals who no longer farmed, (2) survey length or detail, and (3) using only 1 follow-up mailing. From phone calls to non-respondents, we found that 45% of the individuals who did not respond to either the first or second mailing no longer farmed. This result suggested that our actual return rate based on individuals who were actively farming was much higher than reported. Our survey was only 4 pages long, but we asked a number of very specific questions about amount of damage and species causing damage. The length of time needed or the inability of farmers to accurately answer these questions may have dissuaded some individuals from completing the questionnaire. Finally, we had only 1 follow-up mailing. Repeated mailings have been shown to increase response rates (Heberlein and Baumgartner 1978).

Differences between the first and second mailings can be used to speculate about the expected responses from individuals who did not respond to either mailing (Fowler 1993). In general, respondents to the second mailing perceived damage to be less of a problem than those who had responded initially. They also were much less likely to have changed farming practices as a result of deer damage. Fowler (1993) reported people who have a particular interest in the subject matter or the research itself are more likely to return mail questionnaires than those with less interest. Mail surveys with low

response rates may be biased in ways that are directly related to the purpose of the research (Donald 1960, Fillion 1975). Consequently, we speculate that individuals who did not respond to either mailing probably perceived damage to be less of a problem than those who took the time to respond. If true, these 1994 estimates of the amount of damage and the effect of wildlife on causing farmers to change farming practices may be overestimated.

Other concerns with surveys include the ability of respondents to accurately identify individual species causing the damage or to correctly estimate the dollar amount of wildlife-related losses (Flyger and Thoerig 1962, Wakeley and Mitchell 1981, Gabrey et al. 1993). As part of a larger study (Tzilkowski et al. 1997), we compared wildlife damage estimates to corn as reported by farmers to our questionnaire with on-the-ground (field) estimates. Although there was a low correlation between farmer and field estimates, there was no pattern of bias, and overall estimates reported by farmers did not differ significantly from field estimates. Wywialowski (1994) concluded producer-derived estimates of wildlife-caused losses often were conservative, and she believed that producers offered useful predictions of wildlife-cause corn losses.

In summary, our results documented the widespread and ubiquitous nature of wildlife damage to crops across Pennsylvania and identified the white-tailed deer as the primary cause of that damage. As long as there is wildlife, there will be some level of damage. The question is how much are farmers willing and able to tolerate. High numbers of farmers ranking damage levels as moderate to very little suggest that many have already accepted current levels of damage. However, survey results also identified the perceived inadequacy of most control measures currently available to farmers and the problem of posted land adjacent to farmland. These issues will need to be addressed by management agencies in the future.

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Table 1. Area (ha) of crops grown during the 1994 growing season and estimated levels of crop loss (%) to wildlife as reported by Pennsylvania farmers (n=1,003) responding to a questionnaire mailed April (mailing 1) and August (mailing 2) 1995.

| | Area (ha) | | | Loss (%) | | |
|---|---|---|---|---|---|---|
| Crop | *n*[a] | $\bar{x}$ | SE | *n*[b] | $\bar{x}$ | SE |
| Alfalfa | 529 | 25.45 | 1.14 | 511 | 9.35 | 0.50 |
| Corn grain | 591 | 35.74 | 2.40 | 575 | 9.90 | 0.54 |
| Corn silage | 386 | 17.68 | 0.99 | 384 | 7.53 | 0.53 |
| Oats | 289 | 11.54 | 0.85 | 273 | 7.27 | 0.68 |
| Other forage | 211 | 23.64 | 1.73 | 200 | 6.10 | 0.50 |
| Soybeans | 210 | 35.48 | 3.54 | 199 | 8.78 | 0.62 |
| Wheat | 198 | 19.28 | 2.29 | 184 | 5.85 | 0.94 |

[a] ***n*** = number of respondents who grew a particular crop.
[b] ***n*** = number of respondents who estimated loss

Table 2. Approximate economic value (x 1,000 dollars) of damage to 6 crops by wildlife based on combined responses of Pennsylvania farmers (*n* = 1,003) to a questionnaire mailed April (mailing 1) and August (mailing 2) 1995.

| Crop | 1994 value[a] | loss (%) | Potential value[b] | Estimated value of loss[c] |
|---|---|---|---|---|
| Corn grain | 302,820 | 9.90 | 332,799 | 29,979 |
| Alfalfa | 273,600 | 9.35 | 299,182 | 25,582 |
| Soybeans | 69,757 | 8.78 | 75,882 | 6,125 |
| Corn silage | 137,700 | 7.53 | 148,069 | 10,369 |
| Oats | 12,720 | 7.27 | 13,645 | 925 |
| Wheat | 26,136 | 5.85 | 27,665 | 1,529 |
| Total | 822,733 | | 897,242 | 74,509 |

[a] Anon. 1995
[b] Potential value = 1994 value x (1 + (% loss ÷ 100))
[c] Estimated value of loss = Potential value - 1994 value

# DEER DAMAGE INCURRED BY HOMEOWNERS DURING 1995 IN VIRGINIA

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Abstract: Damage caused by white-tailed deer (*Odocoileus virginianus*) is a problem for some homeowners in Virginia. As part of a broaders effort to evaluate the attitudes and perceptions of agricultural producers and homeowners toward deer damage in Virginia, a mail questionnaire was developed and implemented during the fall of 1996. The survey yielded 732 useable responses and, of those, 261 individuals indicated they were homeowners and grew at least one planting during 1995. Many homeowners (36%) indicated that deer caused damage to at least one of their plantings during 1995. Of those who had experienced damage, most (61%, n=57) indicated that deer damage had been moderate to severe. A significant linear relationship was found between the reported damage severity and the reported percentage of plants that were affected by deer. A majority (57%) of those that incurred deer damage believed that damage was higher in 1995 than in the previous 5-year period. Damage occurred most often during the later spring and early summer. Many homeowners (n=119) indicated a willingness to pay for damage prevention, yet fewer (n=71) actually used preventive measures during 1995. Overall, the most often used form of prevention was the use of repellents, followed by fencing. Most respondents (64%) wanted a decrease in the deer population and a significant relationship was found between damage severity and a desire to reduce the deer population in Virginia.

Key Words: deer damage, homeowners, *Odocoileus virginianus*, prevention, survey, white-tailed deer

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# DEVELOPING URBAN DEER MANAGEMENT PLANS: THE NEED FOR PUBLIC EDUCATION

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Abstract: Independent public opinion surveys concerning urban deer (*Odocoileus virginianus*) management were conducted in two Virginia communities. A total of 346 citizens were interviewed in two Random Digit Dial telephone surveys. In addition to questions concerning management techniques and their administration, participants were asked about their experience with deer, their awareness of problems with deer in the area, and their enjoyment of deer. In both localities, non-lethal controls were preferred over lethal controls; trapping and relocation, fencing, repellents, and birth control measures were favored by a majority of residents. The only lethal control acceptable to residents in both communities was the use of controlled hunts. There was no consensus about who should administer deer management or who should be fiscally responsible. Those aware of deer problems are less likely to report enjoying having deer in the area. Preferences for non-lethal controls and lack of consensus on responsibility for deer management demonstrate the need for public education concerning the costs, consequences, and accountability for deer control. Survey results regarding citizens' preferences for various management practices demonstrate the challenges wildlife professionals face in assisting communities in developing deer management plans. Wildlife professionals saddled with managing human-wildlife conflicts need to recognize that part of their role is educating the public about the ecology of the animal(s), management techniques, and their implications. As experience with deer problem increases, citizens are likely to enjoy deer less and become increasingly interested in deer management.

Key Words: deer damage, *Odocoileus virginianus*, public education, urban deer, Virginia, white-tailed deer

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Public education has long been advocated as a means to achieve public acceptance of wildlife management practices. At the North American Wildlife Conference in 1953, Huber stated that "The key to successful wildlife management in any state lies in an informed and cooperative public" (Huber 1953: 631). In the discussion that followed his presentation, Saults commented (about the experience of the Game Department in Missouri): "…we originally started out so we could manage game; then we came to the idea that that was not quite so simple; that what we had to do was manage land; but basically the only thing we can manage is people…" (Huber 1953:637). Educational efforts focused specifically on white-tailed deer (*Odocoileus virginianus*) damage also span several decades. In Virginia, for example, an article dealing with deer damage appeared in the former Game Commission's *Virginia Wildlife* magazine over 30 years ago (Carpenter 1967).

As deer populations increase in the eastern United States, the nature of deer damage, the types of deer management, and the

public's role in wildlife management are becoming more complex. The phrase "deer damage" used to refer to agricultural crop losses, but now includes destruction of ornamental plants in suburban and urban areas, property damage (particularly to motor vehicles), and threats to human welfare, from both injury and disease. Deer have become nuisance animals in many locales, but wildlife agencies continue to treat them primarily as a game species. The growing prevalence of urban values is making hunting unacceptable as a management approach in many communities (Matthews 1992). Finally, public involvement in wildlife management involves diverse groups of stakeholders and increasingly has become political, especially where animal rights groups view deer as needing protection from hunting and other lethal population control methods (Girard et al. 1993, Curtis et al.1995, Decker and Richmond 1995).

Deer damage issues have been the focus of a number of public opinion surveys (Kuser and Applegate, 1985, Cornicelli et al. 1993, Stout et al. 1994, Green et al. 1997), many of which have been used to shape deer management plans as well as public education efforts. Curtis (1995) noted that wildlife managers can be leaders in public policy education, and emphasized the need for both decision-makers and their constituents to be aware of the costs, benefits, and outcomes of different deer management options.

Although wildlife managers increasingly have materials available for public education concerning urban deer management (e.g., the video "White-tails at the Crossroads" produced by the Northeast Deer Technical Committee [1996]; currently available from Committee Chair Steve Webber, New Hampshire Fish and Game, 2 Hazen Drive, Concord, NH 03301), we still need additional research concerning how deer population control methods vary in their acceptability to different stakeholder groups (Decker and Richmond 1995), and how attitudes and experience with deer interact to determine individuals' capacity for wildlife acceptance (Decker and Purdy 1988).

The purpose of our paper is to discuss the results of public opinion surveys in 2 Virginia communities and illustrate how such survey data can be used to identify what citizens need to know about deer management.

## STUDY AREAS

Chincoteague and Williamsburg are heavily developed residential and tourist communities in southeast Virginia. Chincoteague is a 1,500-ha coastal island, where developed areas are interspersed with loblolly pine (*Pinus taeda*), common reed (*Phragmites* spp.), high-tide bush (*Iva frutescens*), and other emergent vegetation characteristic of mid-Atlantic tidal salt marsh ecosystems. Williamsburg lies within the Virginia coastal plain and is comprised of the City of Williamsburg, as well as portions of James City and York Counties. It is a mosaic of undeveloped woodlands (mixed deciduous with loblolly pine), residential subdivisions (characterized by 1/8 to 5-ac lots), intensely developed commercial corridors, recreational open areas (e.g., golf courses), and tidal wetlands.

## METHODS

Census data and estimates from local officials were used to estimate the adult populations at approximately 30,000 for Williamsburg, VA, and 3000 for Chincoteague, VA. Target samples of 300 participants for Williamsburg and 100 for Chincoteague represented 1% of the population and 2% of households for Williamsburg and 3% of the population and 6% of households for Chincoteague. Computer-generated, random-digit tele-phone numbers were used to contact residents in both communities. In Williamsburg, interviewers were undergraduate student volunteers from

the College of William and Mary, whereas, in Chincoteague, interviewers were town employees being paid overtime. Both sets of interviewers received brief training sessions. Each interview included a series of questions about the participant's experience with local deer and opinions about deer management. Each interview took about 5-10 minutes to complete. All interviews were conducted during weekday-evening calling sessions during October and November 1995 in Williamsburg, and October 1996 in Chincoteague. Data were tabulated using a simple database and spreadsheet in Microsoft Works.

## RESULTS AND DISCUSSION

A total of 504 citizens were contacted by telephone during the 2 surveys. In Williamsburg, 302 citizens were reached; in Chincoteague, 102. Eighty-one percent (n=244) of those contacted in Williamsburg agreed to participate, and 79% (n=237) completed all questions. In Chincoteague, 86% (n=88) agreed to the interview and 85% (n=87) completed it. Because these response rates were high, even for telephone surveys (Frey 1989), we were unconcerned about non-response bias. In both communities, 55% of the participants were identified as female. In Williamsburg, 41% of the participants were male and the interviewers did not classify the remaining 4% of respondents. Males made up 43% of the Chincoteague sample; the interviewers did not identify the sex of the remaining 2%. Participants provided information on whether they had hunting experience (Table 1).

### Experience with Deer

In both communities, majorities of those surveyed had seen deer and were aware of deer problems (Table 2). Enjoyment of deer also was high (Table 3). Chi-square analyses revealed that those aware of deer problems wee less likely to report enjoying deer in both Williamsburg and Chincoteague ($X^2$=6.15, 2 df, $p$<0.05, and $X^2$=4.81, 1 df, $p$<0.05, respectively).

### Management Preferences

Despite differences between the 2 communities surveyed, preferences for non-lethal management techniques were very similar (Table 4). In both Williamsburg and Chincoteague, a majority of residents heavily favored trapping and relocation, as well as the use of fencing, repellents, and birth control; controlled hunts were only widely accepted lethal control. Extending the hunting season marginally was acceptable to most participants in both surveys, as was extending the doe season to those in Chincoteague. The remaining techniques offered for participants to consider were not acceptable to most residents; doing nothing, requiring hunters to kill a doe before they killed a buck, and reintroducing predators were the least favored methods in both communities.

Experience with hunting affects management preferences (Table 5). Because non-hunters made up the majority of those interviewed in both study areas, they mirror expressed community preferences to a large extent. Those with anti-hunting views also favored trapping and relocation, use of fencing, repellents, and birth control, but not controlled hunts. Instead, providing food for deer was preferred. A majority of hunters in both Williamsburg and Chincoteague favored extending the general hunting season, use of controlled hunts, and extending the doe season, but did not support the use of fencing and repellents. In Williamsburg, hunters also favored trapping and relocation. Not surprisingly, Chincoteague hunters were the only subgroup in that community who favored modifying the existing ordinance that prohibits hunting. The group of former hunters in Chincoteague favored methods endorsed by both non-hunters and hunters in their community, as well being the only subgroup in either community to favor trapping and euthanizing.

Responsibility for Deer Management

There was little consensus about who was responsible for deer management or who should pay for it. In both Williamsburg and Chincoteague, many respondents acknowledged that they did not know who was responsible for managing deer (31.5% and 39.1%, respectively) and few (25.3% and 9.2%, respectively) identified the Virginia Department of Game and Inland Fisheries as the responsible agency. When asked who should pay for management, some (9.3% in Wil-liamsburg, 27.6% in Chincoteague) cited local government, but a substantial number did not know (17.4% in Williamsburg; 17.2% in Chincoteague).

## CONCLUSIONS

Survey results from these 2 communities confirm that experiences with deer do affect attitudes, where those aware of deer problems enjoy deer less. Preferences for non-lethal controls and lack of consensus on responsibility for deer management demonstrate the need for public education concerning the costs, consequences, and accountability for deer control.

## WILDLIFE MANAGERS' ROLE IN PUBLIC EDUCATION

Although some researchers (e.g., Curtis 1995) see public policy education concerning deer management as an opportunity for wildlife managers, the issue of advocacy of specific management practices by agency personnel in urban deer situations remains controversial. Nearly everyone agrees that urban deer situations have complex human dimensions. In discussing the politics of wildlife damage management, Schmidt (1995:12) stated that "Wildlife policies are what the public allows the biologists to do in the public's name. Whenever science conflicts with political and social concerns, science always loses." We see public education as the mechanism through which science can have a greater impact on policy.

McMullin (1996) describes a prescriptive framework for resource managers to use in involving the public in decision-making. Such a framework, combined with specific information about what the public does and does not know about the issues, provides managers with a blueprint for public education.

Education Concerning Non-Lethal Management Techniques

The overwhelming popularity of trapping and relocation in both communities is an obvious target for public education. Informing citizens of the absence of release sites, high cost, low efficiency, and high mortality rates associated with trap and transfer (Jones and Witham 1990; Ismael et al. 1993) hopefully will reduce the attractiveness of this method. Current limitations and reservations about the use of birth control as a management technique provide another opportunity for education. Citizens do not understand the cost, difficulty of application, or the physiological effects of this management technique. In addition, the political aspects of this approach, particularly the absence of FDA approval for any of the current reproductive inhibitors, must be addressed (Kirkpatrick 1996, Warren and White 1995).

The consequences of feeding deer are another important issue for educational efforts, especially with anti-hunting constituencies. Communicating that feed-ing deer not only fosters dependency on humans, and artificially inflates the biological carrying capacity, but also contributes to further deterioration of the habitat. These facts should help resi-dents realize the long-term effects their actions may have on the environment.

Fencing often is prescribed as a management option in moderate deer density areas where deer prefer highly palatable yard ornamentals to native browse. Hunters may need to learn more about the potential benefits of fencing and

repellents. The aesthetic drawbacks of fencing sufficiently tall to deter deer and costs associated with installing fencing both can limit the use of this technique. Wildlife managers also must educate the general public that fencing alone will not solve deer population problems.

Need for Lethal Controls

Lethal controls currently are the most effective methods to reduce populations of urban white-tailed deer. Cost benefits, as well as physiological and biological considerations, make killing deer preferable to trapping and relocation and birth control. In addition to educating the general public about the efficacy of lethal controls, wildlife managers need to stress to hunters, in particular, the correct implementation of such methods. The inverse relationship between extending deer seasons and hunter effort, as well as the lingering negativity among some hunters about killing doe deer, are issues that need to be addressed.

## FUTURE RESEARCH

The need for public education concerning deer ecology, management techniques, and their implications is demonstrated by public opinions revealed in 2 Virginia communities. Further research is needed to demonstrate the effectiveness of such educational efforts as well as the costs and benefits of involving wildlife managers in public education. Much of the information the public receives concerning wildlife damage management comes from wildlife rehabilitators (Siemer et al. 1992), the media, and animal rights groups. As urban deer problems become increasingly politicized, the necessity of a marketing approach (Wright et al. 1991) to wildlife management will increase. As experience with deer problem increases, citizens enjoy deer less and become more interested in deer management. Wildlife managers committed to public education need to integrate the science of wildlife damage management with wildlife policy more effectively to build public support and ensure that white-tailed deer remain an asset in urban settings.

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Table 1. Respondents' experience with hunting.

| | Williamsburg | Chincoteague |
|---|---|---|
| Hunter | 13.6% | 11.5% |
| Former hunter | 1.7% | 19.5 % |
| Non-hunter | 60.6% | 56.3% |
| Anti-hunter | 13.6% | 10.3% |
| Animal rights | 6.8% | 1.1% |
| Other | 3.8% | 1.1% |

Table 2. Respondents' stated prior experience with deer.

| | Williamsburg | | Chincoteague | |
|---|---|---|---|---|
| | Yes | No | Yes | No |
| Seen a deer in the past year? | 81% | 19% | 95.5% | 4.5% |
| Aware of deer problems? | 50% | 50% | 69.3% | 39.7% |

Table 3. Respondents' stated enjoyment of deer.

| | Williamsburg | | | Chincoteague | | |
|---|---|---|---|---|---|---|
| | Yes | No | Other | Yes | No | Other |
| Enjoy deer? | 75% | 12.7% | 12.3% | 69.3% | 29.5% | 1.1% |

Table 4. Management techniques favored by respondents.

| | Williamsburg | Chincoteague |
|---|---|---|
| Trap and Relocate | 78% | 77% |
| Fencing/Repellents | 65% | 58% |
| Controlled Hunting | 56% | 59% |
| Birth Control | 53% | 68% |
| Extend Hunting Season | 50% | 52% |
| Feed Deer | 43% | 39% |
| Extend Doe Season | 40% | 51% |
| Sharpshooters | 37% | 38% |
| Trap and Euthanize | 27% | 47% |
| Do Nothing | 21% | 17% |
| Kill Doe First | 16% | 31% |
| Introduce Predators | 14% | 16% |

Table 5. Management preferences of respondents, characterized by stated hunting experience.

| | Non-Hunters | Non-Hunters | Anti-Hunters | Anti-Hunters | Hunters | Hunters | Animal Rights | Animal Rights | Former Hunters |
|---|---|---|---|---|---|---|---|---|---|
| Method | Williamsburg | Chincoteague | Williamsburg | Chincoteague | Williamsburg | Chincoteague | Williamsburg | Chincoteague | Chincoteague |
| Trap/Relocate | 78% | 82% | 88% | 89% | 66% | 40% | 94% | 100% | 76% |
| Birth Control | 56% | 78% | 60% | 78% | 28% | 50% | 75% | 0% | 47% |
| Controlled Hunt | 58% | 61% | 34% | 0% | 81% | 80% | 44% | 100% | 53% |
| Fencing/ Repellents | 65% | 57% | 81% | 72.5% | 44% | 40% | 75% | 100% | 62% |
| Sharpshooters | 38% | 51% | 34% | 11% | 31% | 20% | 31% | 0% | 35% |
| Trap/Euthanize | 37% | 49% | 34% | 33% | 41% | 40% | 13% | 0% | 53% |
| Extend Season | 52% | 49% | 16% | 44% | 96% | 70% | 25% | 0% | 59% |
| Extend Doe Season | 43% | 47% | 9% | 33% | 66% | 70% | 19% | 100% | 65% |
| Modify Law | NA | 37% | NA | 11% | NA | 60% | NA | 0% | 47% |
| Feed Deer | 33% | 33% | 72% | 56% | 31% | 50% | 81% | 0% | 41% |
| Kill Doe First | 12% | 31% | 13% | 11% | 25% | 40% | 19% | 0% | 41% |
| Do Nothing | 17% | 20% | 28% | 11% | 22% | 0% | 25% | 100% | 12% |
| Introduce Predators | 10% | 16% | 31% | 11% | 6% | 10% | 25% | 0% | 24% |

# THE USE OF GIS TO DELINEATE POTENTIAL URBAN DEER HABITAT

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Abstract: Overabundant deer herds in urban environments often require new and creative approaches to properly evaluate the situation and gain support for population management. To determine potential white-tailed deer (*Odocoileus virginianus*) habitat for the Harrisonburg, Virginia, Deer Task Force, a geographic information systems (GIS) map was created that reflected current land use in the city. Data were compiled using 2m resolution Digital Ortho Quarter Quads. Using this backdrop, land use zones were digitized on-screen. Wooded (13%), Agricultural (20%), and Open Areas (14%) land use types accounted for nearly half the city's land area and represent a conservative estimate of the amount of available potential deer habitat. Management implications are discussed.

Key Words: deer, GIS, habitat, *Odocoileus virginianus*, overabundance, urban, Virginia

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One of the greatest management challenges faced by wildlife professionals today is that of overabundant deer herds, especially in urban environments. This problem is unlike most other issues faced by wildlife agencies because it is based on social values rather than biological science. This presents serious challenges to the creativity, integrity, and social skills of agencies' professional staff (Doig 1995). So great is this challenge that the Summer 1997 issue of the *Wildlife Society Bulletin* was devoted to this topic (Warren 1997), as were the proceedings from 2 recent symposia on deer overabundance (McAninch 1995, McShea 1997). Deer exist throughout the U.S. and 42 state wildlife agencies have identified at least 195 urban populations (Conover 1995).

Throughout Virginia, deer density has increased dramatically in the last 20 years (Knox 1997), and many of the Commonwealth's cities likely have had deer populations present for 10-30 years. Most complaints associated with urban deer populations have arisen since the 1980s (Conover 1995). The deer population in Harrisonburg, Virginia, remained relatively unchanged until the city annexed land in 1984 and later (1987) enacted an ordinance that prohibited the discharge of weapons, thereby eliminating hunting from within city limits. Since that time, the deer herd has increased as evidenced by damage complaints and deer-vehicle collisions. A task force was appointed by City Council in May 1995 to assess concerns relative to deer in the City of Harrisonburg and to make recommendations to Council.

Current research needs relative to deer overabundance include efficient methods to estimate deer population size and forage abundance at specific landscape scales that range from habitat patches to deer home ranges (Healy et al. 1997). As a first step in this process, we used current geographic information systems (GIS) technology to create a map of land use in Harrisonburg and to estimate how much of the City could be classified as potential deer habitat.

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**STUDY AREA**

Located in Rockingham County, Virginia, Harrisonburg lies on the floor of the Shenandoah Valley and straddles the Interstate 81 corridor. Harrisonburg is a city of 30,000 people and encompasses approximately 45 $km^2$.

**METHODS**

In 1990, the Rockingham County USDA-NRCS office became 1 of only 5 counties in the US to receive high resolution, panchromatic digital ortho-quarter quads (DOQ). DOQs consist of scanned photography flown at an altitude of approximately 12,200 m. The scanned product is combined with a digital elevation model and ground points to rectify the image, which produces an accurate digitizing base that meets national map accuracy standards. This technology eventually will be available nationwide as the US Geological Survey completes flights of all US land areas. Since 1990, 5 additional counties, several cities, and 1 watershed have been completed in Virginia.

Students from James Madison University's Geography Department were trained and worked in cooperation with USDA-NRCS and Virginia Department of Game and Inland Fisheries (VDGIF) personnel to digitize the map from on-screen imagery. The imagery scale was 2 ground meters per pixel. Land use was classified into the following categories: Wooded, Agricultural, Open Areas (included parks, ball fields, schools), Residential A (adjacent to Wooded, Agricultural or Open Areas), Residential B (Urban), Water, and Dense Commercial. Once digitized, the map was reviewed for errors and all broken or unconnected lines were fixed. The image then was imported into GRASS MAPGEN, a map making utility, where fill patterns were selected and acreage values (%) were computed for all categories.

**RESULTS AND DISCUSSION**

The percentage of land area classified into each of the land use categories was as follows: Wooded Area (13%), Agricultural (20%), Open Areas (14%), Residential A (17%), Residential B (30%), Water (<1%), and Dense Commercial (6%) (Figure 1). To produce a conservative estimate of the amount of available deer habitat, we combined the Wooded, Agricultural and Open Areas categories, which accounted for 47% of the City's land area. We believe that >50% of the land area in Harrisonburg could be classified as deer habitat when Residential A lands are added. This becomes important given the fact that this type of potential deer habitat

is located throughout Harrisonburg. Therefore, any management activity being contemplated should be evaluated on a city-wide basis rather than on just a portion of the City. The map we produced also serves as a tool to predict where urban deer conflicts might be expected to occur in the future, based on current conflicts and the corresponding land use categories where they now exist.

## MANAGEMENT IMPLICATIONS

Land use maps derived from high resolution aerial photography represent an efficient means to delineate potential deer habitat in urban areas. These maps provide clues to where deer exist in an urban environment, thereby enhancing efforts to efficiently estimate population size and forage capabilities. Furthermore, they give the layperson, who often is involved in resolving urban deer conflicts, a visual image of the potential range of deer in a particular urban setting. When presented with such information on potential deer habitat and the range of available options to control urban deer, the Harrisonburg City Council ultimately approved a management program to control deer when damage occurs on agricultural lands within city limits.

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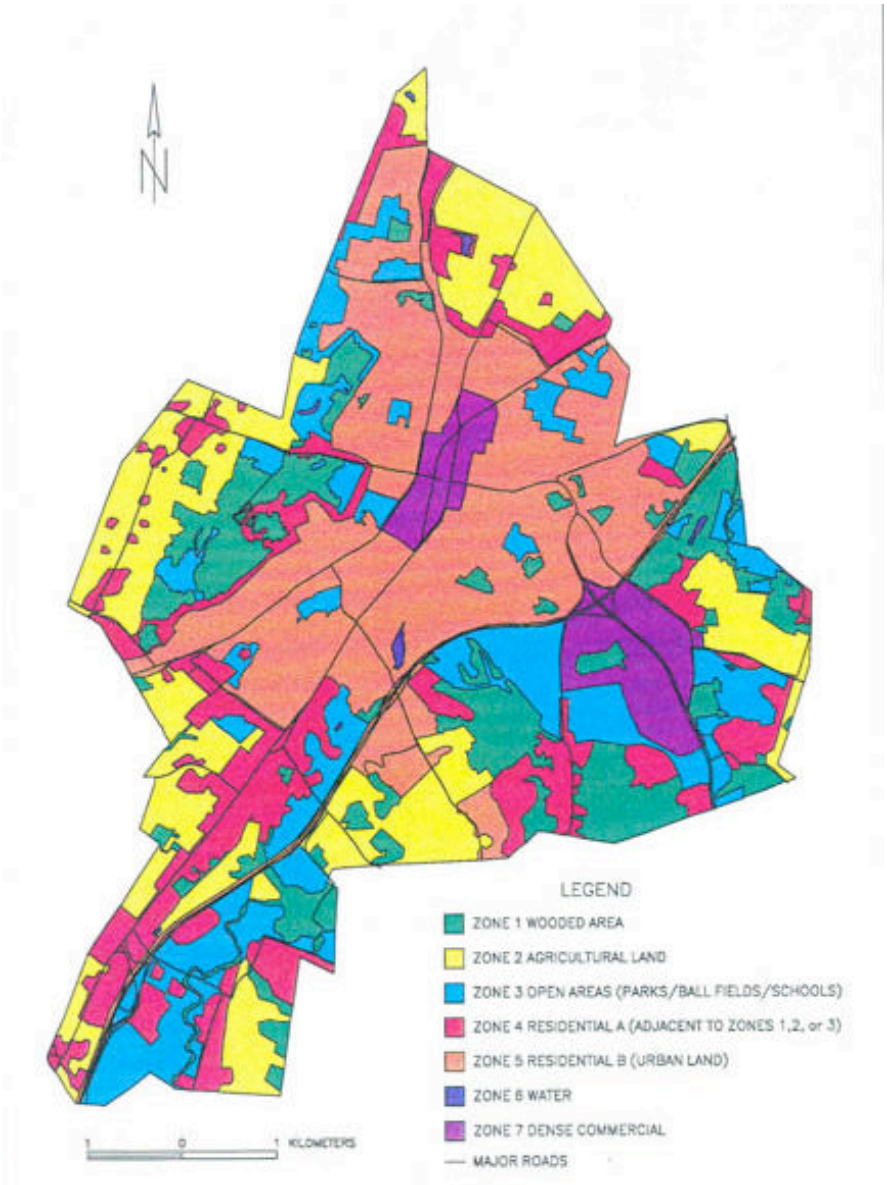


Figure 1. GIS map of land use used to estimate potential deer habitat for Harrisonburg, Virginia, created in August 1995 using 1990 Digital Ortho Quarter Quads. This map was produced at the Virginia Natural Resources Information Center-The USDA Natural Resources Conservation Service in Harrisonburg, VA. Zones were digitized on-screen with 1:12,000 Digital Ortho Photos (1990 flight). The digitizing was done by students in James Madison University's Department of Geography for the Virginia Department of Game and Inland Fisheries. County and city boundaries are "Tiger" 1:100,000 Vectors. UTM projection zone 17. A GRASS/MAPGEN interface was utilized with the production of this map on August 1, 1995.

# AN EVALUATION OF FARMER APPLICATIONS OF DEER DAMAGE CONTROLS

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Abstract: Damage to agricultural crops caused by white-tailed deer (*Odocoileus virginianus*) continues to be a significant concern of farmers in Michigan and elsewhere in the United States. Policy changes that promise to reduce deer numbers may be long in coming, but better application of available damage control techniques may be an immediate alternative for farmers awaiting relief. Conversations with farmers, extension agents, and wildlife professionals suggest that some damage control techniques are underutilized by Michigan farmers, whereas other techniques are applied with little success despite promising field trials. We investigated producers' practices to identify common weaknesses in how deer damage controls were being applied so that Michigan Department of Natural Resources and Cooperative Extension personnel could develop programs to improve the effectiveness of these applications. In January 1997, a 6-page questionnaire was mailed to 250 agricultural producers who indicated that they used some form of deer damage control to protect their crops. Producers were queried about specific methods employed, intensity and frequency of applications, fence maintenance, hunting and shooting techniques, deer harvest ratios, integration of techniques, and the perceived effectiveness of controls and/or combinations of techniques. Recreational hunting, shooting permits, and block permits were the control methods used most frequently by respondents. Although 84% of respondents expressed a desire to reduce the deer herd in the vicinity of their farm, most were not contributing effectively to achieving such a reduction through their own hunter management and deer harvest. Results suggest that educational and management opportunities do exist to encourage producers to more systematically apply and integrate available deer damage controls in Michigan.

Key Words: agricultural crop damage, deer damage controls, efficacy, *Odocoileus virginianus*, survey, white-tailed deer

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## BACKGROUND

Damage to agricultural crops caused by white-tailed deer has received a great deal of attention among farmers, deer hunters, university researchers, and Cooperative Extension and Department of Natural Resources (MDNR) personnel in Michigan (Dudderar et al. 1989, Nelson and Yuan 1991, Nelson and Schomaker 1996, Fritzell et al. 1997). These studies document attitudes and beliefs of stakeholders about crop damage, trends in depredation permit use, stakeholder perceptions of deer numbers, and the effectiveness of block permits. These studies also suggest that farmers may not be using deer controls available to them, may not recognize that such controls are available to them, or may not be implementing controls effectively. Although MDNR managers attempt to limit conflicts between farmers and deer through liberalized deer hunting seasons

and increased availability of antlerless licenses in deer management units (DMUs) where deer numbers are above desirable herd densities, farmers want the agency to do more without regard to the limitations of the agency. In January 1997, the Michigan Farm Bureau threatened to file suit against MDNR to recover costs lost to deer if the agency did not reduce the state's deer population to MDNR's stated goal of 1.3 million deer within three years.

The adjustments agencies often make to deer harvest, such as extended seasons and extra antlerless tags, may not reduce herds or crop depredation problems in all areas in a timely fashion (Hauge 1997). For instance, the preference hunters display for taking antlered male deer (Maedke and Anderson 1994, Fritzell 1998) or the increasing number of areas closed to hunting (Fritzell 1998) may create areas of high deer density that can not be reduced solely with extended seasons or additional tags. Thus, farmers may find that the burden of controlling crop depredation caused by deer rests, in a large part, on them, especially where these "refuges" for deer exist adjacent to their properties. For these reasons, farmers must make effective use of available damage control techniques and not wait for some hoped for change.

Research has shown that producers do not always exercise effective deer damage control. Horton and Craven (1997) found that producers often do not use shooting permits effectively because of taboos against shooting pregnant does or does with dependent fawns. They also indicated that many farmers in Wisconsin did not recognize recreational hunting as a damage control tool. Beringer et al. (1994) believed that a landowner's initiative often determined the ultimate effectiveness of the control techniques used. In Michigan, wildlife professionals and extension agents both agreed that farmers could do much more to reduce crop losses to deer. Unfortunately, little is known about what producers currently are doing to control deer depredation, how they are doing it, and what damage control needs they have.

Our study was conducted to determine what knowledge and information the Michigan State University Cooperative Extension (MSUCE) and the MDNR might be able to offer to farmers to better control losses and effectively reduce deer numbers.

## OBJECTIVES

The objectives of our study were to 1) determine to what extent farmers in Michigan employed effective damage control strategies to minimize deer damage to crops, and 2) identify informational needs that MSUCE and MDNR could fulfill to help farmers improve applications of deer damage controls.

## METHODS

Survey Construction Assumptions

Because we wanted to determine if farmers were implementing "effective" deer damage control, our initial task was to evaluate the "probable effectiveness" of producers' applications. To do this, we devised a survey instrument that would generate quantifiable information about producers' applications of deer damage controls. In constructing the survey, we assumed that standard wildlife damage management principles hold for deer and that the efficacy of techniques documented in the literature were valid. Based on these assumptions, we then attempted to evaluate "probable effectiveness" of farmers' applications of deer damage controls using the following criteria: selection of appropriate control techniques, use and integration of a variety of techniques, rigorous application, monitoring and evaluation, and adaptability. This paper presents our findings on the variety of control techniques employed by farmers and the rigor with which they applied them.

Sample Frame

Farmers who responded to an earlier survey (Fritzell 1997), who had implemented some form of damage control, and who indicated that they would be willing to respond to another survey regarding their application of controls formed our initial survey pool. Additional participants were recruited while visiting a booth operated by the primary author at an agricultural exposition held at Michigan State University during the summer of 1996. Prospective participants also were identified through referrals from other farmers. Each participant's willingness to participate in this study was confirmed by their written response to a letter and postage-paid postcard sent to them asking them about their desire to participate. In all, 252 individuals agreed to participate.

Our sample of producers adequately represented the 7 counties involved in our earlier survey (Fritzell 1997), but we recruited additional producers from 3 other counties. Deer density estimates varied tremendously among counties (from 15 to 60 deer per square mile in 1996) (pers. commun. MDNR personnel), but all participants believed that some form of deer damage control was needed regardless of the estimated number of deer in their county.

Survey Protocol

All participants received by first-class mail a cover letter, a 6-page questionnaire, and a postage-paid return envelope in January 1997. Approx-imately 3-4 weeks after the initial mailing, we sent a reminder letter to non-respondents encouraging their partici-pation. No further mailings or requests were made and no non-response follow-up was conducted.

## RESULTS AND DISCUSSION

Although all participants had agreed to participate, only 178 usable returns were received from the 252 individuals originally sent a questionnaire (a 70.6% response rate). Some producers apparently changed their mind, were out of town, or were too busy. The resulting sample was composed primarily of dairymen, cattlemen, fruit and vegetable growers, and cash grain operators.

Because of the nature of our sampling frame, our results should not be interpreted as being representative of all farmers in Michigan nor all farmers in the counties we studied. We believe the sample may be biased toward individuals who already use more rigorous controls, but we made no effort to document such a bias. Regardless, our data do suggest a need for improvement in application by producers and further assistance from wildlife agencies and Cooperative Extension.

Estimated Annual Losses and Costs of Control

To understand producers' needs relative to crop damage caused by deer, we asked producers to estimate their annual loss attributed to deer by providing us a range of dollar values from "at least ___" to "no more than ___." Responses varied tremendously, but they clearly indicated that farmers perceived these losses to be costly enough to warrant control (Table 1). We also asked respondents to estimate what they typically invested in deer damage control, on an annual basis, for both equipment outlays and labor costs. Producers who used deer damage control reported spending an average of $1,267 on control equipment and 87 hours of paid labor to reduce their losses. Based on these figures, it appears that MDNR and MSUCE would be justified to evaluate the cost-effectiveness of the methods producers were using and to provide additional information on effective methods to producers (Table 1). For example, these agencies could help producers select appropriate control techniques and encourage them to use a diversity of control methods.

Types of Deer Damage Control Applied by Respondents

Respondents used a diversity of deer

damage controls, ranging from fences to lethal controls (Table 2). Based on our past experience and a review of the literature, the techniques they selected should provide some benefit. The majority of respondents reported using recreational hunting as a primary means of control. A large number of fruit growers in our sample also reported using repellents together with out-of-season shooting permits.

Evaluation of Selected Control Applications

*Fencing*—In this category, use of a variety of fencing techniques was reported by producers. For example, among producers who reported using fences, half of the respondents used electric fences, whereas half used only non-electric fences. Although different heights and construction designs complicated our evaluations, we used the frequency with which producers reported conducting an inspection of the condition and maintenance of their fences as an index. The frequency of fence inspections varied from once per day to once every 2-4 weeks for electric fences and once per month to once per year for non-electric fences. Among those who used non-electric fences, 46% inspected their fences once per month, whereas 30% inspected fences less than once every 3 months. Among those who used electric fences, 25% inspected their fences at least once every 3 days, whereas 25% inspected fences less than once per week. Although less frequent inspections of electric fences designed to keep horses and/or cattle within a pasture may be adequate, our research indicates that more frequent inspections are necessary to monitor the charge on fences designed to keep deer away from edible crops, especially when storms, wind, snow, or general plant growth threaten to short the electrical system. Thus, 25% of respondents were not inspecting their fences adequately and inadvertently may be giving deer opportunity to breech these barriers and increase the amount of browsing damage observed within fenced areas.

*Harassment*—No single harassment technique was used widely by respondents, but they reported using a variety of techniques and demonstrated distinct personal preferences (Table 3). In fact, producers apparently rely almost exclusively on a single harassment technique and choose not to integrate active and passive harassment techniques, which typically would increase the effectiveness of their total program (Fig. 1). Effectiveness also could have been improved by assuring adequate coverage of fields with a suitable number of harassment devices and by relocating devices frequently to prevent habituation. Not all respondents appeared to understand harassment application procedures. Only 12 producers reported using propane exploders for deer harassment. Of these, 9 producers used <1 cannon per 10 acres and none used >2 cannons per 10 acres. Seven producers located the cannon(s) in the center of fields rather than at the perimeter or outside of the fields; only one producer relocated his cannon(s) more than once per week to prevent habituation. These results suggest that respondents were not aware that cannons should be placed within 90 meters of cover to effectively deter deer from their preferred browsing locations (Bender and Haufler 1987). The results also suggest that producers who chose exploders are not aware of the need to use 1 cannon per 5 acres and to daily relocate these devices, as recommended by the MSUCE.

*Out-of-Season Shooting Permits*—Respondents also relied on several available applications of out-of-season shooting permits, the permits that allow a producer to kill deer causing damage outside the normal hunting season. Interestingly, few producers use baited stands while shooting under such a permit, despite the recognized effect-tiveness it

displays during the regular fall hunting season and in urban deer reduction programs (Fig. 2). This especially was interesting given that these same producers indicated that baited stands were used frequently by hunters on their lands during fall hunting seasons (Fig. 3). We expected that they would consider using bait when shooting under permit, but this was not the case. Use of baited stands might be a good addition to any shooting permit program, especially where local herd reduction is the ultimate goal.

*Recreational Hunting*— In 1997, a majority of respondents (86%) believed that the size of the deer herd needed to be reduced in their area if crop losses were to be controlled. We believe this sentiment was based on their assumption that fewer deer will result in less crop loss, but this may not be true in all cases (Braun 1996). The key questions we wished to answer were whether the 86% of respondents who believed the herd needed to be reduced acted in ways consistent with their belief in 1996, and did they effectively achieve a level of harvest sufficient to reduce that deer herd? One way to look at this would be to determine whether respondents maximized their probability of killing deer by utilizing all available days to hunt deer. Although pulse hunting (i.e., periodic rest days and hunt days) may produce higher harvests than those where people are in the field day in day out, we believe the probability of killing a deer is directly related to whether anyone is out attempting to kill a deer on any particular day.

Respondents reported that their farms were hunted, on average, 54% of the 93 days that encompass Michigan's deer seasons, or approximately 3.8 days per week. This means that farms were being hunted more than just on weekends, but we also believe there were times when there were few or no hunters in the field. Based on the numbers of hunters reported for each season, some farms were hunted most intensely during the general firearms season (Fig. 4). Several farms had no hunters during muzzleloader and late bow seasons, which indicates that additional opportunities to harvest deer exist on those farms. In fact, only 49% of respondents had hunters active during all 4 seasons, whereas 18% had no hunters during at least 2 of 4 seasons.

Another measure of how rigorous a farmer used hunting as a control was the proportion of hunters who possessed antlerless tags and were allowed to hunt on farms. All hunters in Michigan get a buck tag, but antlerless tags must be obtained through a lottery. There are 2 types of tags: general, which can be used on all lands in a Deer Management Unit; and private lands landowner preference tags, which allow landowners and individuals invited by the landowner to receive a permit to shoot antlerless deer on private property. If a greater proportion of the hunters given access by a farmer to hunt on the farm had applied for an antlerless tag, we believe that indicates good hunter management on the part of the farmer and a sincere intention to focus the harvest on female deer. Farmers with "significant damage" also may request and purchase additional block permit tags to shoot additional antlerless deer. Block permits are large blocks of bonus antlerless tags sold directly to farmers with qualifying losses to help them reduce deer populations in localized areas during the regular deer hunting seasons.

One-half of respondents who desired a herd reduction had no knowledge of the proportion of hunters on their farm who had applied for a general antlerless tag. Similarly, one-third of respondents had no knowledge of how many hunters on their farm had applied for a landowner preferences tag despite the fact that a producer's tax identification number is required when applying for such a tag. Among respondents who were able to enumerate the proportion of hunters who

applied for a general antlerless tag, one-half indicated that only 50% of the hunters had done so. Among respondents reporting on the proportion of hunters who applied for a landowner preference tag, 60% indicated that <½ of the hunters had done so. Farmers should be communicating to hunters the need to shoot does and require them to apply for anterless tags. Our data suggests that producers are not placing this responsibility on these hunters.
Some hunters who received permission to hunt on a farm may not have applied for lottery tags believing the producer would receive block tags. It may be more effective and less costly for farmers to simply encourage hunters to purchase their own antlerless tags rather than purchasing block tags. More importantly, by requiring hunters who intend to hunt on a farm to apply for an antlerless tag, the farmer reinforces the message that antlerless deer need to be taken and makes hunters cognizant of the producer's problems and costs.

*Buck:Antlerless harvest ratios*—We also evaluated harvest effectiveness by looking at the number of antlerless deer and bucks reportedly shot on respondents' farms in 1996. Current deer density, buck/doe ratio, and productivity of females in an area can influence the harvest rate of antlerless deer; so will the behavior of hunters on lands adjacent to the farm. In Michigan, 25% of deer hunters personally will not shoot an antlerless deer (Fritzell 1998). In Wisconsin, 33% reportedly will not shoot an antlerless deer (Maedke and Anderson 1994). If a farmer truly intends to reduce the deer herd, then 1 to 2 antlerless deer must be harvested for each antlered buck taken; this number will be higher if hunters on neighboring properties do not shoot antlerless deer. Harvest data for 1996 obtained from respondents ($\bar{X}$ = 2.63 + 2.88 S.D. antlerless deer per buck taken) appear consistent with their attitude that the herd needed to be reduced. However, 19% of respondents did not keep track of or know the deer harvest from their farm. Just as accurate records are important to wildlife managers, they also should be to farmers who are trying to reduce deer numbers on their farms. This mean harvest rate (2.63 antlerless deer per buck taken) conceals the fact that >50% of respondents who stated a desire to reduce the herd reported a harvest rate below 2 antlerless deer per buck taken.

The majority of the harvest clearly occurred during the firearms season, followed by the muzzleloader season, and then the bow season. One possible explanation may be the heavy use of block permits during the firearms season (Fig. 5). We found that block permits have a substantial impact on the ability of producers to obtain a favorable harvest ratio. Producers who lack block permits have difficulty achieving a harvest rate >1 antlerless deer per buck killed. However, even among those producers who obtained block permits, 40% failed to achieve a harvest rate of >2 antlerless deer per buck taken in 1996 (Fig. 6). We suspect that not all block permits issued to a producer are filled by people hunting the farm. Block permits can be used during any of Michigan's deer seasons, but they are used primarily during the firearms season and often are reserved for family members. These permits might be better utilized if late season muzzleloader and archery hunters were encouraged to hunt on farms still possessing block permits and where producers were encouraged to allow greater access to non-acquaintances (Fig. 7).

## SUMMARY

We found that producers invest significant time and money in efforts to control deer damage and that these producers rely heavily on 1 or 2 damage control techniques. However, these efforts do not appear to be reducing losses adequately. Also, producers are not encouraging the hunters who hunt on their property to apply for antlerless tags or to take full

advantage of all hunting seasons. Producers are not monitoring the harvest of deer on their farm and are not shooting enough antlerless deer (aside from the block permit program) to achieve the desired reduction in local deer density.

## IMPLICATIONS

Our data suggest that agencies should help producers evaluate and improve the efficacy of their control efforts by (1) informing them of the errors commonly being made in implementation of controls, (2) reducing reliance on only one control technique, (3) identifying and eliminate practices that promote habituation of deer to harassment devices, and (4) encouraging more frequent and regular inspections of fences. Agencies should help producers better understand the implications of population dynamics, the need to harvest antlerless deer, and the necessity to keep accurate annual harvest records if they are to successfully achieve local herd reduction on their farm. Furthermore, agencies should identify producers who possess unfilled block permits so that interested late season muzzleloader and archery hunters can assist these producers fill these permits after the regular firearms season closes. Finally, our data suggests that participation in block permit programs may be needed if producers are to achieve the desired harvest ratios that will lead to local herd reduction in the area of their farm.

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Table 1. Respondent estimated annual costs of deer damage and estimated labor hours and equipment costs of deer damage control efforts on farm.

| | |
|---|---|
| Estimated minimum annual losses to deer per farm | Mean = $6,349 (s.d. = 12,107) |
| Estimated maximum annual losses to deer per farm | Mean = $14,773 (s.d. = 27,628) |
| Estimated annual deer damage control equipment expenses per farm | Mean = $1,267 (s.d. = 3,161) |
| Estimated annual deer damage control paid labor hours per farm | Mean = 87 hours (s.d. = 179) |

Table 2. Proportion of respondents who reported use of selected types of deer damage controls.

| | Proportion of respondents using control technique |
|---|---|
| Deer fences | 25% |
| Repellents | 64% |
| Cultural techniques | 40% |
| Harassment | 33% |
| Lethal Controls | 94% |
| Shooting Permits | 53%* |
| Recreational hunting | 99%* |

* Proportion of those using lethal controls

Table 3. Distribution of harassment techniques employed by respondents who attempted to control deer damage through use of harassment means.

| Active harassment | Proportion of respondents using the control |
|---|---|
| Non-lethal gunfire | 39% |
| Shellcrackers | 30% |
| Other active harassment means | 19% |
| **Passive harassment** | **Proportion of respondents using the control** |
| Propane exploders | 36% |
| Sirens | 6% |
| Scarecrows / human effigies | 34% |
| Other stationary devices | 12% |

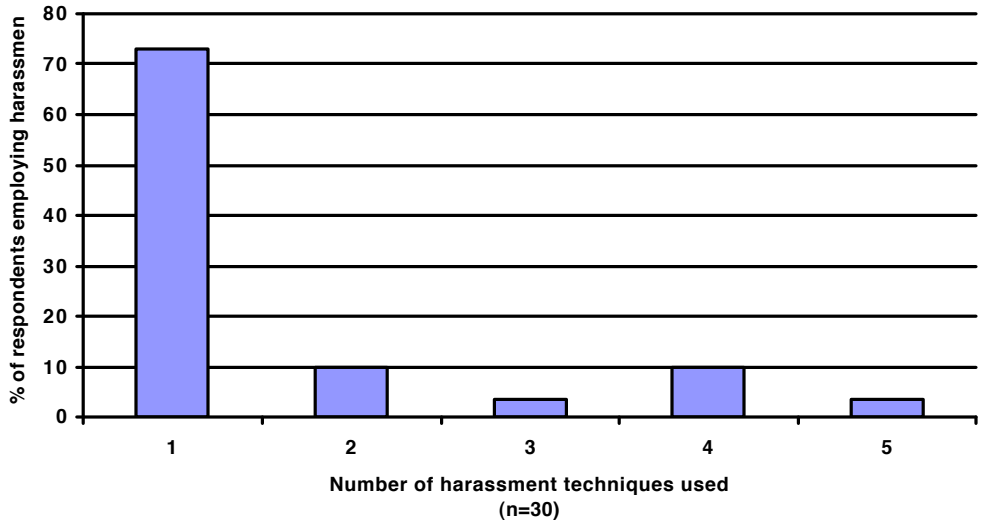


Figure 1. Proportion of respondents who employed harassment and the number harassment techniques used to haze deer in 1996.

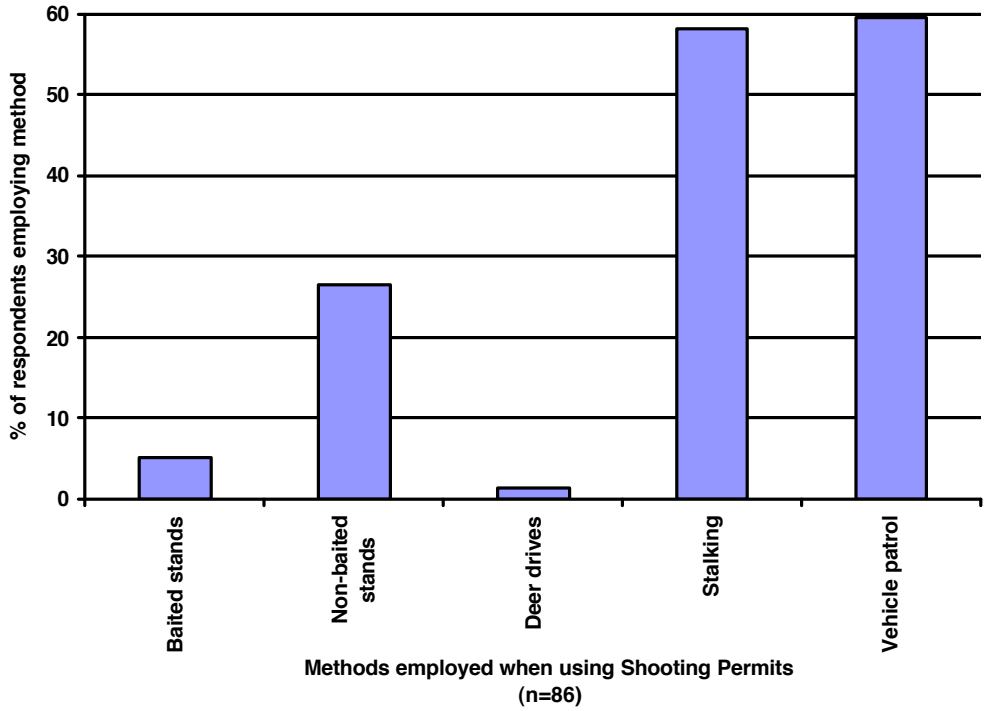


Figure 2. Proportion of respondents who used shooting permits and the specific methods employed when attempting to take deer under a shooting permit.

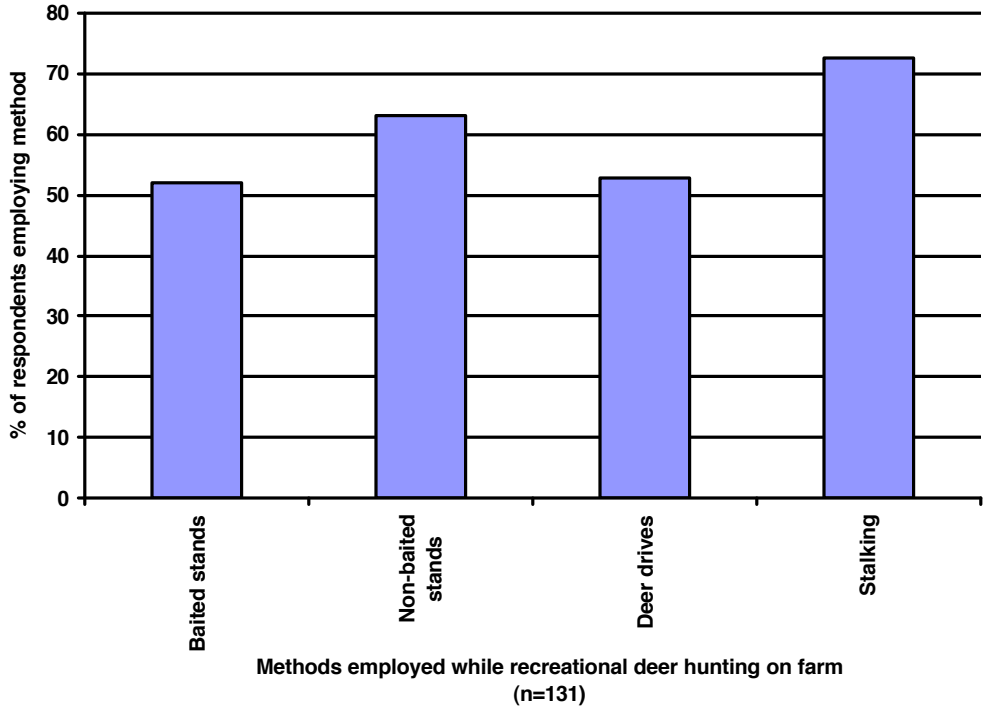


Figure 3. Proportion of respondents who allowed recreational deer hunting and the specific methods employed when attempting to take deer.

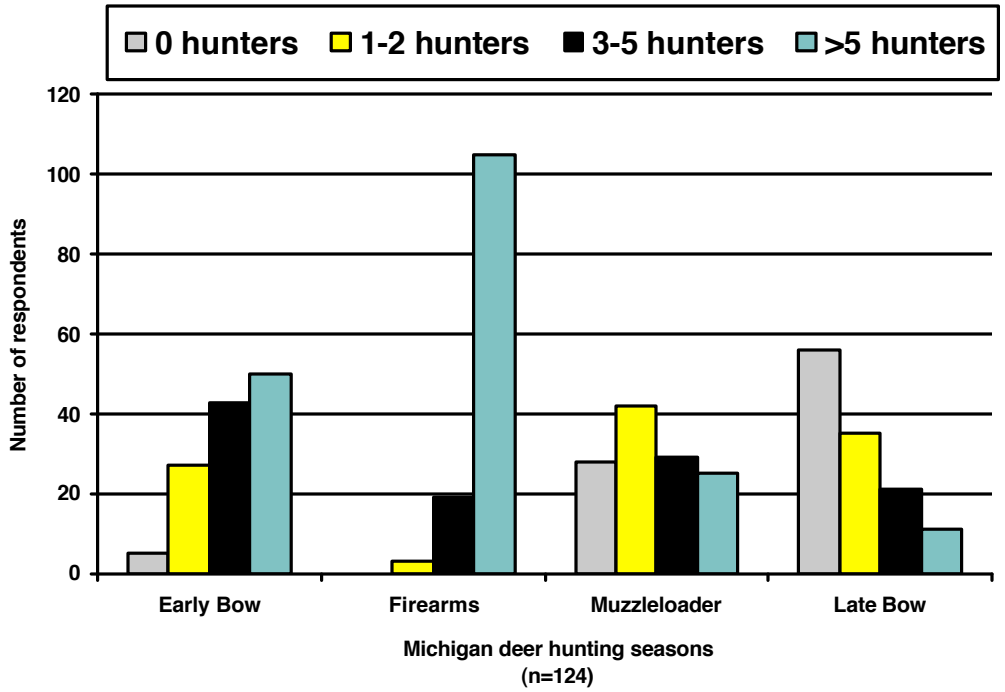


Figure 4. Number of deer hunters on the farm during Michigan's archery, firearms, muzzleloader, and late archery seasons, as reported by respondents who indicated that the deer herd needed to

be reduced in the vicinity of their farm in 1996.

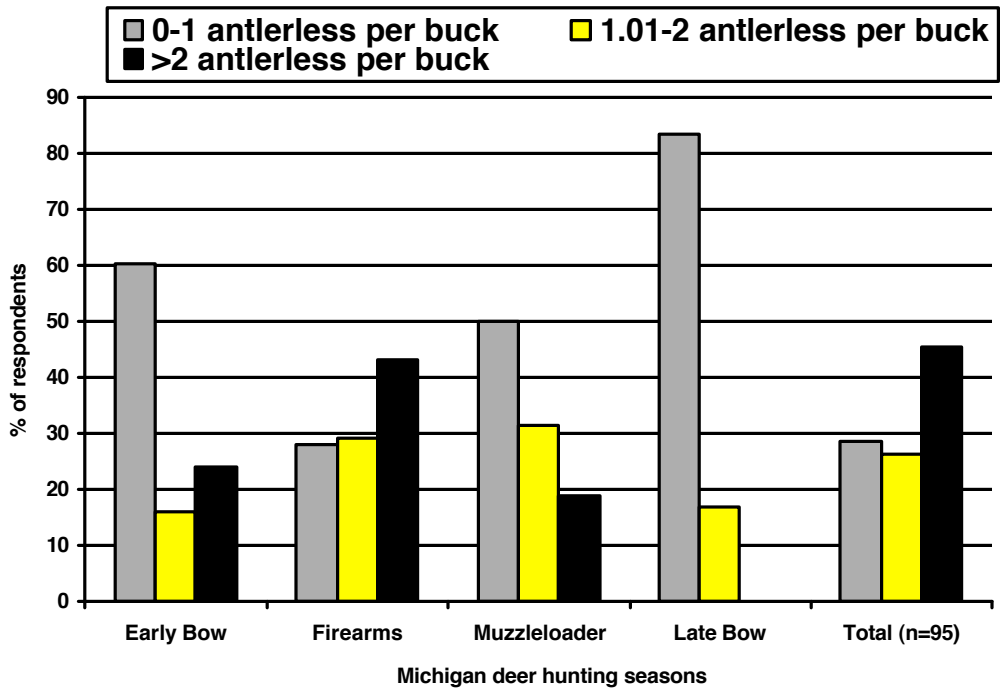


Figure 5. The number of antlerless deer harvested in relation to buck harvest on farms during the 1996 Michigan archery, firearms, muzzleloader, and late archery seasons, as reported by respondents who indicated that the deer herd needed to be reduced in the vicinity of their farm in 1996.

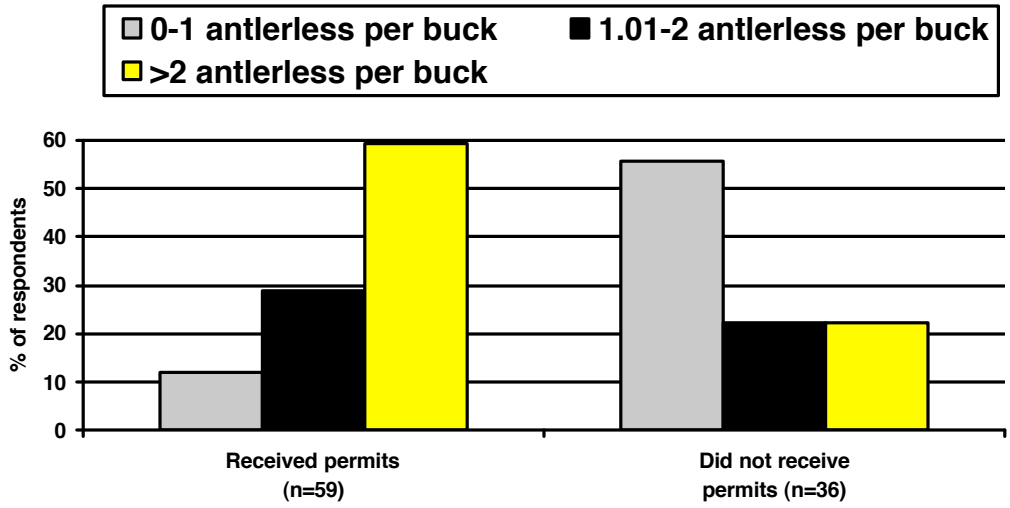


Figure 6. Effect of block permits on proportion of antlerless deer in the harvest (antlerless deer harvested per antlered buck taken), as reported by respondents who indicated that the deer herd

needed to be reduced in the vicinity of their farm in 1996.

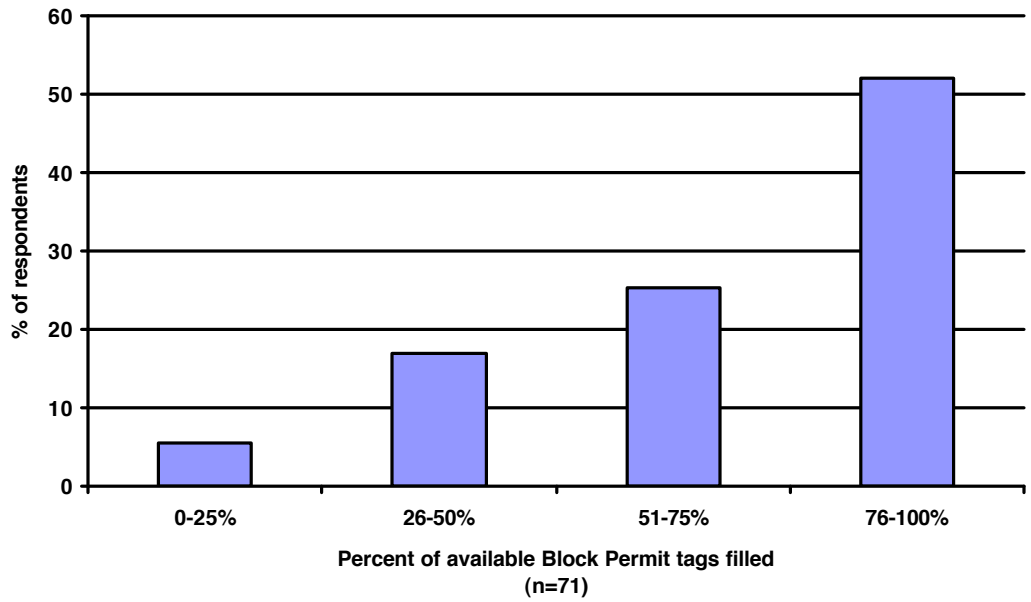


Figure 7. Percent of available block permit tags used by respondents who indicated that the deer herd needed to be reduced in the vicinity of their farm in 1996.

# CHARACTERISTICS OF GRAY SQUIRREL RELEASE SITES SELECTED BY KENTUCKY NUISANCE WILDLIFE CONTROL OPERATORS

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Abstract: A telephone survey of Kentucky nuisance wildlife control operators (NWCOs) ($n$ = 66) was conducted in April of 1997 to assess their knowledge and practices regarding nuisance gray squirrel (*Sciurus carolinensis*) release-site habitat. Thirty-three percent of NWCOs ($n$ = 22) trapped and relocated ≥1 nuisance gray squirrel in the previous year and these individuals/companies were selected for the survey. NWCOs trap and release >1,700 squirrels annually in Kentucky. Sampled release sites varied in size from 18 to 5,200 acres, and >70% were classified as poor to marginal habitat. Three of the release sites sampled provided adequate to optimum gray squirrel habitat. Actual release site habitat quality was in direct contrast to the opinions of NWCOs regarding suitable gray squirrel habitat. NWCOs' responses to questions concerning winter food, cover, and reproductive requirements indicated that they understood and were selecting suitable gray squirrel habitat components. Results of this survey indicate that thousands of squirrels are being translocated to both private and public land annually, with unknown consequences on survival and population demographics. Furthermore, although Kentucky NWCOs have an adequate understanding of the biological requirements of gray squirrel habitat, they are selecting unsuitable release sites.

Key words:, gray squirrel, Kentucky, nuisance wildlife, release sites, relocation, *Sciurus carolinensis*, translocation.

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The nuisance wildlife control industry has experienced rapid growth since the mid-1980s (Barnes 1995a, Barnes 1995b, Braband 1995, Curtis et al. 1995). Several factors have contributed to the expansion of this industry. Increased urbanization and growing urban wildlife populations have resulted in greater numbers of human-wildlife conflicts. Concomitant with this increase in human-wildlife conflicts and expansion of the nuisance wildlife control operator (NWCO) industry, biologists and managers have begun asking numerous questions regarding the humaneness and efficacy of moving large numbers of nuisance wildlife around the landscape.

Much variation exists among states' regulations concerning nuisance wildlife control operators. La Vine et al. (1996) found that 45.8% of U.S. states required private NWCOs to obtain a permit or license. Only 25 states required license/ permit prerequisites such as training courses, operator exams, education, experience, or agency review. Although 80% of the states have regulations regarding repellents, poisons/pesticides, and trapping (La Vine et al. 1996), translocation of nuisance wildlife largely is unregulated. Craven (1992) observed that 47 states allowed off-site release of nuisance wildlife. A more recent survey of state wildlife agencies showed that 90% of states allowed some translocation of nuisance wildlife (T.G. Barnes, unpublished data). In addition, no state guidelines exist outlining species-specific habitat requirements of release sites.

The lack of regulation and/or guidelines regarding nuisance wildlife translocations has important biological and policy implications. In a review of translocation studies, Griffith et al. (1989) found that translocation success was associated directly with release site location and habitat quality. In the absence of guidelines and/or regulations, release sites may be selected by NWCOs with limited wildlife management training (Barnes 1995a,b). Based on release site location, results of NWCOs' trans-locations could have positive, neutral, or negative effects on translocated animals and/or resident populations. Important questions regarding survival, movements, disease transmission, and impacts of translocated wildlife on population demographics of resident wildlife remain unanswered. The first step to resolve these issues is to quantify the numbers of wildlife being released and release-site habitat.

The objectives of this study were to characterize nuisance gray squirrel release sites, to assess knowledge of NWCOs in Kentucky on habitat requirements of gray squirrels, and to determine the suitability of those release sites for gray squirrels.

**METHODS**

We conducted a telephone survey in April 1997 of all NWCOs ($n$ = 66) permitted by the Kentucky Department of Fish and Wildlife Resources (KDFWR). Only NWCOs who trap and release nuisance gray squirrels were included for study. The survey instrument included 25 questions regarding NWCO company profiles, education, and gray squirrel habitat characteristics. At the termination of the questions, NWCOs were asked to provide specific locations of gray squirrel release sites.

After completion of the telephone survey, we visited every NWCO-provided release site ($n$ = 11) and measured habitat quality using Habitat Suitability Indices (HSI) (Allen 1987). At each release site, a transect was established on a randomly chosen compass bearing. At randomly selected distances from the starting point, 10 20- x 20-m plots were sampled. The

ocular tube method (James and Shugart 1970) was used to estimate total tree canopy and percent hard mast species in the canopy. Mean diameter breast height (dbh) of trees was calculated for all trees ≥80% of the height of the tallest tree in the plot (Allen 1987). HSI values were calculated using formulas presented by Allen (1987).

Education of NWCOs participating in the survey was classified as 1 = <high school, 2 = high school, 3 = high school +, 4 = associate's degree, 5 = bachelor's degree, 6 = >bachelor's degree. Release site characteristics were scored for each respondent. Association between perceived suitability of release sites and level of education for NWCOs was tested using the Kruskal-Wallis test and Kendall's measure of association (Ott 1992).

## RESULTS AND DISCUSSION

All 66 permittees were contacted (100% response rate) and 33% ($n$ = 22) had trapped and relocated ≥1 nuisance gray squirrel during the previous year. These companies/individuals then were asked the survey questions and all 22 (100% response rate) responded. The majority (90.9%) of NWCOs individually owned their nuisance wildlife operations; 2 were part of franchises. Most (63.6%) were not listed in the phone book and received the majority (59.1%) of their business through referrals. Typically, respondents (81.8%) employed <5 people, on a part-time basis (57.1%), which was similar to rates found in earlier surveys (Barnes 1995a,b). Eight of the 9 respondents who worked full-time lived in or near large cities, and all respondents who worked part-time lived in or near small towns or in rural areas. These results parallel those in other studies (Barnes 1995b, Curtis 1995), which suggest that metropolitan areas are more likely than rural areas to support full-time NWCOs.

Education of respondents and their employees varied from <high school to a Ph.D.; the majority (76.3%) had no formal education beyond high school. A previous study (Barnes 1995b) reported 52.2% of NWCOs had >high school education. Only 3 respondents had a degree in a wildlife-related field (i.e., zoology, biology, entomology). The majority (63.6%) of respondents had attended ≥1 wildlife damage short course/workshop, an increase from earlier reports (Barnes 1995a,b). Three respondents had attended a Fur Trappers College.

Kentucky NWCOs trapped and released an average of 1,786 nuisance gray squirrels/year; 34% of these animals were released on public lands. The size of perceived release sites ranged from 10 to 10,000 acres ($\bar{x}$ = 674.9, SE = 469.8). The majority (86.4%) of NWCOs stated that they chose release sites having large overstory trees and ≥50% canopy cover, and located a substantial distance from major roadways (68.2%) All respondents stated that they chose release sites having snags and/or cavities. In addition, 63.6% of respondents stated that ≥50% of the trees at the release sites produced hard mast. There were no differences ($P$ = 0.201) and no correlation ($r_k$ = 0.22) between education and perceived suitability of release-site habitat characteristics. Respondents also were asked to assess the importance of specific habitat characteristics to the quality of release sites. With the exception of presence of wildlife, all characteristics were valued as important to very important by respondents (Table 1).

Release sites sampled varied in size from 18 to 5,200 acres and were located in 5 counties on both private and public land, including 3 private farms, 4 city parks, 1 city cemetery, 2 nature/wildlife

sanctuaries, and 1 state park. HSI values varied from 0.00 to 0.89 ($\bar{x}$ = 0.40, SE = 0.08). Life requisite values, winter food index (SIWF), and cover/reproduction index (SICR) were used to calculate a habitat suitability index (HSI) for release sites (Allen 1987). SIWF includes the number of hard mast producing species and the proportion of total canopy cover that is composed of hard mast producing trees $\geq$25 cm dbh. Percent canopy cover and mean dbh of overstory trees are included in SICR (Allen 1987). Ten sampled sites provided adequate cover/reproductive requirements, whereas only 3 sites provided adequate winter food requirements, as indicated by the SICR and SIWF, respectively (Table 2).

The ecological and management implications of releasing large numbers of squirrels into poor or marginal habitat are unknown. No published studies have documented the effects of translocation on either the nuisance individual or resident wildlife populations. We expect that, because nuisance squirrels will act as artificial dispersers, they will be exposed to the potential disadvantages of dispersal as outlined by Stenseth and Lidicker (1992). These disadvantages include uncertainties of finding food, shelter, and an appropriate social environment, and increased predation hazard. Poor quality habitat release sites are expected to magnify these disadvantages because of limited resources. As a result, we hypothesize that nuisance squirrels translocated to poor quality environments will have low long-term survival rates.

## CONCLUSIONS

Our data indicate that, regardless of education, Kentucky NWCOs have a sufficient understanding of suitable gray squirrel habitat characteristics. Many NWCOs with less formal education indicated that they primarily trapped nuisance wildlife as a hobby rather than a reliable source of income. These respondents have an interest in wildlife and wildlife-related issues, thus are expected to have a general to advanced level of knowledge concerning habitat, at least for common species such as the eastern gray squirrel. Respondents indicated that they were choosing mature forested areas with a diversity of mast-producing trees. However, habitat assessments of NWCO-selected release sites showed that NWCOs in Kentucky are translocating nuisance gray squirrels to unsuitable habitats, as defined by the HSI model.

Several factors may explain the contradiction between knowledge and actual practice among Kentucky NWCOs. First, response bias is expected with any survey. Respondents may have provided information based on what they believed was appropriate rather than actual practices. Secondly, NWCOs in Kentucky may not be taking enough time to adequately assess selected release sites. While the majority of sites satisfied the cover/reproductive requirements, only 3 sites provided adequate winter food requirements. In addition, 8 of 11 sites were located on public lands that provided easy access, and all sites were located near the cities/towns in which the NWCO worked. Based on these results, NWCOs in Kentucky probably are selecting release sites based on 3 factors: forest stand maturity, accessibility, and proximity to the job site.

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Table 1. Importance of habitat characteristics to a sample of Kentucky nuisance wildlife control operators ($n$ = 21) when selecting gray squirrel release sites (1 = not at all important, 2 = slightly important, 3 = important, 4 = very important, 5 = extremely important).

| | Importance value | |
|---|---|---|
| Characteristic | Mean | SE |
| Percentage of mast-producing trees | 4.57 | 0.16 |
| Types of trees | 4.14 | 0.19 |
| Size of forested area | 4.05 | 0.20 |
| Size of dominant trees | 4.05 | 0.20 |
| Proximity to capture site | 4.05 | 0.29 |
| Number of tree species | 3.90 | 0.18 |
| Age of trees | 3.76 | 0.23 |
| Amount of shade | 3.33 | 0.20 |
| Presence of wildlife | 2.62 | 0.33 |

Table 2. Mean vegetative measurements (*n* = 10) including size in acres (ac), mean percentage of canopy cover, mean diameter breast height (dbh), mean percentage of canopy that is mast-producing, maximum number of mast species, and calculated habitat suitability index (HSI) values, including cover/reproduction index (SICR) and winter food index (SIWF) of release sites selected by a sample (*n* = 8) of nuisance wildlife control operators in Kentucky.

| County | Ownership | Size (ac) | Canopy Cover (%) | | Mean dbh (cm) | | SICR | Mast Overstory (%) | | Mast species (#) | SIWF | HSI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Mean | SE | Mean | SE | | Mean | SE | Maximum | | |
| Hopkins | private | ---- | 10.0 | 6.8 | 48.7 | 17.4 | 0.00 | 6.0 | 6.0 | 1 | 0.07 | 0.00 |
| Fayette | public | | 216 | 48.0 | 5.7 | 41.1 | 3.4 | 1.00 | 0.0 | 0.0 | 0 | 0.10 | 0.10 |
| Jefferson | public | 333 | 35.5 | 10.5 | 60.6 | 23.5 | 0.85 | 8.0 | 8.0 | 1 | 0.22 | 0.22 |
| Fayette | public | | 170 | 23.0 | 11.6 | 53.1 | 5.3 | 0.76 | 15.0 | 10.7 | 1 | 0.22 | 0.22 |
| Grayson | public | 637 | 55.0 | 6.2 | 31.7 | 1.8 | 0.87 | 11.0 | 9.9 | 2 | 0.35 | 0.35 |
| Grant | private | ---- | 60.5 | 8.5 | 27.4 | 2.0 | 0.81 | 8.0 | 3.7 | 5 | 0.39 | 0.39 |
| Fayette | public | | 374 | 56.5 | 10.2 | 26.4 | 1.5 | 0.74 | 14.0 | 7.2 | 2 | 0.42 | 0.42 |
| Fayette | private | | 18 | 61.0 | 9.2 | 26.7 | 1.8 | 0.76 | 23.0 | 12.2 | 2 | 0.46 | 0.46 |
| Jefferson | public | 31 | 54.0 | 10.7 | 31.9 | 5.5 | 0.71 | 43.0 | 11.4 | 3 | 0.60 | 0.60 |
| Jefferson | public | 5,200 | 71.0 | 5.6 | 44.5 | 4.8 | 1.00 | 37.5 | 10.2 | 4 | 0.74 | 0.74 |
| Hopkins | public | ---- | 63.0 | 8.9 | 54.5 | 2.0 | 1.00 | 90.0 | 10.0 | 3 | 0.89 | 0.89 |

# CONSERVATION OF A DINOSAUR IN MODERN TIMES— SOUTH CAROLINA'S ALLIGATOR MANAGEMENT PROGRAM

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Abstract: American alligator (*Alligator mississippiensis*) conservation is necessary given the animal's role in wetland ecosystems and its economic value. Although the alligator appears to be no longer threatened with extinction, the reptile's perceived reputation and a burgeoning human population combine to create a management paradox. Alligator management in South Carolina consists of a Nuisance Control Program, a Private Lands Harvest Program, and public education. Annually, over 750 alligator complaints are received by the South Carolina Department of Natural Resources (SCDNR), and harvest averages about 250 animals. To address alligator/human interaction in rural habitats, a harvest on private lands was established in 1995. The program, which has been well received by the public, encompasses over 27,000 acres in 7 counties and is valued over $75,000. Brochures, presentations, and the media have been utilized effectively to educate the public about alligators. A holistic approach is suggested for successful conservation of a species that has mixed attributes.

Key Words: alligator, *Alligator mississippiensis*, South Carolina, wildlife management

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## INTRODUCTION AND HISTORY

Persevering for over 200 million years, crocodilians truly are living dinosaurs. Of the 23 species found worldwide, the American alligator (*Alligator mississippiensis*) occupies the northern most limit of the group's range and is the only species found in South Carolina.

The alligator has a storied history in the Palmetto State. Many early explorers described the species' presence and there are written accounts of Civil War soldiers using the animal's hide and meat. During the early 1900s, alligators were hunted without regulations or restrictions on take. In 1955, a law that prohibited night shooting, which originally was intended for white-tailed deer (*Odocoileus virginianus*), provided the first protection for alligators. Alligator trappers were required to possess licenses and tags beginning in 1962.

Despite these early regulations, the South Carolina alligator season was closed in 1964 due to low population densities. The alligator was afforded further protection under a series of federal laws in the late 1960s, which were precursors of the Endangered Species Act of 1973. However, established interstate poaching networks still threatened the species' recovery.

Legislation that contributed significantly to the recovery of the alligator was an amendment in 1970 to the Lacey Act of 1900. The Lacey Act, which prohibited the transportation of illegally harvested game (birds and mammals) across state lines, was amended and now included alligators. This regulation effectively ended the poaching era, and South Carolina's alligator population began its recovery.

Subsequently, the promulgation of the Endangered Species Act of 1973 enhanced the alligator's recovery and provided research funding to determine status and

begin to answer other biological questions. Creation of the Convention on International Trade in Endangered Species (CITES) also contributed to its recovery by regulating the export of alligator hides, meat, and parts.

During the 1970s and early 1980s, the alligator was listed federally as threatened on the coast and as endangered elsewhere in South Carolina. The alligator was added to the state endangered species list in 1979 because of the animal's low reproduction rate and slow potential for recovery. Then, in June 1987, the U.S. Fish and Wildlife Service reclassified the American alligator from endangered or threatened to the category of "threatened due to similarity of appearance" throughout its range (Fed. Register 52(107), 4 June 1987). Reclassification was based on evidence that suggested that the species no longer was deemed biologically endangered or threatened, but federal protection still was necessary to regulate take and commerce to protect the American crocodile (*Crocodylus acutus*) in the United States and other endangered crocodilians in foreign countries.

While the alligator was recovering during the last three decades, the South Carolina coastal area, which supports the highest alligator populations (Rhodes 1996), rapidly was being developed by humans. In the tri-county region around Charleston, for example, human population growth rose 41% from 1973 to 1994, whereas the amount of land converted to urban uses expanded 255% (Lacy and Jensen 1997). Consequently, human and alligator conflicts began to rise.

**NUISANCE ALLIGATOR CONTROL PROGRAM**

Prior to the alligator being reclassified in 1987, the only means the South Carolina Department of Natural Resources (SCDNR) had available to rectify alligator complaints from the public was relocation of problem animals or, in rare instances, harvest. Relocation was deemed ineffective because of high labor demands and cost, lack of suitable relocation sites, and the animal's ability to home (Murphy and Coker 1984). Harvest of an endangered species was allowed only in certain instances. Thus, there was no effective means to remedy nuisance alligator complaints.

The Florida Game and Fresh Water Fish Commission determined that the best approach to remove nuisance alligators was to contract with private hunters (Hines and Woodward 1980). This strategy maintained the agency's position that when an alligator was killed, its commercial value would be realized, and the problem simultaneously would be resolved.

Following this same protocol, South Carolina's Nuisance Alligator Program was established in 1988. Five nuisance alligator agents were contracted; these agents would receive 50%, SCDNR would receive 42.5%, and a hide broker would receive 7.5% of the hide revenue. Agents were permitted to retain all revenue derived from meat and other by-product (e.g., skulls) sales.

The number of alligator complaints has risen steadily (Table 1), and today the number of alligators harvested averages about 250 animals annually. A decline in hide prices in the early 1990s lead to a change in the hide revenue distribution. Agents currently receive 85%, whereas SCDNR and the hide broker split the remaining 15%. Economic analysis suggests that agents need to receive approximately $25/ft for a hide to remain profitable.

The current Nuisance Alligator Program effectively resolves public alligator

complaints. However, SCDNR manpower needs will have to be addressed as complaint numbers rise, and a mechanism is needed to retain agents when hide prices are low.

## PRIVATE LANDS ALLIGATOR PROGRAM

The majority of nuisance alligator complaints originate from urban areas (Rhodes, unpubl. data), but landowners in rural areas also are coping with increasing alligator populations. Many residents reluctantly tolerated the popu-lation increase, but others illegally shot nuisance alligators as a means to reduce local populations. Faced with a resource being wasted and requests from private landowners for relief, SCDNR began investigating in 1991 the feasibility of establishing an alligator season on private lands.

The first alligator season in 31 years was approved for four counties (Beaufort, Charleston, Colleton, Georgetown) in the fall of 1995. The owners of 13 properties participated and 17 trappers harvested 127 alligators (Table 2). In 1997, the area open to harvest was expanded to include private lands in all or a portion of seven counties (those listed above, plus Berkeley, Dorchester, and Jasper) and annual harvest increased to 211 alligators.

Landowners are required to pay certain fees (license, tags, hide validation), but they are permitted to retain 100% of any revenue generated from product sales. Thus far, gross revenue has exceeded $75,000 for each season.

The SCDNR Private Lands Alligator Program effectively has addressed alligator conflicts on private lands while allowing landowners the opportunity to realize an economic benefit from supporting alligators in their wetlands. Having an economic incentive to conserve habitats that support alligators, in turn, benefits other wetland-dependant species.

## INFORMATION DISSEMINATION

Whether from perceived fear or general interest, alligators garner tremendous attention by the public. SCDNR annually receives over 1,500 requests for information pertaining to alligators. The agency has developed several mediums to meet this demand.

A brochure that provides an overview of the species' natural history is available for distribution. An educational bulletin board is on display at one of SCDNR's most visited offices. Several popular and scientific articles are produced each year for media distribution and posting on the agency's homepage. Over a dozen talks are given annually to community associations, nature clubs, and at vacation resorts. Lastly, SCDNR person-nel actively are involved with local media outlets (i.e., newspaper, radio, television) to educate the public about alligators.

## CONCLUSIONS

Like the animal itself, the Alligator Program in South Carolina has evolved to meet its many challenges. Because a variety of multiple-user groups, each with either positive or negative attitudes toward alligators, developed over time, a management program was created and implemented to address the needs of these constituents. For managers seeking examples of successful management efforts for a wildlife species, especially one associated with opposing attitudes, the successful alligator programs developed by agencies in the Southeast serve as good models.

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Table 1. Summary of South Carolina's nuisance alligator harvest, 1988-1997.

| Year | Complaints Received | Removal Permits Issued | Alligators Harvested | Alligators Harvested Per Tag Issued | Average Length (cm) | Avg. $/30.5 cm | Meat Sold (kg) |
|---|---|---|---|---|---|---|---|
| 1988 | 550 | 433 | 370 | 0.85 | | 44.45 | |
| 1989 | 458 | 376 | 268 | 0.71 | | 52.01 | |
| 1990 | 535 | 358 | 253 | 0.71 | | 59.46 | |
| 1991 | 645 | 421 | 271 | 0.64 | | 47.11 | |
| 1992 | 711 | 365 | 210 | 0.58 | | 30.22 | |
| 1993 | 615 | 380 | 235 | 0.62 | 222.8 | 22.18 | 1,843.8 |
| 1994 | 673 | 420 | 250 | 0.60 | 235.3 | 34.61 | 2,910.7 |
| 1995 | 741 | 449 | 280 | 0.62 | 237.1 | 45.19 | 3,031.5 |
| 1996 | 786 | 358 | 238 | 0.66 | 233.8 | 37.54 | 2,692.9 |
| 1997 | 770 | 382 | 246 | 0.64 | 235.4 | 20.00 | 3,228.2 |

Table 2. Summary of Private Lands Alligator Harvest, 1995-97.

| Year | Number Properties | Number Trappers | Tags Issued | Harvest | Success Rate (%) | Average Length (cm) | Sex Ratio (% males) | Meat Produced (kg) |
|---|---|---|---|---|---|---|---|---|
| 1995 | 11 | 17 | 159 | 127 | 80 | 206.3 | 60 | 1,078.4 |
| 1996 | 11 | 13 | 166 | 128 | 77 | 211.2 | 69 | 1,563.6 |
| 1997 | 28 | 18 | 395 | 211 | 53 | 217.8 | 72 | 2,110.8 |

# THE PRESS AND CITIZEN PARTICIPATION: A CONTENT ANALYSIS

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Abstract: We conducted a content analysis of regional New York State newspapers to assess media coverage of the Department of Environmental Conservation's (DEC) deer management program. The goal of this analysis was to ascertain media depiction of DEC's deer management program during the 1985-97 time period. Specifically, this research examines how deer management issues were portrayed both prior to and after implementation of a DEC public participation program (the Citizen Task Force [CTF] process) to determine if deer management issues received more favorable coverage after CTFs were implemented.

Key Words: citizen task force, content analysis, deer, Department of Environmental Conservation, management, media, New York, *Odocoileus virginianus*, public participation

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## INTRODUCTION

Research has shown that the media—primarily television and newspapers—are the most widely cited sources of information for a variety of publics (Tichenor et al. 1980; McCallum et al. 1991; Scherer and Yarbrough 1991; Ostman and Parker 1986/1987). According to Atkin (1991), television is the most influential medium, followed by newspapers, radio, and magazines. Similarly, Cottle (1993:108) states that mass media are likely to be of "…major importance in the selection, transformation, and circulation of environmental meanings in modern society." Although some researchers may question the power of mass media in terms of ultimate effects, most agree that the media's influence exists less in dictating opinion and more in setting the agenda in terms of the general public's concerns (McQuail 1994). Along these lines, McLeod et al. (1996) found that increased local media use is positively correlated with interest in local politics and community knowledge.

Given this, communication efforts by federal and state governments ought to focus more on mass communication activities when considering education or outreach programs. Agencies interested in benefiting from mass media need to understand how media information sources present issues. Knowing more about how the media depict a wildlife or natural resource conflict, for instance, may help guide agency communication and outreach efforts, reduce unnecessary community conflict, and lead to more thoughtful, informed, and effective community discussion.

Content analysis of media texts (such as newspaper articles) is one method for understanding how the media present issues. Stone et al. (1966:5) define content

analysis as "…any research technique for making inferences by systematically and objectively identifying specified characteristics within the text." Most inferences in content analyses are drawn after researchers have assigned meaning to text units through coding procedures (i.e., humans read text and make decisions about the text in a subjective process). However, methods also exist for computer analysis of text frequency that avoids some of the problems common with human coding. We used such computer-aided methods in our research.

Past content analysis research has examined such varied texts as presidential speeches, fairy tales, personal letters, and even suicide notes (Stone et al. 1966). In the media area, most content analyses focus on newspaper or other journalistic texts. Tichenor et al. (1980) looked at the relationship between community type and structure and acquisition of knowledge from newspapers. They examined coverage of issues ranging from the siting of a nuclear power plant to sewage disposal in nineteen different communities. Their research indicated that newspaper coverage was related to community type—rural community newspapers commonly provided coverage on less conflict-ridden local events whereas urban community newspaper covered more national and international events, frequently focusing on conflicts.

Kellert's series of studies that examined American attitudes, behaviors, and knowledge about wildlife also included a content analysis. Kellert and Westervelt (1981) examined attitude shifts toward wildlife during a 75-year time period by sampling clips from 2 rural and 2 urban newspapers in the far West, the Rocky Mountain area, the Northeast, and the South. Each wildlife article was coded using a typology of 10 attitudes: aesthetic, dominionistic, ecologistic, humanistic, moralistic, naturalistic, negativistic, neutralistic, scientistic, and utilitarian.

Kellert's research yields some interesting, but not terribly surprising findings. The most prevalent attitude conveyed in 48% of these newspaper articles was the utilitarian view—a practical and material outlook toward animals. The humanistic wildlife view—an interest and affection toward wildlife—was the second most prevalent wildlife attitude, appearing in 16% of the articles. The humanistic and aesthetic attitudes toward animals were found more often in urban newspapers, whereas rural newspapers were more likely to convey a utilitarian wildlife attitude in their coverage.

A more recent content analysis (Corbett 1992) looked at this difference in community structure and newspaper coverage of wildlife issues. Like Tichenor et al. (1980), Corbett also found that newspaper coverage in 6 different Minnesota communities largely depended on the respective communities' structures. She also found that urban newspapers were more likely to cover conflict-ridden stories than were rural newspapers. Corbett examined coverage of wildlife themes—utilitarian versus preservation—in urban and rural newspapers. As predicted by Corbett, urban newspapers carried articles with preservation- and conservation-oriented themes, whereas the rural media focused more on utilitarian wildlife themes.

Stout and Knuth (1995) conducted a content analysis of 180 newspaper articles in the Rochester, New York, area to examine the relationship between an agency's communication efforts and number and kinds of stories the media reported. Researchers were looking for changes in attitudes and opinions of suburban residents about deer and deer management after a New York

Department of Environmental Conservation (DEC) communication plan had been implemented. The cornerstone of this communication plan was a Citizen Task Force (CTF)—a group of representative stakeholders convened to provide a deer population management recommendation. In addition to content analysis, these authors also used survey and evaluation methodologies to understand residents' views on deer and deer management, as well as information channels used to obtain information about these topics. Verifying media research results mentioned earlier, Stout and Knuth (1995) found that the majority of respondents received their information from newspapers, television, and radio. The evaluation also indicated little change occurred in public attitudes and opinions among residential property owners—in other words, the impacts of DEC's communication plan were slight.

Their content analysis of newspaper articles identified 2 primary themes: deer population management strategies and the controversy surrounding deer management. Stout and Knuth (1995) found that newspaper coverage focused primarily on the controversy and less on substantive recommendations or information. However, most of the agency's communication with the press occurred after the task force decision was made. This serves as a telling example of the disconnect between agency and media information sources, and consequently the stakeholders. As previously mentioned, the extant literature suggests that citizens routinely rely on mass media, especially newspapers and television, to obtain information. Perhaps a more proactive stance in interacting with the media—in addition to other communication activities—would produce more substantive coverage of the issue.

This paper presents our examination of newspaper coverage of the DEC's deer management program from 1985 to 1997. Of particular interest is newspaper coverage of the DEC's CTF process, which first was implemented in the early 1990s.

## BACKGROUND: DEER MANAGEMENT IN NEW YORK

Since 1990, DEC has used a participatory, citizen-based approach for decision-making about white-tailed deer (*Odocoileus virginianus*) population levels in specific areas of the state. This type of management approach initially was implemented because of growing discontent among hunters and an increasing demand for public participation (Nelson 1992). During the late 1980s, opposition to DEC management was so intense that the agency came close to losing deer management authority. DEC objectives for using a more participatory, task force approach included improving agency image, enhancing communication, increasing stakeholder involvement, and broadening management support among diverse groups of the public (Nelson 1992).

New York is divided into roughly 80 Deer Management Units (DMUs). Within almost every DMU, a CTF is convened every 5 years to establish deer population objectives for that unit. Citizens are chosen to represent various stakeholder interests such as homeowner, hunting, farming, highway safety, conservation and wildlife, and tourism and business interests. CTF meetings are attended by $\geq$1 DEC deer biologist who may provide technical information relating to deer biology and management considerations. In addition, a "neutral" party, often a Cornell Cooperative Extension (CCE) Agent, facilitates each CTF meeting. Often, the deer biologist or CCE Agent will distribute a press release to alert the media about the CTF process, its purpose and members, and any resulting

recommendations.

The CTF generally meets twice with a 2- to 4-week interval between meetings to provide time for CTF members to contact and solicit input from stakeholders. Input generally is obtained through a questionnaire that CTF members submit to individual stakeholders. The first CTF meeting usually is informational in nature, where the CCE Agent offers introductory comments and the DEC biologist gives a presentation on deer biology and the human dimensions of deer management. At the second meeting, CTF members share information gathered from stakeholders and then attempt to achieve consensus on amenable deer population objectives. The CTF approach has been effective in providing participating citizens an opportunity to learn about deer management and to help set acceptable deer population objectives.

## PURPOSE OF RESEARCH

One of the major functions of the CTF process was to achieve broader, more equitable representation and participation from stakeholders in New York's deer management program. This outcome has been realized (Nelson 1992). However, a subsidiary concern was that information about the success of the CTF process, and the discussions that occurred in these meetings, be communicated to the public to ensure that a more democratic discourse about deer management develops among this wider audience. Although the DEC did not mount a coordinated campaign to publicize the activities of these CTFs, many of these meetings frequently were covered, especially where controversial deer situations existed. Given the potential impact of this coverage, and the amount of effort devoted statewide to the CTF process, it would have seemed prudent to determine whether these CTF processes were being presented in fundamentally positive or negative ways. Further, it would be reasonable to ascertain what impact CTFs had on the public discourse about deer management as a whole. Knowledge of media treatment can be used to evaluate whether CTFs had any impact on the general public's understanding of deer management.

We conducted a content analysis of regional New York State newspapers to assess media coverage of the deer management program. The goal of our analysis was to ascertain media depiction of the DEC's deer management program during the 1985-97 time period. Specifically, we examined how deer management issues were portrayed both prior to and after implementation of the CTF process to assess whether deer or deer management issues received more favorable coverage after CTF implementation. The hypothesis being tested is:

- DEC's implementation of the CTF process for deer management produced more positive newspaper coverage of deer issues and the deer management program.

Examination of articles printed before and after DEC implemented the CTF process may provide an indicator of whether this public participation program generated more positive newspaper media coverage of the agency and its program.

## METHODS

We used Nexis/Lexis to obtain articles printed in New York State newspapers from 1985 to 1997. We selected the 1985 start date to assure sufficient coverage before the CTF process was implemented in 1989-1990. The following keywords and phrases (from the full text of the articles) were used to identify relevant newspaper articles:

- deer management and/or citizen task force(s);
- deer and/or citizen task force;

- deer and/or public participation;
- deer management and/or public participation; and
- deer and/or wildlife and/or citizen task force(s).

Originally, 366 articles from New York State newspapers (*The Albany Times Union*, *The New York Times*, *The Buffalo News*, and *Newsday*) were downloaded. Of those 366 articles, 235 were found suitable for review, that is, they concentrated on deer issues in some way. The full text of each article was formatted and then analyzed using VBPro, a computer content analysis program. By using computers instead of human coders to analyze content, better coding reliability is achieved and overall reliability is enhanced.

Computer-aided content analysis relies on the numerical analysis of word frequencies to characterize text. This normally is done through the use of word "dictionaries" that address particular concepts. For instance, the researcher may create a dictionary to analyze the frequency with which "positive" words appear in a text as a way to characterize the overall "positive-orientation" of that text. Similarly, "negative" words can be counted and analyzed. Previous work in the field has identified dictionaries for a wide variety of concepts and issues (Weber 1990).

In this exploratory study, we began by examining all terms that appeared in the sample of articles and selected terms that we believed reflected positive or negative evaluative dimensions. Only terms that appeared relatively frequently in the text sample were selected for further analysis.

The selected terms then were factor analyzed to see whether the frequency of their co-occurrence in paragraphs could help us identify underlying dimensions of meaning in the text. Many separate factors were revealed in this analysis. However, two factors could be interpreted easily as either a "positive" factor (terms such as "like," "success," "support," "happy") or a "pragmatic" (or problem-oriented) factor (words such as "damage," "disease," "injure," "loss," "concern," "complain").

From these factors we computed two simple summed indices of the frequency with which these terms appeared in a given article. The more times a "positive" term appeared in an article, the higher the article would be rated on the scale measuring "positive" orientation. Similarly, articles with more "pragmatic" terms mentioned would be rated more highly on the "pragmatic" orientation scale.

We also measured the frequency of occurrence of terms that referenced the CTF process (words such as "deer management unit," "citizen task force," "deer biologists") and that mentioned DEC. Again, these frequencies were analyzed at the level of the article. Thus, articles that mentioned CTFs more frequently would get higher scores on the "CTF" scale; a high number of references to DEC would increase the value on the "agency" scale.

**RESULTS**

We divided the sample of articles into two groups: those written before the introduction of CTFs in 1990, and those written after. Because CTFs were phased in over time, we could not establish an exact representative date for the implementation of all CTFs; our somewhat arbitrary division date corresponds generally to the time when most CTFs first were introduced statewide. Also, our data show that CTF terms did not appear initially until 1990-1991.

We then analyzed the frequency of appearance of "positive" oriented terms

and text in those two periods. If CTFs contributed to a more positive discourse on deer in the press, we would expect this value to increase across the two periods (Table 1). However, it is possible that CTFs also might convey a negative orientation to the discourse, so we analyzed differences in the "pragmatic" orientation as well (Table 1).

The frequency of "positive" orientation increased significantly across the two time periods, whereas the frequency of "pragmatic" orientation decreased, though not significantly so. These outcomes are consistent with our hypothesis. Thus, the data suggest that positive press coverage about deer increased in the post-CTF period.

However, our analysis does not reveal whether that increase was due specifically to the discussion of CTFs. To examine the role of CTFs in press discourse more closely, we examined relationships between the occurrence of CTF terms and either "positive" orientation or "pragmatic" orientation (Table 2). References to CTFs were more likely to occur in articles that featured a "pragmatic" orientation and less likely to occur in articles that featured a "positive" orientation. These relationships remained significant even after we controlled for the number of words in a given article. In other words, CTF terms did not correlate positively with pragmatically-oriented terms simply because longer articles afforded more opportunity for the appearance of terms. We did a similar analysis on the appearance of agency-related terms, but found no significant relationships.

**DISCUSSION**

Although we found an increase in the overall "positive" orientation of newspaper articles after the first appearance of CTFs, we also found that specific references to CTFs in these articles were associated most frequently with pragmatic terms and issues (or conversely, a negative association with the frequency of "positive" oriented terms). How can this apparent paradox be explained?

First, it is possible that other unidentified factors may have fostered the increase in "positive" orientation over the years. Historical factors that are not yet accounted for in these data may explain this rise. However, the widely held belief that deer coverage has become more contentious and more conflict-oriented over the years belies this argument. No particular factor other than CTFs immediately is evident that would account for this rise. Still, more detailed explorations of our data are needed to uncover other possible explanatory factors.

Our hypothesis is that CTFs may have increased overall "positive" orientation specifically because they brought contentious deer issues into the open and generated discourse by the press. It is no surprise that CTF terms occurred more frequently in association with pragmatically-oriented terms; that is the reason for the very existence of CTFs. However, even though CTF-specific articles often featured very prag-matically-oriented discourse, it is possible that the *overall* level of "positive" orientation would be raised over time by the appearance of CTFs in the press coverage.

We suspect that CTFs brought issues out into the open in a way that may have defused or deflected later conflict on the issue. This would be congruent with theories of newspaper journalism that focus on the role of conflictual narratives. After a conflict first has been covered, one should expect later discourse on that issue to be less conflicted and perhaps more policy-oriented.

This hypothesis can be analyzed by

looking at time series data on the frequency with which CTFs are mentioned and level of "positive" orientation in the text. As illustrated in Figure 1, mention of CTFs occurred cyclically, especially from 1992-1994. "Pragmatic" orientation of text was especially strong in these years. However, in the years immediately *following* heavy CTF coverage, overall "positive" orientation increased, which turned the entire period of coverage in a positive direction. In fact, when we looked at overall degree of "positive" orientation by year, we found that the highest level of "positive" orientation in coverage occurred directly after the period of most frequent reference to CTFs. Thus, one may speculate that any increase in "positive" orientation lagged behind the discourse reflected in the press (Figure 2). We also noted a cyclic pattern in the appearance of "positive" orientation, and that the most recent decrease (1997) in "positive" orientation again was associated with a period of increased reference to CTFs.

Let's look at some specific examples of CTF newspaper coverage to get an idea of how this process might work. First are examples of text that specifically mention CTFs, and, where CTFs are mentioned, "pragmatic" oriented terms are more likely to appear:

> "To reduce deer-car collisions, roadside brush clearance, more effective road signs…are among the alternatives the task force will weigh." *Buffalo News*, March 4, 1997.
>
> " `We've seen a lot of thin deer and deer that seem to be suffering,' said Patricia Frankemolle, a member of the North Haven Citizens Task Force…" *Newsday*, March 28, 1994.
>
> "In response, Council Member Jane S. Woodward said the task force proposed by Mrs. Santillo was seen as a stalling tactic devised by the forces opposed to bait-and-shoot. `We've studied, we've talked, we've investigated, we've done all that for the past several years,' Mrs. Woodward said." *Newsday*, March 4, 1997.
>
> " `That means beleaguered homeowners' most effective option may be the cumbersome one selected two years ago by a North Haven citizen task force,' Lowery said: obtaining a nuisance hunting permit to have deer shot in the backyards where they are creating a nuisance." *Newsday*, January 2, 1995.

Next are examples of text that show how deer management was perceived to be successful. These text examples do not mention CTFs necessarily, but they use previous deer management successes as grounds for positive coverage of deer issues.

> "In the final year of a five-year birth-control experiment aimed at reducing an increasing Fire Island deer population, residents and researchers conducting the program are calling it a success." *Newsday*, June 8, 1997.
>
> "The deer take has been rebounding during the last three years and New York's award-winning deer management practices will continue to ensure healthy deer herds and successful hunts in the future." *Newsday*, May 25, 1997.
>
> "The DEC believes that the slight reduction in reported collisions statewide may have resulted from successful deer management efforts, the winter kill in some parts of the state, and the

reluctance of some motorists who hit a deer to claim it because of reports of rabies." *Buffalo News*, September 16, 1994.

These examples of program success are not credited necessarily to specific sources (such as CTFs) in every case. Readers may not be aware that CTFs themselves contributed to positive coverage. Similarly, we found that agency-related terms were related to neither "positive" nor "pragmatic" orientation. Thus, readers of articles about deer, if they are affected by the articles they read, are likely to conclude that the deer situation is "getting better" without thinking about or attributing a reason to that improvement.

DEC and other agencies may want to increase mass media outreach efforts specifically relating to CTFs and other public participation processes. Such actions initially may increase "pragmatic" orientation of coverage given to deer management issues. However, over time, our data suggest that "positive" oriented coverage will increase—perhaps as a direct result of earlier, more controversial coverage of CTFs. Gaining media attention often is time-consuming and difficult for an agency. However, because audiences use mass media as their prime information sources, agencies may benefit more from purposefully obtained media coverage than by other outreach activities. At best, the mass media should not be ignored as a viable communication tool.

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Table 1. Variation in "positive" and "pragmatic" orientation in pre- and post-Citizen Task Force implementation, as reflected by the frequency of use of CTF terms per article.

| | Pre-CTF (up to 1990) | Post-CTF (1990 and after) |
|---|---|---|
| Positive-orientation | 1.7 | 2.9* |
| Pragmatic-orientation | 2.5 | 1.5 |

*= significant difference (t-test), $p < .05$

Table 2. Correlations between frequency of occurrence of Citizen Task Force (CTF) terms in newspaper articles and a "positive" and "pragmatic" orientation.

| Correlation with: | Pragmatic orientation | Positive orientation |
|---|---|---|
| CTF terms | .14*** | -.16** |
| CTF terms, partialled for number of words in article | .18*** | -.13* |

* $p < .05$, ** $p < .01$, *** $p < .001$

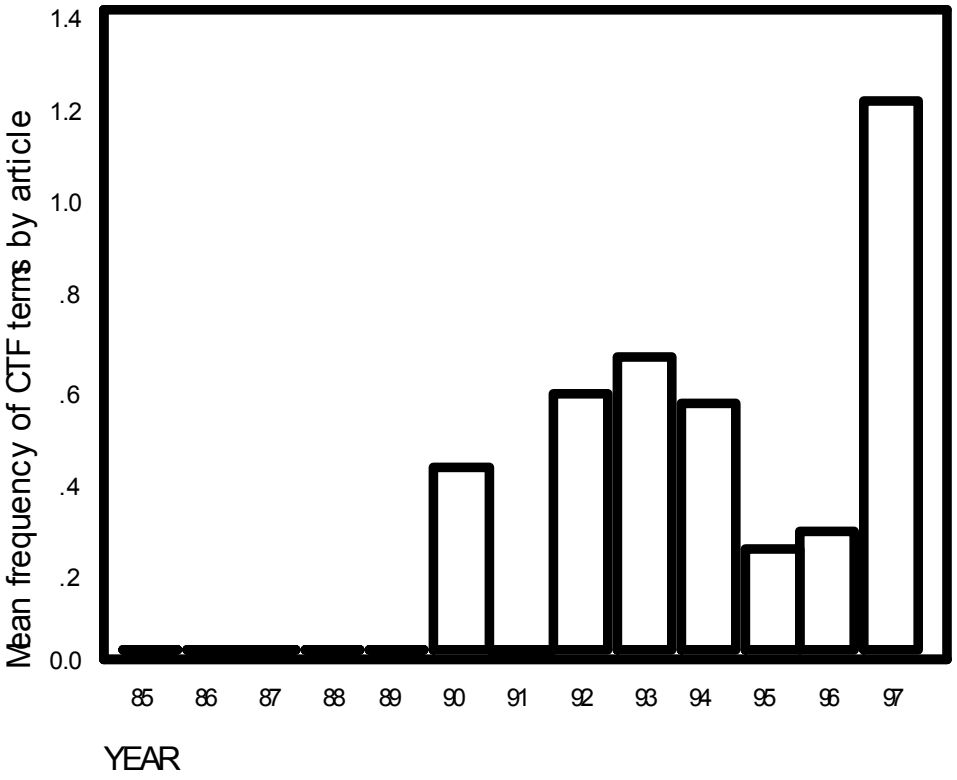


Figure 1. Mean frequency for which Citizen Task Force (CTF) terms are mentioned in New York newspaper articles over the period 1985-1997.

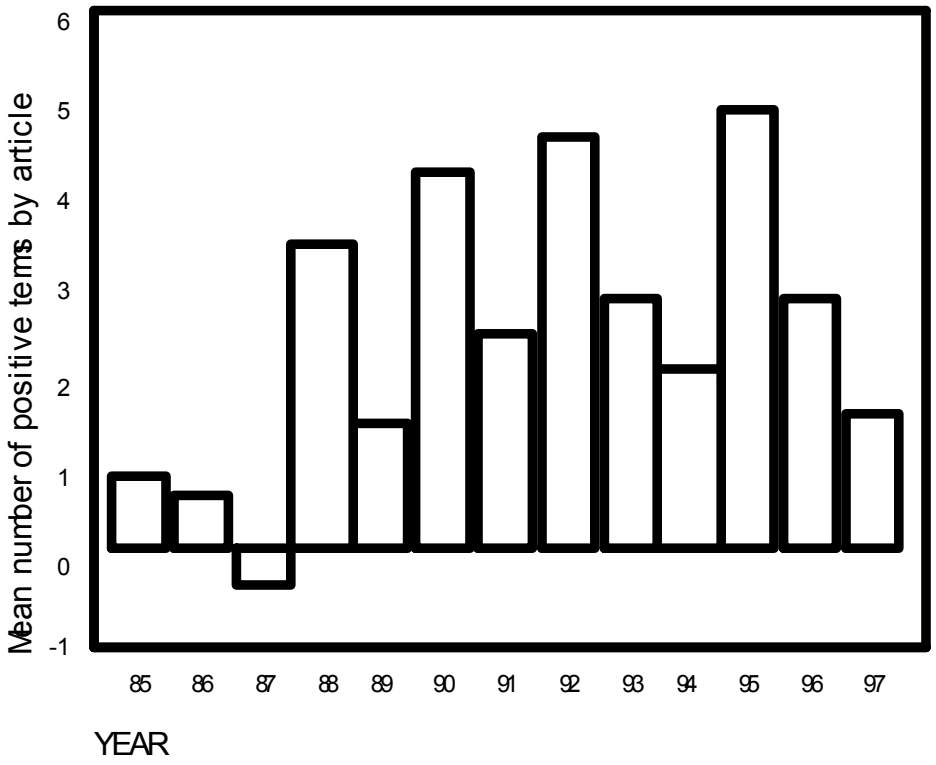


Figure 2. Frequency of "positive" orientation to New York newspaper articles, by year, for the period 1985-1997.

## BIRD ABUNDANCE AT ACCOMACK COUNTY SOUTHERN LANDFILL, MELFA, VIRGINIA, IN RELATION TO VARIOUS MANAGEMENT ACTIVITIES

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Abstract: Birds, especially gulls (*Larus* spp.), are attracted to landfills, and when landfills are close to airports, birds can pose a threat to aircraft safety. We conducted a 1-year ecological study to address concerns of the Federal Aviation Administration (FAA) and Accomack County, Virginia, officials over potential wildlife hazards caused by the Accomack County Southern

Landfill. During 48 surveys conducted from December 1995 to December 1996, we observed 112,693 birds at the landfill ($\bar{x}$ =503). Nine species represented 97% of all observations. Bird numbers varied during the year, increasing during winter and declining during summer. Bird abundance appeared unaffected by trash baling, with 629 and 612 birds per observation before and after implementation of a trash baling program on 24 January 1996, respectively. Bird management methods instituted by the landfill included harassment, exclusion, repellents, shooting, and habitat alteration. Pyrotechnics and pyrotechnics supplemented with shooting were used inconsistently and had only limited and temporary effects. Bird abundance actually increased 43% and 172% for gulls and crows (*Corvus brachyrhynchos*), respectively, while harassment supplemented by shooting was being conducted. Birds appeared to prefer bare (unvegetated) ground or trash habitats. We recommend continuing harassment of birds with pyrotechnics supplemented with shooting and limiting the amount of bare ground. Wildlife damage management should be conducted by professional biologists because when methods are applied inappropriately or inconsistently, desired results are difficult to achieve.

Key Words: bird abundance, damage, Eastern Shore, gulls, landfill, *Larus* spp., nuisance, Virginia, wildlife damage management

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## INTRODUCTION

Landfills are known to attract birds, which are potential hazards to aircraft, especially during take-off and landing. Because of the potential to attract birds and other wildlife, Federal Aviation Administration (FAA) Order 5200.5A recommends a 10,000-ft buffer between an airport and a landfill when turbine-powered planes use the airport. Accomack County Southern Landfill (ACSL) is located 9,000 feet from Accomack County Airport. The flight pattern takes aircraft over the landfill where soaring birds may pose a hazard to aircraft.

Gulls are abundant in this region of Virginia. Over 80% of gulls on the Eastern Shore of Virginia nest on the numerous islands and marshes on the ocean side of the peninsula (Barry Truitt, The Nature Conservancy, pers. commun.). Herring gulls (*Larus argentatus*) first began nesting on the Eastern Shore in 1955 and nesting pairs now number in the tens of thousands (Barry Truitt, The Nature Conservancy, pers. commun.).

At the request of FAA and Accomack County officials, we conducted a study of bird use at ACSL. Objectives were to identify species and numbers of birds by season, behavioral activity, and habitat, and to evaluate bird management techniques at the landfill from December 1995 to December 1996.

Accomack County is located at the northern end of the Eastern Shore of Virginia, a narrow peninsula bordered by the Atlantic Ocean on the east and the Chesapeake Bay on the west. ACSL is located in southwestern Accomack County. The landfill facility is 113 acres with an active face of 1,000 square feet. The landfill handled almost 18,000 tons of trash in 1996, approximately 49 tons per day. Trash is compacted into 1-ton bales (5.0 x 4.0 x 2.5 ft [L x W x H]), stacked, and buried. After baling began, the active face (where trash was dumped) increased to approximately 3 acres.

## METHODS

Bird surveys were conducted 1 day/week using a completely randomized design. Four surveys were conducted each day, at sunrise, 09:30 hr, 12:30 hr, and 15:00 hr. Birds were surveyed for 5 minutes at 3 observation sites. The observation site that initiated each observation period was

drawn randomly for each survey. During each 5-minute interval, the following data were recorded: species, number, activity, habitat type, location, and any other significant information (e.g., any deterrent in use at the time of observation). Locations were recorded using maps of the landfill overlain with a 100-ft grid system. Binoculars (7 x 35mm) and spotting scope (10 x 60mm) were used to identify birds. Data were analyzed using descriptive statistics (i.e., mean, variance, standard error, standard deviation, and range), and frequency distributions per month were displayed.

## RESULTS

Bird Abundance Trends

Over the 48 surveys conducted, 112,693 birds and 50 species were recorded. Nine species representing 97% of all bird observations were grouped into 4 different bird groups: **blackbirds** (European starlings [*Sturnus vulgaris*], red-winged blackbirds [*Agelaius phoeniceus*], common grackles [*Quiscalus quiscula*], brown-headed cowbirds [*Molothrus ater*]); **crows** (American crows [*Corvus brachyrhynchos*]); **gulls** (greater black-backed [*Larus marinus*], herring, laughing [*L. atricilla*], ring-billed gulls [*L. delawarensis*]); and **vultures** (black [*Coragyps atratus*], turkey vultures [*Cathartes aura*]).

Bird abundance varied greatly among months and ranged from 1,064 mean birds per observation in January to 187 mean birds per observation in June (Table 1). There also were substantial differences in abundance among the 4 bird groups (Fig. 1). Gulls comprised 74% of all birds observed, followed by crows (12%), blackbirds (9%), and vultures (2%).

Gulls were the most abundant bird group at the landfill. A maximum of 852 gulls per observation was observed in January, whereas only 135 gulls per observation were seen in June (Fig. 1). Herring gulls were the most abundant bird, comprising 47% of all birds observed. Herring gulls, and the less abundant greater black-backed gull, were most numerous during the winter (Fig. 2). Laughing gulls were the second most numerous bird species and were observed from late March to October. Ring-billed gulls also were numerous, though only present from December through March.

Crows, the second largest bird group, were nearly 6 times less numerous than gulls. Crows were observed all year; a high of 151 crows per observation was observed in October and a low of 9 crows per observation was seen in June (Fig. 1). American crow was the only crow species observed.

Blackbirds were present consistently throughout the study, although their populations fluctuated greatly. Mean numbers per observation ranged from 123 in December 1996 to only 1 in August 1996 (Fig. 1). Starlings were the most numerous of the blackbirds (88% of total) and were present each month. Red-winged blackbirds, the only other blackbird species seen, were observed frequently (9% of total).

Vulture population numbers fluctuated seasonally, increasing in fall and winter and decreasing in spring and summer (Fig. 3). In December 1996, vulture numbers reached a mean of 40 birds per observation and then, in May, the population decreased to a mean of 4 vultures per observation (Fig. 1). Turkey vultures were more abundant than black vultures and their population peaked in December 1996, whereas black vulture populations peaked in October (Fig. 3).

Habitat Types Used by Birds

When birds were on the ground at the landfill, they were found in only a few habitat types. Birds were observed on bare ground (57%), trash habitat (13%), short grass (<10 in.) (6%), agricultural fields (6%), and structures (5%) (Table 2).

Habitat use was similar among all bird species, with only slight variations (Table 2). However, blackbirds, primarily starlings, used structures more often than all other birds (15% vs. 5%, respectively). Few birds other than gulls used asphalt or temporary pools of standing water (Table 2).

Bird Management

Baling is a method of handling waste where refuse is compacted into dense blocks to reduce the amount of exposed surface area. To address FAA concerns about potential wildlife hazards caused by ACSL, a baling operation was implemented in January 1996 to reduce the attractiveness of the landfill to birds. On 6 survey days prior to baling, a mean of 634 birds per observation was recorded; in contrast, 615 birds per observation, on average, were seen on the first 6 survey days after baling had begun. Of the 4 bird species (European starling, American crow, turkey vulture, herring gull) present in sufficient numbers both pre- and post-baling, none appeared to be affected by baling (Fig. 4).

Landfill staff conducted harassment of gulls. Loud noises (e.g., human voices, clapping of hands) and physically chasing birds out of and away from buildings were used. Pyrotechnics first were used on 5 June 1996 and inconsistently thereafter until October. Other methods of harassment used included spraying gulls with water from a hose, spraying the taste repellent ReJeX-iT® (methyl anthranilate) on loose trash, bales, and standing water, and shooting as a supplement to harassment. Shooting to supplement harassment began in November and only after a Migratory Bird Depredation Permit was obtained. Shooting was conducted by a County Animal Control officer.

Initially, pyrotechnics alone were only temporarily effective because of inconsistent use. Birds grew accustomed to the noise and quickly would return to the active face after flying to a field across the street or towering over the landfill for 5-10 minutes. Later, better results in reducing bird numbers were obtained when pyrotechnics were fired more consistently and aggressively. Harassment with pyrotechnics supplemented with shooting also was conducted inconsistently; shooting was confined to 2 days during the 2-week period of use and only 14 herring and ring-billed gulls were shot. During the first 2 surveys after harassment was supplemented with shooting, bird populations increased from a mean of 332 to 407 birds per observation (Fig. 5). Blackbird and vulture numbers decreased slightly after shooting began (Fig. 5).

Water spray directed from a hose was an effective, yet temporary, harassment technique. Groups of up to 75 gulls were observed avoiding the spray, but returned when the water was turned off.

The taste repellent ReJeX-iT® did not repel birds from feeding on trash bales. During 2 surveys in August, bales and temporary puddles of water were sprayed with the repellent, but birds continued to feed. Laughing gulls that fed on repellent-laced trash were observed drinking water frequently.

Overhead wire grids were installed at approximately 8-ft intervals to reduce gull access to bales at the rear of the baling building. Although overhead wire grids deterred ring-billed and herring gull, laughing gulls were able to easily maneuver between the wires.

Approximately 13 ac of landfill were devoid of vegetation (i.e., bare ground), including the active face. Birds, particularly gulls, were observed more often on bare ground sites than on vegetated sites (Table 2). Several sites of bare ground were seeded with grass and

gulls avoided seeded areas once the grass grew $\geq$ 6 in. tall.

## CONCLUSION

Bird Abundance Trends

Landfills are dynamic situations where bird populations fluctuate greatly during the year depending on many factors, including seasonal migrations, available food resources, and breeding behavior (Belant et al. 1995). Due to within year fluctuations in bird abundance, we were unable to identify a primary factor responsible for reducing bird numbers. ACSL implemented an integrated wildlife damage management (IWDM) program during this study, which included baling, installing overhead wire grids, harassing birds with pyrotechnics and water spray, applying ReJeX-iT®, shooting to supplement harassment, and altering habitat.

Gull abundance decreased during November. Gulls were absent or low in abundance at the landfill during mornings in October and November compared to previous months. Also, gull populations fluctuated in response to local farming activities (e.g., gulls visited nearby fields that had been plowed recently during the period May through September).

Blackbird populations remained constant from October through December, whereas most other bird groups decreased. Blackbirds usually start flocking during the late fall and winter and consequently were seen in higher numbers. Blackbirds usually fed on bare ground near the bales, waiting for herring gulls to drop food scraps while feeding on the bales.

Crow abundance was reduced in November and December. Crows responded well to harassment efforts and easily were disturbed from bare ground sites during November and December.

Vultures were observed each month and were most numerous in the fall and winter. Turkey vultures were more abundant than black vultures. Like the other 3 bird groups, most vultures were observed on bare ground, except when vultures took cover from pyrotechnics in the woodland habitats. Vultures were wary of human activity and generally fed at the end of the day. When frightened, vultures loafed in nearby trees and returned to feed on bales only when they perceived the threat was gone. Vultures remained at the landfill until sunset, when they flew back to the roost.

Bird Management

Several factors may have affected bird populations at the landfill, yet it is unclear to what extent each factor was responsible. Baling trash appeared to have little effect on overall bird numbers. The baling operation began in late January, around the time when many bird species were observed at their yearly maximum. Also, surveys were not equally divided between pre- and post-baling, which would have facilitated comparison of the efficacy of baling in reducing bird abundance, and many species of birds were not present until after baling had started.

Compacting trash into bales made it more difficult for birds to get at food items. Because of their strong beaks, gulls were able to pick food items from the bales. Birds quickly discovered that trash stored inside the baling building awaiting compaction was an easier meal. Gulls and starlings entered the front and rear of the baling building, and walked or rode the conveyor belt used to move the bales. Chasing birds out of the building, closing doors when not in use, and installation of an overhead wire grid largely resolved these problems.

Gulls and other birds avoided areas with tall grass, presumably because it obscured visibility. Areas seeded with grass were visited less frequently by birds than those

without grass. Also, fewer birds were observed in short grass (<10 in) than in tall grass (≥10 in).

Similar to other studies (e.g., Curtis et al. 1995), we found that ReJeX-iT® did not deter birds from feeding on trash. However, laughing gulls that had fed on the methyl anthranilate-covered bales drank water more frequently than those feeding on untreated bales, indicating a possible side effect of the repellent. Given their more stout beak, laughing gulls were able to pick out food items from below the surface and continued to feed on repellent covered trash.

Although pyrotechnic use started in June, they were not used consistently by landfill staff until October. When used consistently, they were effective in harassing gulls and crows. After pyrotechnics initially were fired, gulls remained in the air a few minutes, but then attempted to return. If harassed vigilantly, gulls would fly to a nearby field or borrow pits, and return only gradually to the landfill. Few gulls were observed on several mornings in October and November, probably due to intensified harassment. Crows and vultures also were frightened by pyrotechnics.

Shooting began in November and reinforced the use of pyrotechnics. However, harassment was inconsistent at a time when bird numbers were increasing at the landfill (migrating herring gulls). Gull and crow numbers increased by 43% and 172%, respectively, during the period when harassment with pyrotechnics was supplemented with shooting. In contrast, blackbird and vulture numbers decreased 11% and 34%, respectively, after harassment supplemented by shooting was implemented. However, the increase in bird abundance after shooting may be an artifact of the small number of observations (only 2 surveys before and after shooting) rather than a meaningful increase. Additionally, ring-billed and herring gulls were believed migrating onto the Eastern Shore of Virginia for the winter during the evaluation period. Shooting has been shown to greatly reduce bird abundance when combined with pyrotechnics. (B.U. Constantin and D.T. Blasky, U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Animal Damage Control, unpubl. data; K.J. Preusser and J.E. Forbes, U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Animal Damage Control, unpubl. data).

## MANAGEMENT RECOMMENDATIONS

The IWDM program, as currently implemented at the landfill to reduce bird abundance, should continue. However, to ensure a consistent and effective program, Accomack County should consider securing a private contract for bird management at the landfill or devote a county employee solely accountable for bird management.

Grass on the landfill site should be maintained at a height of 7-14 inches. The Virginia Department of Environmental Quality (DEQ) permits vegetation on the active face at landfills, but suggests that grass be kept <18 inches tall (Milt Johnston, Virginia Department of Environmental Quality, pers. commun.).

Baling of trash should continue because it reduces the exposed surface area, and theoretically reduces the trash's availability to wildlife. However, even these exposed bales create an attraction for wildlife and must be covered daily.

Pyrotechnics should continue to be used to harass blackbirds, crows, gulls, and vultures. When birds were harassed aggressively and consistently, their numbers were reduced. Whenever possible, harassment should be conducted from the heavy equipment to deter birds

from associating the equipment with food (the “pied piper" effect). Because birds may become accustomed to the noise of pyrotechnics, the current shooting program should continue as a means to supplement harassment.

**LITERATURE CITED**

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Curtis, P.D., C.R. Smith, and W. Evans. 1995. Techniques for reducing bird use at Nanticoke Landfill near E. A. Link Airport, Broome County, New York. Proceedings of the Eastern Wildlife Damage Control Conference 6:67-78.

Table 1. Number of birds recorded per observation by month at the Accomack County Southern Landfill, Virginia, from December 1995 to December 1996.

| | Number of Birds per Observation[a] | | | | |
|---|---|---|---|---|---|
| Month | N | Mean | Standard Deviation | Minimum | Maximum |
| December | 18 | 498 | 289.36 | 0 | 1148 |
| January | 23 | 1064 | 582.44 | 97 | 2578 |
| February | 24 | 655 | 307.16 | 26 | 1184 |
| March | 18 | 449 | 312.97 | 58 | 1303 |
| April | 16 | 378 | 190.14 | 79 | 735 |
| May | 16 | 272 | 169.62 | 56 | 691 |
| June | 16 | 187 | 107.30 | 52 | 362 |
| July | 16 | 323 | 189.13 | 70 | 774 |
| August | 16 | 663 | 486.11 | 202 | 2146 |
| September | 16 | 657 | 255.52 | 239 | 1191 |
| October | 16 | 561 | 437.37 | 26 | 1472 |
| November | 16 | 289 | 180.53 | 19 | 547 |
| December | 4 | 551 | 423.59 | 52 | 1088 |
| Overall Mean | 17 | 503 | 302.36 | 75 | 1171 |

[a] An observation consisted of 3 consecutive 5-minute periods, each covering a section of the landfill. There were 4 observations per day for 4 days per month.

Table 2. Habitat use by the four most numerous bird groups observed at Accomack County Southern Landfill, Virginia, from December 1995 to December 1996[a].

| | Percent of Birds Observed | | | | |
|---|---|---|---|---|---|
| Habitat Type | Gulls | Blackbirds | Crows | Vultures | All Birds |
| Agricultural Field | 8 | 0 | 2 | 0 | 6 |
| Asphalt | 4 | 0 | 0 | 0 | 3 |
| Bare Ground | 61 | 44 | 47 | 41 | 57 |
| Bare Ground (Trash) | 12 | 11 | 16 | 17 | 13 |
| Long Grass (>14 in) | 1 | 1 | 0 | 2 | 0 |
| Short Grass (<10 in) | 6 | 7 | 8 | 9 | 6 |
| Marsh | 1 | 5 | 1 | 1 | 1 |
| Shrubs | 0 | 3 | 0 | 0 | 0 |
| Structure | 5 | 15 | 2 | 4 | 5 |
| Temporary Standing Water | 2 | 0 | 0 | 0 | 2 |
| Unpaved Road | 0 | 0 | 0 | 0 | 0 |
| Woodland | 0 | 12 | 23 | 24 | 5 |
| Total Birds Observed | 84251 | 10328 | 13501 | 2770 | 112693 |

[a] There were 4 5-minute observations per day on 4 days per month.

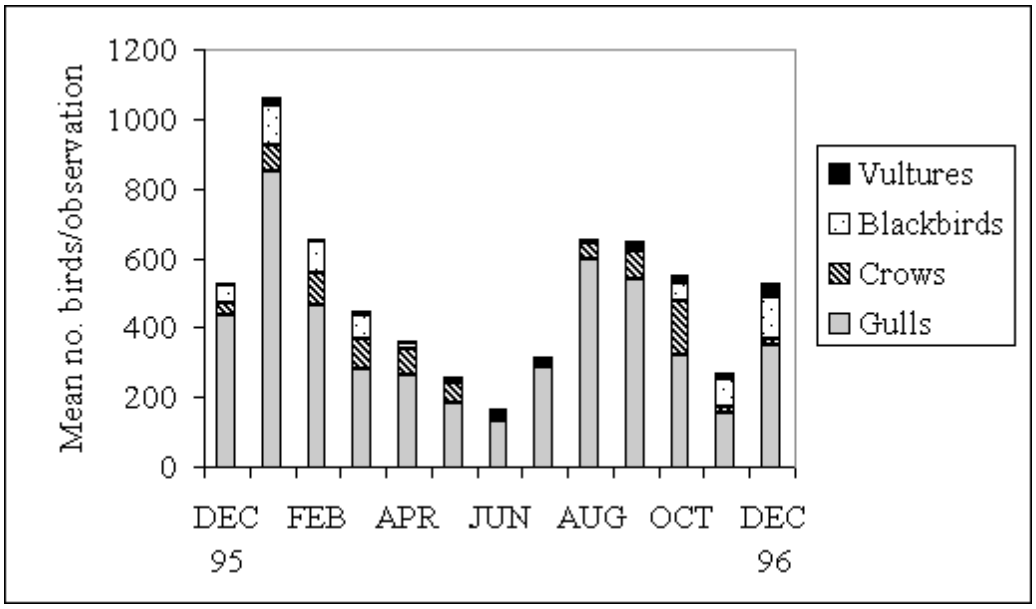


Fig. 1. Mean number of birds per observation for the four most numerous bird groups at Accomack County Southern Landfill, Virginia, from December 1995 to December 1996. There were 4 5-minute observations per day on 4 days per month. Bird groups include: blackbirds (European starlings, common grackles, red-winged blackbirds, and brown-headed cowbirds), crows (American crows), gulls (laughing, herring, ring-billed, and greater black-backed gulls), and vultures (black and turkey vultures).

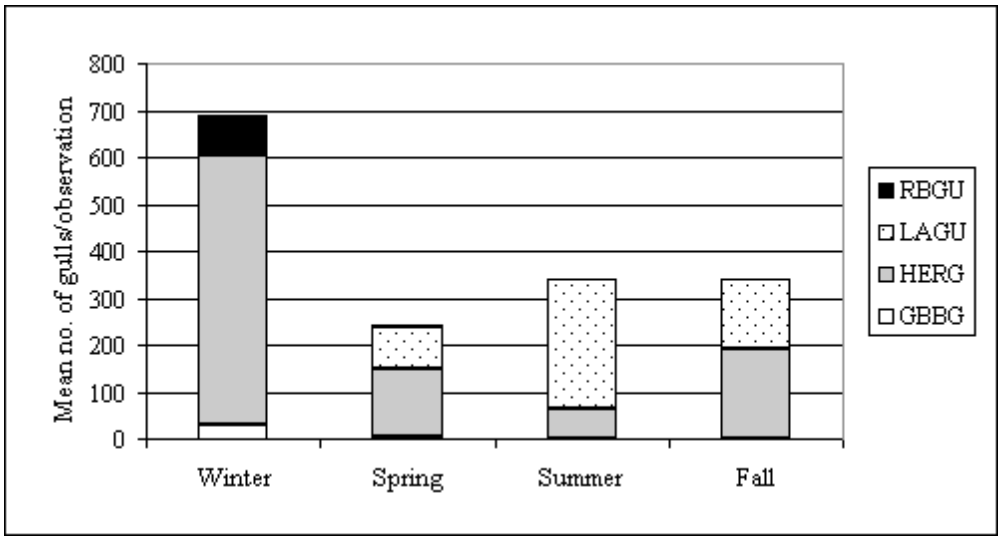


Fig. 2. Mean number of gulls by species per observation at Accomack County Southern Landfill,
Virginia, from December 1995 to December 1996. Gull species include ring-billed (RBGU), laughing
(LAGU), herring (HERG), and greater black-backed (GBBG). There were 4 5-minute observations
per day on 4 days per month.

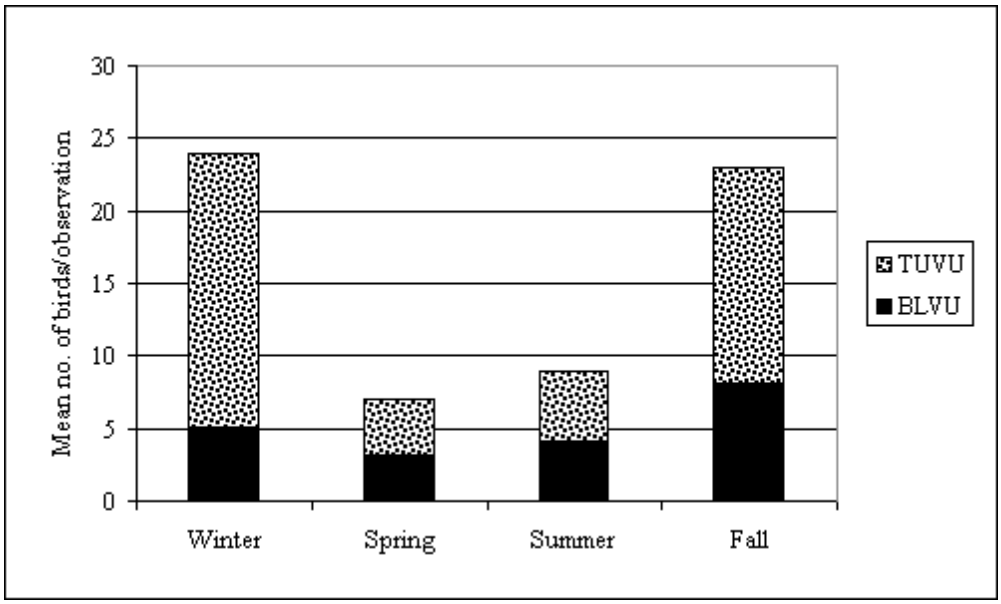


Fig. 3. Mean number of vultures by species per observation at Accomack County Southern Landfill,
Virginia, from December 1995 to December 1996. Vulture species include black (BLVU) and turkey
(TUVU). There were 4 5-minute observations per day on 4 days per
month.

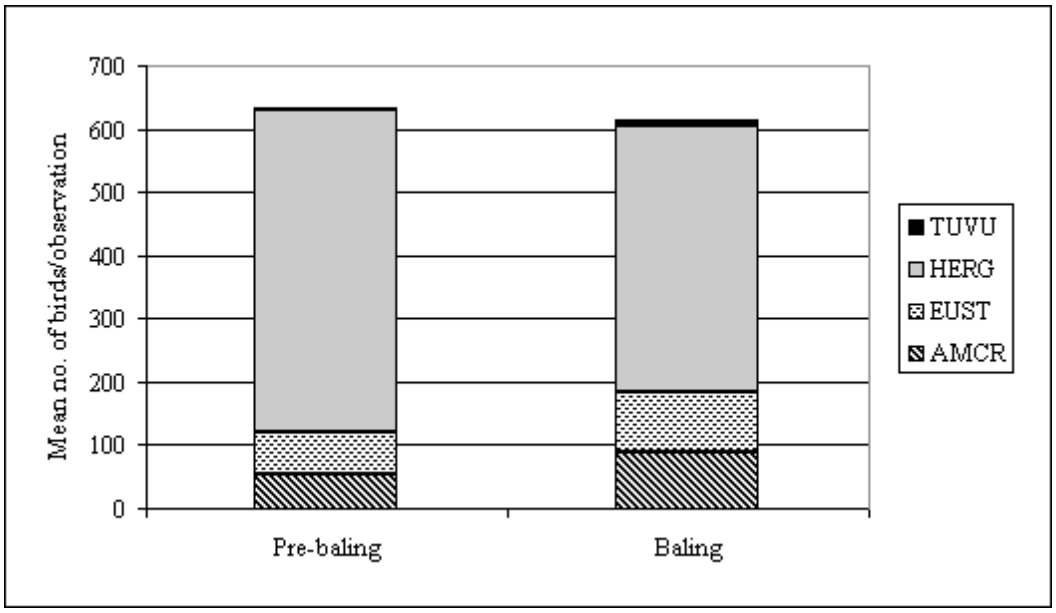


Figure 4. Mean number of birds per observation period for turkey vultures (TUVU), American crows
(AMCR), European starlings (EUST), and herring gulls (HERG) that were observed during 6 survey
days before baling and 6 survey days after baling had commenced at Accomack County Southern
Landfill, Virginia. Baling began on 24 January 1996. There were 4 5-minute observations per day on 4 days per month.

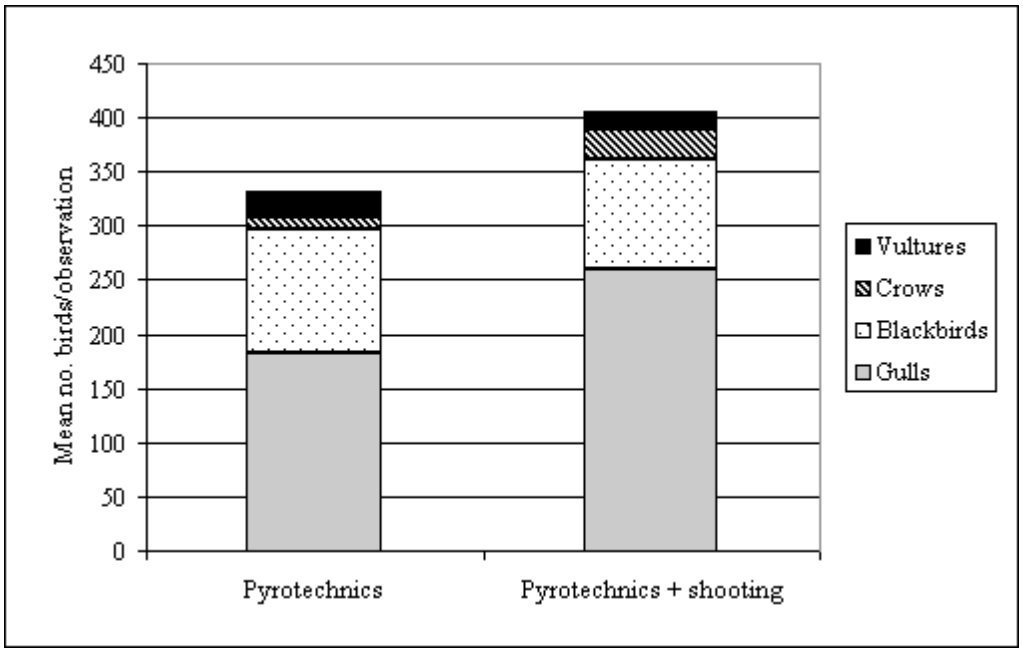


Figure 5. Mean number of birds per observation for 2 survey days using pyrotechnics and for 2 survey days using pyrotechnics combined with shooting to harass birds. Shooting program began in November 1996. There were 4 5-minute observations per day on 4 days per month.

# ATTEMPTED RELOCATION OF A RING-BILLED GULL ROOST AT WASHINGTON NATIONAL AIRPORT

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Abstract: Gulls, particularly ring-billed gulls [*Larus delawarensis*], have been identified as a threat to aircraft operations at Washington National Airport (now Ronald Reagan National Airport) in northern Virginia. Through bird surveys conducted in 1992, 1993, and 1997, an estimated 7,000 gulls were observed roosting during winter on the Potomac River near the airport. A harassment program was run on 5 consecutive evenings, 24-28 February 1997, to relocate the roosting gulls. Six to 8 people shot pyrotechnics from shore and 2 boats for 2 hours prior to dusk each evening. Each evening the gulls arrived consistently later than the prior evening and formed the roost in different locations on the Potomac and Anacostia Rivers. No difference in gull numbers was seen within critical airspace or on the airport through bird surveys conducted before, during, and after the harassment program. Although the harassment program seemed to change the gulls' behavior, no significant difference was observed in the threat presented by gulls to aircraft. Potential alternatives to increase the effectiveness of future harassment programs include harassing the gull roost earlier in the winter season and reinforcing harassment with lethal shooting.

Key Words: airport, gulls, harassment, *Larus delawarensis*, pyrotechnics, roost dispersal

Proc. East. Wildl. Damage Manage. Conf. 8:174-179

## INTRODUCTION

Birds can pose a serious hazard to aviation. When birds are present in the vicinity of an airfield, they may collide with incoming or departing aircraft and cause the plane to crash, resulting in the possible loss of human life (Godin 1994). A collision involving a bird, or flock of birds, and an aircraft commonly is known as a "bird strike". Gulls, the most commonly struck birds in the United States, are involved in 30% of all reported strikes in which the species was identified (Cleary et al. 1996). The Federal Aviation Administration (FAA) recognizes the threat that bird strikes pose to aircraft safety and has defined rules governing wildlife hazard management at airports bearing FAA certificate.

Birds, including several species of gulls (*Larus* spp.), have been recognized as potential threats to aircraft operations at Washington National Airport located in northern Virginia (Figure 1). Due to various bird-aircraft collisions at National Airport, the FAA determined in 1991 that an ecological study was warranted (Federal Aviation Regulation, Part 139.337). National Airport officials requested the assistance of the Wildlife Services (WS) program of the United States Department of Agriculture, Animal and Plant Health Inspection Service, to perform an ecological and monitoring study in 1992 and 1993, respectively. Prior to 1 August 1997, WS was known as Animal Damage Control. The studies revealed approximately 7,000 mixed species of gulls (approximately 98% ring-billed gulls [*Larus delawarensis*] and 2% greater black-backed gulls [*L. marinus*] and herring gulls [*L. argentatus*]) roosting on the

Potomac River, at the confluence with the Anacostia River adjacent to the airport, from September-March each year. As a result of these studies, several management actions were recommended to the airport, one of which was to relocate the winter gull roost (Lowney 1994).

In 1996, National Airport again enlisted WS to assist in identifying and managing existing wildlife hazards at the airport. Most management alternatives previously recommended by WS had been implemented, including filling and re-grading of the airfield to reduce standing water, removal of pier pilings used by gulls for loafing, and thinning of woodland habitat used by blackbirds for roosting. Gull abundance was reduced within the airfield since 1993, but no change in the roosting population was observed. WS again recommended the relocation of the winter gull roost to reduce gull presence at the airport. Subsequently, the airport agreed to implement a relocation program. This paper reports the results of the gull roost harassment effort.

**STUDY AREA**

National Airport accommodates commercial air carrier, commuter, and business and private aircraft. National served 15.5 million passengers and handled 304,776 take-off and landings in 1995 (Metropolitan Washington Airports Authority 1996).

The airport covers approximately 800 acres and contains 3 runways, 3 terminal buildings, numerous parking areas, and a grass covered Aircraft Operations Area (AOA). To the north of the AOA is Roaches Run Wildlife Sanctuary, which is managed by the National Park Service, to the east is the Potomac River and confluence with the Anacostia River, to the south is a 300-acre bay of the Potomac River, and to the west lies Alexandria, Virginia.

Roaches Run Sanctuary contains a grassy park, a shallow 100-acre tidal lake, and 2 parking areas. The lake is encircled with a strip of hardwood trees. During winter, gulls, primarily ring-billed gulls, often loaf on mud flats at the south end of the lake during low tide. The Potomac River is approximately ½ to ¾ miles wide in the area adjacent to the airport. The large bay on the south end is shallow and much of its bottom is exposed during low tide.

**METHODS**

Gull harassment was conducted on 5 consecutive evenings, 24-28 February 1997. Six to 8 people were positioned each afternoon to harass gulls with pyrotechnics. A minimum of 4 people were located along the shoreline of the airport, including an Airport Operations Officer, who had contact with the control tower. In addition, 2 boats were out on the Potomac River each day; each boat contained a driver and a person to fire pyrotechnics. Pyrotechnics used included bird bangers and screamers fired from single or double shot pistols and shell crackers fired from a 12-gauge shotgun. Harassment began 2 hours before sunset and ceased at dark to decrease the possibility of harassing gulls into the path of an approaching plane. Runways remained open for all but 42 minutes throughout the harassment program.

Gull numbers were recorded through standardized bird surveys, conducted 3 times each month by WS biologists, as well as incidental observations made by Airport Operations and River Rescue personnel. An F-test was used to test for differences in gull numbers related to the harassment program.

**RESULTS**

Approximately 600 screamers, 200 bangers, and 165 shell crackers were fired throughout the harassment program. Survey results showed no significant difference ($p > 0.05$) in the number of gulls observed before, during, and after implementing a harassment program ($F = 0.52$, df=2,3) (Table 1).

Throughout the period of harassment, changes in gull behavior were observed. Initially, gulls flew into the area approximately 1 hour before dusk and well above the surface of the water. They congregated on Hains Point, a peninsula located between the Potomac and Anacostia Rivers, before moving down onto the water. Subsequent to roost dispersal, gulls flew in close to the water's surface. Additionally, gulls no longer landed on Hains Point. Gulls seemed to arrive each evening later than the prior evening and settled on the river immediately. The timing of the gulls' initial arrival was not recorded, so this conclusion was based only upon observation. The number of gulls seen entering the roosting area did not diminish (Table 2).

**BIRD STRIKES**

The only bird strike recorded occurred on 25 January 1997, prior to initiation of harassment. An A320 aircraft struck 12 ring-billed gulls upon take-off from runway 18/36. That flight continued to its destination; the runway was closed briefly, cleared of debris, and then re-opened immediately. We believe that other bird strikes occurred at National Airport during February-March 1997, but none was reported to Airport Operations.

**DISCUSSION**

The harassment effort to relocate the ring-billed gull roost from the Potomac River adjacent to National Airport did not reduce the threat that gulls pose to aircraft operations. There are several potential alternatives that may increase the effectiveness of the harassment program for future years.

Whereas 5 consecutive evenings is sufficient to disperse blackbird [Family *Icteridae*] and European starling [*Sturnus vulgaris*] (Johnson and Glahn 1994, Transport Canada 1992) and cormorant [Family *Phalacrocoracidae*] roosts (Mott et al. 1992), gulls may need a longer period of harassment to affect their behavior. Site fidelity in gulls may be stronger to a particular roost site than that of starlings, blackbirds, or cormorants.

This harassment program was conducted in late February, after gulls had been established on the roost for several months. Booth (1994) stated that birds are more likely to leave a roost site if they have occupied it only for a short time than if they have been there for several weeks. A harassment effort commencing in November, when the winter roost is just forming, may be more effective in dispersing the gulls at National Airport.

Three types of pyrotechnics were used throughout this harassment program: bangers, screamers, and shell crackers. Supplemental methods of harassment could be used in conjunction with those already listed to make the program more effective. Tape recordings of distress calls and sirens can be played through a loudspeaker on a vehicle or a boat to supplement pyrotechnics (Godin 1994). Pyrotechnics also can be reinforced by shooting a limited number of birds (Godin 1994). Pyrotechnics reinforced by shooting reduced gull abundance from 5,400 to 400 gulls in a 3-day period at a New York landfill (Forbes 1996). The deployment of shooters at John F. Kennedy International Airport reduced gull strikes by 66-90% (Dolbeer and Bucknall 1994).

An alternative to an intensive, 1-time roost relocation effort would be to harass employment of a seasonal, full-time harassment team has proven to be effective in reducing strikes involving gulls at Atlantic City International Airport (USDA 1993).

The attempted roost relocation effort provided us the opportunity to review previously used methods for similar undertakings. With the information collected throughout this effort, potential improvements in these methods have been identified and can be implemented in the

next project of this nature.

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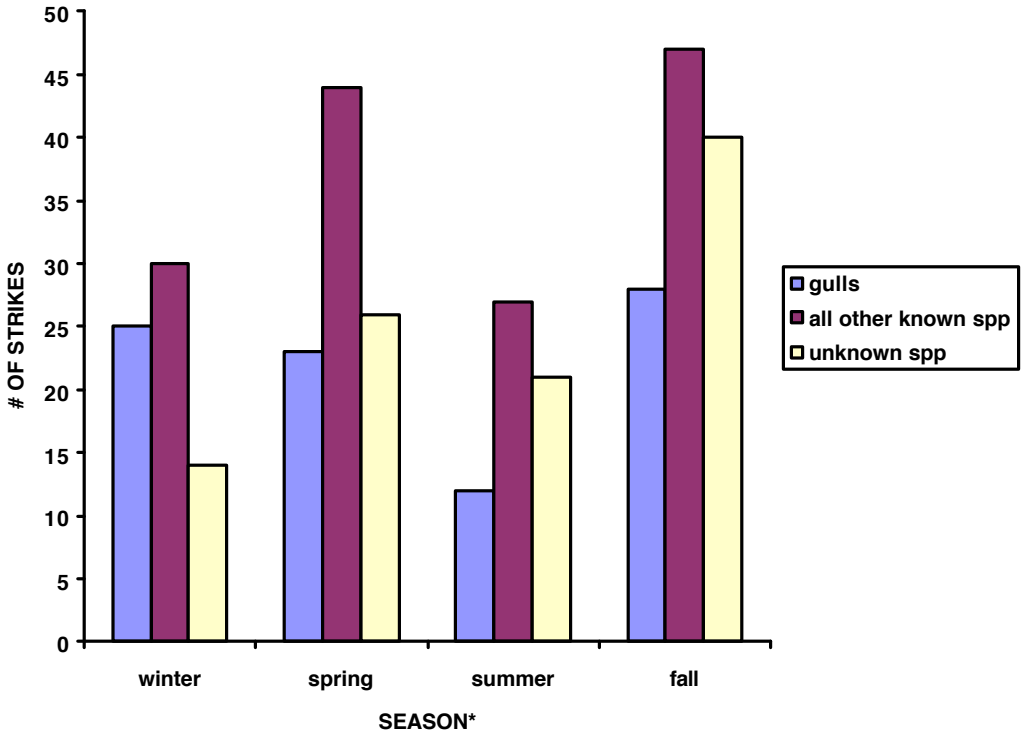


*winter - December, January, and February
spring - March, April, and May
summer - June, July, and August
fall - September, October, and November

Figure 1. Total number of bird strikes reported to FAA involving gulls, other birds of known species, and birds of unidentified species within each season at Washington National Airport from 1989 - 1996.

Table 1. Number of ring-billed gulls observed at Washington National Airport during each survey period on survey days before, during, and after the gull roost relocation program 24-28 February 1997.

| | SURVEY PERIOD | | | |
|---|---|---|---|---|
| DATE | 1 (at dawn) | 2 (at 9:45) | 3 (at 13:30) | 4 (at 16:15) |
| 13 February | 1055 | 241 | 113 | 1235 |
| 28 February | 417 | 103 | 72 | 182 |
| 5 March* | 836 | 54 | 45 | 92 |

*low visibility due to fog, numbers were probably higher

Table 2. Number of ring-billed gulls observed at the confluence of the Potomac and Anacostia Rivers at the end of the survey days before, during, and after the gull roost relocation program conducted at Washington National Airport 24-28 February 1997.

| DATE | TIME | # OF GULLS OBSERVED |
|---|---|---|
| 5 February | 17:45 | >3500 |
| 13 February | 16:45 | >2500 |
| 28 February | 17:50 | >2700 |
| 5 March* | 17:05 | >350 |
| 17 March | 18:20 | >3500 |

*low visibility due to fog, numbers were probably higher

# CONTROLLING GREAT-TAILED GRACKLE DAMAGE TO CITRUS IN THE LOWER RIO GRANDE VALLEY, TEXAS

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Abstract: Great-tailed grackle (*Quiscalus mexicanus*) damage to citrus is a serious concern to producers in the lower Rio Grande Valley of Texas. Damage caused by grackles pecking fruit is initiated by breeding colonies in the spring on immature fruit and extends through the fall and winter on ripening fruit. The most significant damage occurs during the post-breeding period of July through September when neither the currently registered DRC-1339-treated dog food bait nor frightening strategies are effective. Observations by Texas Wildlife Services personnel suggested that watermelon was highly attractive to grackles during the period when dog food baits are poorly accepted. Two control strategies using watermelon to bait large cage traps and to formulate DRC-1339 baits were evaluated in cage and field trials during a 2-year research project. This paper reports on the development and preliminary evaluations of a unique trap design and the 0.1% DRC-1339-treated watermelon bait. Summer field trials in citrus groves were conducted to evaluate the effectiveness and safety of trapping and DRC-1339 baiting. Results of preliminary evaluations clearly demonstrated the utility of these methods for controlling grackles. Although the effectiveness of these methods for controlling grackle damage in citrus groves was less conclusive, no measurable hazards to non-target wildlife were documented. With suggested modifications, both methods may provide a viable means to reduce grackle damage to citrus during a period when other alternative methods are ineffective.

Key words: cage trap, citrus damage, DRC-1339/watermelon bait, Great-tailed grackle, *Quiscalus mexicanus*, Texas

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Great-tailed grackle (*Quiscalus Mexicanus*) populations are associated with locally severe damage to citrus fruits (e.g., grapefruit, oranges) in the lower Rio Grande Valley of Texas (Hobbs and Leon 1987). Damage occurs when grackles peck at the fruit, which leaves either holes or external blemishes. Damage commences in the spring when breeding grackle colonies nest in citrus groves and extends through the fall and winter as fruits ripen. Resident birds and their offspring are presumed responsible for most damage problems, given that most damage occurs before fall migration. In 1987, grackle damage to grapefruit alone exceeded $2.2 million, with average losses of $295/ha (Johnson et al. 1989). In ad-dition,

estimates of damage from grackles to row and truck crops in this intensively farmed region exceed $4 million annually (J. Hobbs, Texas Wildlife Services, pers. commun.). Grackle preda-tion on the eggs and young of resident bird species, such as the white-winged dove (*Zenaida asiatica*), also is a docu-mented problem (Blankenship 1966).

Although frightening techniques help reduce damage to citrus during the late fall and winter, site tenacity by grackles makes these techniques less effective during the post-breeding period of July through September (Rappole et al. 1989), when the greatest amount of damage appears to occur (Johnson et al. 1989). The difficulty in frightening grackles from groves during the summer (Rappole et al. 1989) and the limited movements of these birds during this period (Rappole et al. 1989) suggest that population reduction may be a practical and biologically sound damage management strategy.

DRC-1339-treated dog food has been used in some situations to reduce grackle populations (Tipton et al. 1989). How-ever, past experience of USDA/APHIS/ Wildlife Services (WS) field personnel suggested that this bait was accepted poorly during summer months. Obser-vations by WS personnel in Texas indicated that watermelon was highly attractive to grackles during this period when dog food baits were not accepted. Watermelon potentially could be used to attract grackles to traps or to formulate a new DRC-1339-treated bait.

The objectives of our research were to (1) identify or develop a suitable trap design for capturing grackles, (2) investigate and develop a DRC-1339 treated watermelon bait, and (3) evaluate the potential effect-tiveness of each for reducing grackle damage to citrus during the summer months.

Numerous people assisted and supported this cooperative research effort, including the following present or past employees with the National Wildlife Research Center (NWRC) or the Texas WS program: Bob Beech, Jesus Cerda, Martin Mendoza, Ray Ramos, David Reinhold, Ricky Sramek, Patrick Smith, and David Trevino. We thank the late Jerry Roberts and the Analytical Chemistry personnel at the NWRC for their assistance in formulation and analytical studies. We especially thank Ray Prewett of Texas Citrus Mutual and the Texas citrus producers for their continued support during this project. Mark Tobin provided helpful comments on an earlier draft of this manuscript. This research partially was funded under cooperative Service agreement # 12-34-74-0245-TF with Texas Citrus Mutual.

## METHODS

Cage Trap Development and Evaluation

Three large (2.4 x 2.4 x 1.5 m) cage traps were assembled from 4 (2.4 x 1.5 m) side and 2 (2.4 x 1.2 m) top panels that were constructed from 2.5 x 5 cm welded wire fencing stapled onto 5 x 5 cm framing lumber. Traps were assembled by fastening panels together with plastic cable ties. Once assembled, each trap was supplied with dog food and cracked corn in rubber pans, water in a poultry waterer, a rubber pan bird bath, and roosting perches. A (2.4 x 1.2 m) plywood sheet was fastened to the roof panel to provide shade. Three trap designs were used, including a modified Australian Crow Trap (MAC) that used a crow ladder entrance with a 11.4 cm spacing between rungs (Zajanc and Cummings 1965), a modified blackbird decoy trap (DECOY) that incorporated enlarged entrance holes (NWRC Files, Ft Collins, CO), and a Bob-type pigeon cage trap (BOB) that had 2 (33 x 86 cm) bob entrances (Clark 1975). Based on our observations of grackle behavior during a

1-week trial exposure period to each trap design, we modified each of the traps before proceeding with a replicated evaluation of trap designs. Modifications made to the MAC and DECOY traps included the addition of 2 (15 x 15 cm) ground entrances, similar to those recommended for MAC traps when attempting to capture crows (Zajanc and Cummings 1965). The BOB trap was modified by including a wide funnel entrance (FUNNEL) of our own design (Figure 1). The funnel device tapered from a 86 x 33 cm opening to a 15 x 15 cm opening and projected into the trap about 60 cm. A 33 x 91 cm guide fence was positioned outside the center of the entrance opening to direct grackles into the funnel.

During spring 1993, we evaluated the 3 modified trap designs at 2 livestock feeding sites: the McAllen High School Farm, near McAllen, Texas, and the Tres Corales Ranch, Hidalgo County, Texas. To replicate these trials further, we repeated our evaluation at the latter site during spring 1994. To compare the relative effectiveness of these traps in capturing grackles, we positioned the 3 traps < 5 m apart at each site to reduce position bias on trap results. To reduce trap shyness, open traps were pre-baited with dog food and watermelon for up to 2 weeks. In addition, traps were pre-baited over weekends and other times when they were secured open and not tended. We baited traps with equal amounts of bread, watermelon, and dog food. Following the initial pre-baiting period, trapping at the McAllen High School Farm extended from 17 March to 25 March. Traps at the Tres Corales ranch were tested from 14 April to 19 May 1993 and again from 4 April to 15 April 1994. During these periods, traps were serviced daily, except for weekends, when they were not operated. Any grackles captured during trapping were removed daily and either marked and released or disposed of by euthanasia. All non-target animals were released unharmed from traps.

We recorded the number of grackles and non-target species trapped daily for each trap design. In addition, we estimated the number of grackles present within 100 m of the traps daily. We ranked grackle capture rates (number captured/day) among trap designs from each site or year and analyzed these data using a Kruskal-Wallis analysis. A Tukey's test was used to separate differences among means. No attempt was made to analyze capture rates of non-target species.

During summer 1993, we re-evaluated traps of the design that was most effective during the spring 1993 trials. Traps were deployed at 4 citrus groves (2-4 ha in size) located in eastern Hidalgo County. Sites were selected based on their past experience with grackle damage and on our observation of grackle presence and fruit damage during an inspection conducted in August. To assume independence among grackle populations, the citrus groves we selected (Anderson Estate, Freeloma, Rio Farms, B&B Enterprises) all were separated by $\geq$5 km.

At the edge of each grove, we deployed 1 trap baited with pieces of cut watermelon. Traps were pre-baited for approximately 1 week before initiating trapping. To restrict predators, we initially installed a multi-strand electric fence around the perimeter of each trap. We later removed these fences and operated the traps only during daylight hours. Traps were operated for approximately 1 month (11 August 1993 to either 8 or 10 September 1993) and rendered between 21 and 25 actual trapping days at each site.

To assess grackle and non-target species activity at each grove, we counted the number of grackles and non-target birds

seen in the immediate vicinity of these groves twice weekly during the trapping period. Groves were visited sequentially at about the same time each day from 0830 to 1130 h.

DRC-1339/Watermelon Bait Development and Testing

Initial development of the DRC-1339 watermelon formulation required examination of methods to effectively disperse the chemical in the watermelon. We found that chopping and homogenizing the pulp was the most practical method. This involved inserting an impeller (~2.5 cm) connected to a stainless steel shaft (~20 cm long) and mounted in an electric drill into a halved watermelon and chop-ping the pulp using an up and down motion for about 2 minutes. DRC-1339 was added to the homogenized water-melon mixture and blended for an ad-ditional minute using the impeller until the DRC-1339 appeared to be distributed evenly.

To evaluate the utility of the formulation and formulation procedure, we examined the dispersion of the DRC-1339 chemical within the watermelon formulation and its degradation under simulated field conditions. The first objective involved analyzing samples of treated watermelons for DRC-1339 content. The second objective involved chemical analyses of treated watermelons after 4 h and 8 h in a lighted environmental chamber maintained at $90^0$F.

Following formulation testing, we conducted preliminary trials to evaluate acceptance by and mortality of grackles exposed to 0.1% wt/wt DRC-1339 as delivered in our watermelon bait. Groups of 4 to 8 grackles were transported to a 2.4 x 2.4 x 1.5-m holding pen outside the WS storage facility near McAllen and supplied with perches, shade, and rations of dog food, cracked corn, and water. On the first day of the trial, untreated watermelon pulp was presented to penned birds for 4 h. We observed grackle behavior for 20-30 min after initial presentation to see if they would consume watermelon. We observed grackles from about 6 m away using a parked vehicle as a blind. After this exposure, we removed the watermelon from the pen and assessed watermelon consumption. Procedures during the second day of the trial were identical to the first, except that DRC-1339 was formulated into watermelon halves at 0.1% wt/wt of watermelon pulp using technical DRC-1339 previously assayed for active ingredient. After exposure to treated watermelon, we kept these grackles in captivity for an 3 additional days to assess mortality.

In 1995, an additional cage trial was conducted to assess the acceptance of an enhanced treated bait by grackles. A water soluble watermelon flavoring (Robert Koch Industries, Denver, CO) was added to the treated bait to help mask the odor of the DRC-1339. This cage trial was conducted similar to those previously run and used DRC-1339 treated watermelons with and without the 0.2% flavoring added to a 1 kg sample. Each 1-kg sample was presented to 8 grackles that had been pre-baited for 1 day with untreated watermelon. We estimated the amount of consumption of each sample the following morning and all birds were observed for 3 days after exposure to assess mortality.

DRC-1339/Watermelon Field Trials

***Bait formulation***—Current 24C label directions for bait formulation stipulate that we remove 10 pounds (4.5 kg) of watermelon pulp from the rind and place it in a large bowl. We then broke the pulp into small pieces by hand to facilitate chopping by the rotating impeller blade, used in an up and down motion for 2 minutes. We added 4.5 grams of technical DRC-1339 to this pulp/juice mixture and

distributed the chemical evenly by stirring it with the rotating impeller blade for an additional minute.

*Study sites*—Field trials were initiated in 1994 and continued in a similar manner in 1995. In July of both years, 6 grapefruit groves with a history of severe grackle damage were selected from within eastern Hidalgo County. To assure independence among grackle populations, all groves were spaced $\geq$ 5 km apart. During each year, 3 of the 6 groves were selected randomly to receive DRC-1339-treated watermelon baiting; the other 3 sites served as untreated controls.

*Treatments*—Treatment sites were pre-baited with untreated chopped watermelon for 1 to 3 days. The slurry mix was placed in bowls made from halved and excavated watermelons, which were situated in areas of the grove where grackles were observed to congregate. In 1994, 3 bowls, each containing 1 kg of chopped watermelon, were placed daily on elevated platforms and another 3 bowls were placed on the ground spaced approximately 30 m apart. In 1995, 5 bowls, each containing 1 kg of chopped watermelon, were placed exclusively on raised platforms located throughout the grove to facilitate baiting during irrigation. To enhance acceptance of treated bait in 1995, bowls were covered with a 2.5-cm cross section slice of watermelon (Watermelon Slice Lid), which was laid on its side and held in place with tooth picks.

Groves were baited during the last week of July in both years. Freshly prepared 0.1% DRC-1339-treated chopped watermelon was distributed at sunrise daily for 1 or 2 days, in bowls containing either 0.5 or 1 kg of treated watermelon. Treatment bowls were placed only at locations where more than negligible pre-bait consumption had occurred previously or high grackle use was noted. Treated bait was exposed only during the daylight hours for a minimum of 8 h daily.

Between 2 August and 17 August 1995, 4 additional groves (Buce, Chilson, Loop, Vealds Valley) were baited with DRC-1339/watermelon or a combination of DRC-1339/watermelon and DRC-1339/dog food. A process of 1 day of pre-baiting followed by 1 day of baiting was used, and all bowls were positioned on the ground. Overall, 2 to 4 kg of treated watermelon were applied at all 4 sites, and 0.9 to 1.4 kg of 1% treated dog food also was applied at the Buce and Chilson Grove sites, respectively.

*Bait consumption*—The contents of each watermelon bowl were weighed at the beginning and end of each day and consumption was estimated by subtracting the final weight from the initial weight. Weight loss due to evaporation was assessed daily by placing a bowl with an equal amount of chopped watermelon outside under a welded wire enclosure that prevented consumption by grackles and other animals. The proportion of weight loss from this enclosed bowl was subtracted from that of exposed bowls to estimate watermelon consumption by grackles.

*Grackle populations*—Grackle popula-tions in the immediate vicinity of both treated and control groves were estimated visually as birds were flushed from groves by observers driving the perimeter of each grove. Populations were sampled 3 times daily starting 3 days before treatment and ending 3 days after the end of treatment. The 3 daily sampling periods were from 0700 to 1100 h, 1100 to 1500 h and from 1500 to 1900 h. Once sampling times for each period were selected, groves were visited at approximately the same times each day. In addition, groves were visited weekly at these selected times and grackle populations were estimated beginning 7 days after treatment and ending about the

end of August.

*Damage assessment*—In 1995, we assessed grackle damage in the 2 treated and 2 control groves by examining all fruit on 15 trees in each grove for the presence or absence of grackle damage (Johnson et al. 1989). We selected the first tree at random; subsequent trees were selected systematically based on a tree-count interval determined by dividing the estimated number of trees in the grove by 15. Percent damage was calculated based on the total number of fruits damaged divided by the total number of fruits examined. Starting in September, or approximately 40 days after initial treatment, we conducted a second damage assessment, using procedures identical to those used in the first assessment and involving the same trees previously sampled. Differences in the percent of fruits damaged between the first and second assessment were assumed to represent the percent of damage sustained following treatment.

*Non-target hazards*—We used 3 methods to assess potential hazards to non-target animals, primarily birds. These involved pre- and post-treatment censuses, pre-bait and bait exposure observations, and dead animal searches. Non-target censuses were conducted at both treated and control groves 3 days immediately before treatment and 3 days immediately after treatment ended. Censuses were conducted along two 500-m transects, one inside the grove and the other in an adjacent habitat. Censuses were conducted between 0700 and 1100 h, and each grove was censused about the same time each day.

Pre-bait and bait exposure observations were conducted at treated sites 3 times/day during days of pre-baiting and baiting. These consisted of 30 min observations of all DRC-1339-treated watermelon bowls from a selected observation point located > 30 m away. Using binoculars or a spotting scope, we recorded the number and species of birds and other animals observed consuming treated or untreated watermelon every 5 min.

Dead animal searches were conducted at treated sites between 1500 and 1900 h on all baiting days. We used the same transects established for non-target censuses as our search areas.

**RESULTS**

Cage Traps

Initial observations of the unmodified traps suggested that grackles generally were wary of the traps, but were likely to approach a trap by landing nearby and walking up to it rather than landing on it. Thus, ground entrances seemed necessary to optimize trap success. In addition, we sensed that modifications were needed on the Bob trap because grackles were reluctant to push the bobs to enter this trap.

During 8 trapping days at the McAllen High School Farm site, 5, 8, and 67 grackles, respectively, were caught in the MAC, DECOY, and FUNNEL traps, which translates to capture rates of 0.6, 1.0, and 8.4 grackles/day for these traps. The total number of grackles trapped exceeded the average daily grackle population observed at this site, estimated at 62.5 birds during the trapping period. At the Tres Corales ranch, trapping was conducted from 14 April to 19 May, but, because grackle populations dropped to only 25 birds after 10 May (from an average population of 122 grackles previously in the area), only 18 trapping days were considered. The number of grackles caught during these 18 trapping days was 2, 6, and 29 birds, respectively, for MAC, DECOY, and FUNNEL traps. Capture rates (0.1, 0.3, and 1.6 grackles/day) at this site were lower for all trap designs, and appeared to

be affected by raccoon activity around traps during part of the trapping period. During 10 trapping days in April 1994, 44, 24, and 74 grackles, respectively, were captured at Tres Corales with MAC, DECOY, and FUNNEL traps (capture rates: 4.4, 2.4, and 7.4 grackles/day, respectively). Higher capture rates at this site in 1994 may have be due to a larger grackle population, which averaged 272.5 grackles observed during the trapping period, and the lack of predators. We noted higher capture success for DECOY and MAC traps that were positioned under tree limbs, where grackles commonly dropped down onto the traps from perching positions on these limbs.

Although capture rates for each trap design varied among sites and years, ranked capture rates among traps per site differed significantly ($P=0.0110$). The FUNNEL trap achieved consistently higher capture rates and differed ($P<0.05$) from both the MAC and DECOY traps. Ranked capture rates did not differ ($P>0.05$) between the MAC and DECOY trap designs.

The trapping success of FUNNEL traps used in citrus groves was considerably lower compared to earlier results. At Rio Farm, only 23 grackles were trapped during 25 trap days (trap success rate=0.92 grackles/trap/day), where the average population of grackles observed within the vicinity of this grove was >200 during the trapping period. At Freeloma, only 16 grackles were captured during 21 trap days (0.76 grackles/trap/day), but the mean population here was estimated at only 7.1 grackles during the trapping period. No grackles were trapped at Anderson Estate or B&B Enterprises during 22 and 21 trap days, respectively. We observed very few grackles at either of these groves.

DRC-1339/Watermelon Bait Development and Testing

Our preliminary formulation method (using the impeller blade for 2 minutes) was effective in chopping the melon into small pieces. Neither the size of the impeller blade nor time spent chopping produced much difference in the uniformity of the bait matrix, except for reducing the pulp almost to all juice. Pulp pieces made with the existing procedure ranged from approximately 1 g to 20 g, with a mean of approximately 8 g. DRC-1339-treated watermelon baits formulated at NWRC in an identical manner had a mean concentration of 0.098% (CV=7.8%) immediately after formulating. However, baits placed in an environmental chamber and exposed to simulated field conditions (90°F for 4 and 8 hours) had mean chemical concen-trations of 0.066% (CV=0.63%) and 0.058% (CV=1.4%), respectively.

The formulation procedure was simple and practical to perform under field conditions, but we found that initial crushing of larger pieces by hand was necessary to obtain uniform pulp texture. During the cage trials, grackles that fed on both treated and untreated watermelons perched on the edge of the rind and consumed pieces of pulp that floated in the pulp/juice matrix. In the first trial, only 3 of 8 grackles ate from either the untreated or treated watermelon and 3 died. In the next 2 trials, which involved 6 and 4 grackles, all consumed treated watermelon and all 10 died. In a subsequent cage trial, grackles were repelled by 0.1% DRC-1339 treated watermelon with 0.2% watermelon flavoring. Eight caged grackles consumed approximately 160 g of treated watermelon without flavoring, but consumed only a negligible amount of the flavored melon. Consistent with previous trials, all 8 birds died within 24 hours after exposure.

DRC-1339/Watermelon Field Trials

*Bait application, grackle use, and*

*consumption*—At the 3 groves selected for treatment during 1994 (Thompson-East, Thompson-West, Rio Farm-East), pre-bait acceptance appeared adequate after 2 days of pre-baiting. However, differential evaporation and consumption by bees confounded an accurate assessment of consumption by birds. Treated groves were baited either for 1 day (Thompson-East and Thompson-West) or 2 days (Rio Farm-East), where 1.5 or 3.0 kg of DRC-1339-treated watermelon was available per day, respectively. Post-treatment weights-of remaining treated watermelon indicated that birds did consume the product. Observations of the watermelon bowls conducted as part of our non-target evaluations (see below) provided a useful index to grackles' use of the watermelon. During 9 hours of pre-treatment observations during 1994, we recorded 435 grackles (48.3 grackles/hour) at the 3 pre-baited sites, whereas, during actual treatment, we observed 87 grackles (14.5 grackles/hour) at the treated bait during 6 hours of observation. Although grackles' use of bowls positioned on the ground was, on average, almost 1.5 times that of those on platforms, we detected no significant difference ($\underline{P}$=0.51) in use between bowls placed on the ground vs. those on platforms.

Puncture marks made by grackles through the watermelon slice lids, as used during 1995, provided a better index to how grackles responded to bowl placement. However, after pre-baiting the Anderson, B&B Airport, and Cray for 3 days, only Anderson demonstrated adequate pre-bait consumption to warrant baiting. Use of watermelon pre-baits positioned on platforms during 1995 was only 3.4 grackles/hour of observation. At B&B Airport and Cray, our observations suggested that grackles spent only a small part of the day in the grove, thus limiting the time available to find and consume watermelon. A fourth grove (Steward) later was selected, pre-baited, and treated by WS personnel. Five and 6 kg/day of treated bait, respectively, were applied during 2 days of baiting at Anderson and Steward.

*Grackle Populations*—Variability of grackle populations over time (Figures 2 and 3) may have masked changes in populations due to treatment. Grackle populations varied not only among days, but also within a day. Populations in untreated groves varied among morning, mid-day, and late afternoon censuses (P=0.0001), where morning counts consistently were higher (P=0.05) than the other 2 counts.

Our analysis of grackle population response to treatment involved 4 treatment groves (3 treated in 1994, 1 in 1995) and 4 control groves (3 used in 1994, 1 in 1995). Data from other treatment groves used in 1995 were incomplete and not used in our analyses. Ranked grackle populations 3 days before and 3 days after treatment did not differ (P=0.1482) between treated and control groves. However, grackle populations increased at 3 of 4 control groves and decreased by 37% - 85% at the 4 treated groves (Figures 2 and 3). We suspect the increase in grackle populations at control groves was associated with irrigation operations during post-treatment. Irrigation may have masked more dramatic treatment effects at the 3 groves that were treated during 1994. The Anderson grove (irrigated) showed an 85% reduction in grackle populations in response to treatment in 1995. Similarly, the Steward grove and other groves baited only with watermelon showed a 50-80% reduction in grackle populations immediately after treatment (Table 1). At 2 groves (Buce and Chilson), large pre-treatment grackle populations were reduced by at least 90% when 1% dog food baits were combined with watermelon baiting (Table 1).

Grackle populations that remained weeks after treatment may or may not have been influenced by treatment. An analysis of variance of the slope of grackle population trends over the month following treatment showed no significant difference (P=0.282) between treated and control groves. However, populations at treated sites appeared to remain low at least 2 weeks after treatment, whereas grackle populations at control groves during the same period consistently exceeded pre-treatment levels (Figures 2 and 3).

*Citrus Damage*—During 1995, damage assessments conducted at 2 treated and 2 control test sites at the time of treatment and again ~40 days later suggest that DRC-1339/watermelon baiting reduced grackle damage. Damage recorded at the 2 treated groves was slightly less than estimated initially, whereas control groves experienced slightly greater damage ($\underline{t}$=-4.357, d.f.=2, $\underline{P}$=0.0488) (Table 2). We suspect that much of the damage occurred prior to treatment in late July and the small decreases in assessed damage between assessments may represent the degree of error in our assessment methodology.

*Non-target Hazard Evaluations*—The 3 methods we used to assess non-target hazards associated with DRC-1339/watermelon baiting all revealed no evidence of significant non-target hazards. Our surveys of non-target populations 3 days before and 3 days after treatment found 25 species of birds and 2 species of rabbits present within the test groves. However, of these 27 species, only mourning doves (*Zenaida macroura*) were present in sufficient numbers to allow analysis. Changes in mourning dove populations before and after treatment did not differ (F=0.23; d.f.=1,6; P=0.65) between treated and control groves. During 1994, mourning dove populations increased immediately after treatment in all but 1 treated grove and in all control groves, whereas, during 1995, dove populations decreased slightly over the same period (Table 3). However, only several of these within-grove changes were significant (Table 3). We suspect that the changes in dove numbers, like those of grackles, were related to irrigation operations at these groves.

One cottontail rabbit (*Sylvilagus floridanus*) was observed feeding at a watermelon bowl during 54 hours of observation at 65 watermelon bowls (includes both pre-baiting and baiting periods). In contrast, 681 grackles fed at these bowls during this same period.
We found no carcasses of non-target species during 3.8 hours of searching within and adjacent to treated groves during each day of treatment. However, we found 6 dead grackles at Steward after baiting during 1995.

**DISCUSSION**

Our results suggest that the large funnel entrance cage trap of our own design was most successful in capturing great-tailed grackles. This is consistent with previous observations (West and Brunton 1967) that suggest that ground entrance traps, such as the Chachalaca trap, are more effective than the MAC trap. The large entrance and guide fence features of this trap facilitate entry by grackles that normally approach a trap by walking up to and around them. The use of a large, tapering entrance has been reported previously and was recommended as the best way to capture black-billed magpies (*Pica pica*) (Clark 1975). The tapering of the entrance also reduces escapes by grackles and precludes larger birds and mammals from entering. Although measuring escape rates was not a stated objective of this study, we noted that very few grackles escaped from this trap.

Several factors may account for the reduced capture success of the FUNNEL trap during summer in citrus groves. Low or inconsistent number of grackles in the proximity of these traps probably was paramount. Few birds were trapped at most sites because few birds were present on days we trapped. We suspect the electric fences we installed around the traps initially may have reduced trap success. At Anderson Estate, grackles rapidly consumed watermelon during pre-baiting, but appeared to avoid the trap completely after the electric fence was installed. This avoidance persisted after the electric fence was removed. Following the removal of these fences, we ran traps only during daylight hours to limit the effects of predation. This also reduced the length of the trapping day to <11 hours, and traps were not operated during early morning hours just after sunrise when grackles are most active.

Efficacy of 0.1% DRC-1339 treated watermelon in our cage trials was consistent with toxicity data of DRC-1339 to great-tailed grackles. Using cage trials, West and Brunton (1967) calculated an $MLD_{100}$ for DRC-1339 to great-tailed grackles at 1.8 mg/kg. Using an average weight of 200 gm for a male grackle, then a single 1 gm piece of 0.1% bait should be lethal (approximately 1 $MLD_{100}$) even when allowing for some degradation of the chemical. However, the rapid degradation of chemical content we observed in these baits necessitated that fresh baits be prepared daily.

Temporal variation of grackle numbers in citrus groves provided information about the effective timing of such treatments. Based on times when grackles are most abundant in groves, treatment probably should be applied early in the morning when groves are being irrigated. Our field efficacy tests suggest that DRC-1339-treated watermelon may reduce grackle populations in citrus groves during the summer and have no measurable effects on non-target populations. Although extensive use by grackles may have limited our ability to accurately assess impacts on non-target species, we believe our tests indicated that watermelon baits should be placed on elevated platforms or on the ground along the edge of groves to limit exposure of non-target species to the treatment. More recent records of DRC-1339/watermelon baits during 1996 and 1997 control operations at 15 groves in the Rio Grande Valley (Wildlife Services Files, McAllen, TX) further demonstrate the efficacy of this formulation. About 1-2 liters of this formulation used for 1 day reduced grackle populations in citrus groves from 75-100% ($\bar{X}$ =89.6%) within a week after treatment compared to pre-treatment populations that ranged from 20-275 birds.

By reducing grackle populations in citrus groves, one also presumably reduces the amount of damage they caused to ripening fruit. In the cases where we measured damage, this appeared to be true. The apparent reduction of damage in these groves over time may have been an artifact of damage assessment error rather than a treatment effect. However, it also suggests that no appreciable new damage occurred after baiting, which was in contrast to the measurable damage that occurred at our 2 control groves.

**MANAGEMENT IMPLICATIONS**

Watermelon appears to be effective as a trap bait and a DRC-1339-treated bait used to reduce summer grackle populations associated with citrus damage, without detectable hazard to non-target species. This has critical importance to efforts to reduce citrus damage because previous studies indicate that most damage by grackles occurs during summer (Johnson et al. 1989) and alternative methods are not effective at this time

(Rappole et al. 1989).

Trapping likely will not remove grackles from the population as rapidly as toxic baiting does, but it supplements baiting and should be considered part of an integrated control program. An advantage of trapping is that it can be conducted by growers, whereas, under the current 24C registration, DRC-1339 baiting can be conducted only by WS personnel. Small portable traps might be more practical for growers to place within or move about in the grove than the large traps we utilized. We suggest that the entrance dimensions for these smaller traps must be the same as those of the larger traps, and food, water, and shade must be provided to grackles or any non-target species that might enter the trap. Traps should be pre-baited and the doors left open for several days (or until evidence that watermelon bait is being consumed). Traps should be set at sunrise to correspond with peak grackle activity in groves and checked before dark to prevent predation. Trapping during periods of irrigation also will increase trap success because grackles are more numerous in groves at these times.

A number of factors need to be considered when using DRC-1339-treated watermelon. First, the DRC-1339 treated watermelon bait quickly degrades in response to heat and light. It should be used immediately after preparation, especially at sunrise to correspond with peak grackle activity and lower temperatures. We also recommend using watermelon slice lids to shade the treated bait and help retard degradation. Lids appeared to increase acceptance by grackles and helped limit access to the treated bait by non-target birds. Regarding potential non-target hazards, DRC-1339-treated watermelon is not as selective in controlling grackles as the previously registered DRC-1339-treated dog food bait. Therefore, watermelon should be used only when the latter bait is ineffective. We have no conclusive evidence that placing bait on the ground or on platforms affected its effectiveness or safety, so both options should be evaluated by the applicator. Although ground placement sometimes may be preferable, the timing of baiting with respect to irrigation efforts suggest that the use of platforms may be more effective and logical.

Although not the panacea for controlling grackle damage to citrus, removal of post-breeding grackles from citrus groves with traps or DRC-1339/watermelon baits can provide additional methods to control citrus damage during a period when alternative methods typically are ineffective.

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Table 1. Counts of great-tailed grackles (*Quiscalus mexicanus*) in citrus groves 1-day before (PRE-COUNT) and approximately 1 week after (POST-COUNT) 1 or 2 days of treatment with 0.1% DRC-1339-treated watermelon alone (WATERMELON ONLY) or in combination with 1% DRC-1339-treated dog food (WATERMELON + DOG FOOD) by Texas Animal Damage Control personnel in August 1995.

| | | NUMBER OF GREAT-TAILED GRACKLES | | |
|---|---|---|---|---|
| GROVE | TREATMENT | PRE-COUNT | POST-COUNT | % REDUCTION |
| STEWARD** | WATERMELON ONLY | 50 | 20 | 60 |
| LOOP FARMS | WATERMELON ONLY | 30 | 15 | 50 |
| VEALDS VALLEY | WATERMELON ONLY | 75 | 15 | 80 |
| BUCE | WATERMELON & DOG FOOD | 500 | 30 | 94 |
| CHILSON | WATERMELON & DOG FOOD | 200 | 20 | 90 |

** 2 consecutive days of baiting

Table 2. Changes in percent of estimated great-tailed grackle (*Quiscalus mexicanus*) damage to citrus in Hidalgo County, Texas, as assessed during the last week of July (immediately following treatment) and on 6 or 7 September 1995 at 2 treated and 2 control groves following treatment with 0.1% DRC-1339-treated watermelon.

| | JULY DAMAGE (%) | SEPTEMBER DAMAGE (%) | CHANGE IN DAMAGE (%) |
|---|---|---|---|
| TREATED GROVES | | | |
| ANDERSON | 4.8 | 4.3 | -0.5 |
| STEWARD | 4.1 | 2.5 | -1.6 |
| CONTROL GROVES | | | |
| RIO FARM-EAST | 1.0 | 2.3 | +1.3 |
| THOMPSON | 14.0 | 15.7 | +1.7 |

Table 3. Mean number of mourning doves (*Zenaida macroura*) observed in or adjacent to treated and control citrus groves in Hidalgo County, Texas, during 3 consecutive days before and after treatment with 0.1% DRC-1339-treated watermelon during July 1994 and July 1995.

| | PRE-TREATMENT $\bar{X}$ ± S.E. | POST-TREATMENT $\bar{X}$ ± S.E | % CHANGE |
|---|---|---|---|
| TREATED GROVES | | | |
| ANDERSON (1995) | 21.67 ± 1.66 | 13.33 ± 1.33 | -38.6 ** |
| RIO FARM-EAST (1994) | 9.67 ± 4.70 | 4.33 ± 1.45 | -55.2 |
| THOMPSON-EAST (1994) | 14.33 ± 4.37 | 23.67 ± 0.67 | +65.2** |
| THOMPSON-DW (1994)* | 38.00 ± 17.0 | 65.00 ± 9.0 | +71.1 |
| CONTROL GROVES | | | |
| RIO FARM-EAST (1995) | 5.33 ± 1.45 | 3.67 ± 2.03 | –31.1 |
| RIO FARM-WEST (1994) | 36.0 ± 4.04 | 51.0 ± 9.07 | +41.7** |
| STEWARD (1994) | 21.0 ± 3.51 | 25.67 ± 4.25 | +22.2 |
| STEWARD-HARGILL (1994) | 9.33 ± 1.76 | 20.0 ± 10.60 | +89.3 |

* ONLY 2 PRE-TREATMENT AND 2 POST-TREATMENT CENSUSES WERE CONDUCTED AT THIS GROVE

** INDICATES SIGNIFICANT ($P < 0.05$) CHANGES BASED ON T TEST OF MEANS

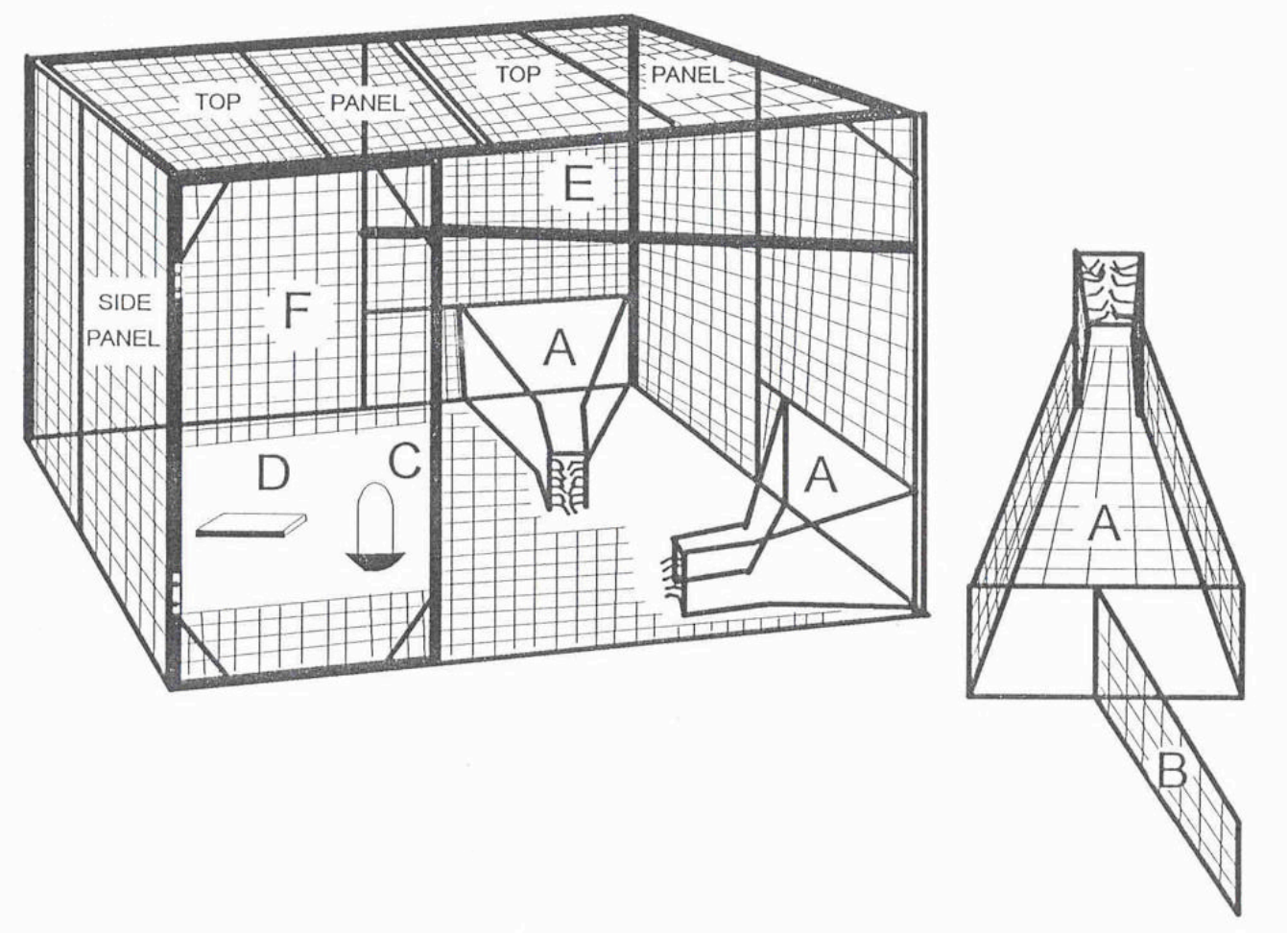


Figure 1. A 6-panel (4 [2.4 x 1.5 m] side panels and 2 [2.4 x 1.2 m] top panels) great-tailed grackle (*Quiscalus mexicanus*) cage trap that features a large (86 x 33 cm) funnel entrance (A), the opening of which tapers to 15 x 15 cm, and a 33 x 91 cm guide fence (B). A poultry waterer (C), food tray (D), and perch (E) are provided to sustain grackles or other captured birds. A (0.8 x 1.4 m) hinged door (F) on the front side panel allows access for servicing. Hot weather options not shown include a (2.4 x 1.2 m) plywood sheet fastened to the roof panel to provide shade and an 11-L rubber pan filled with water for a bird bath.

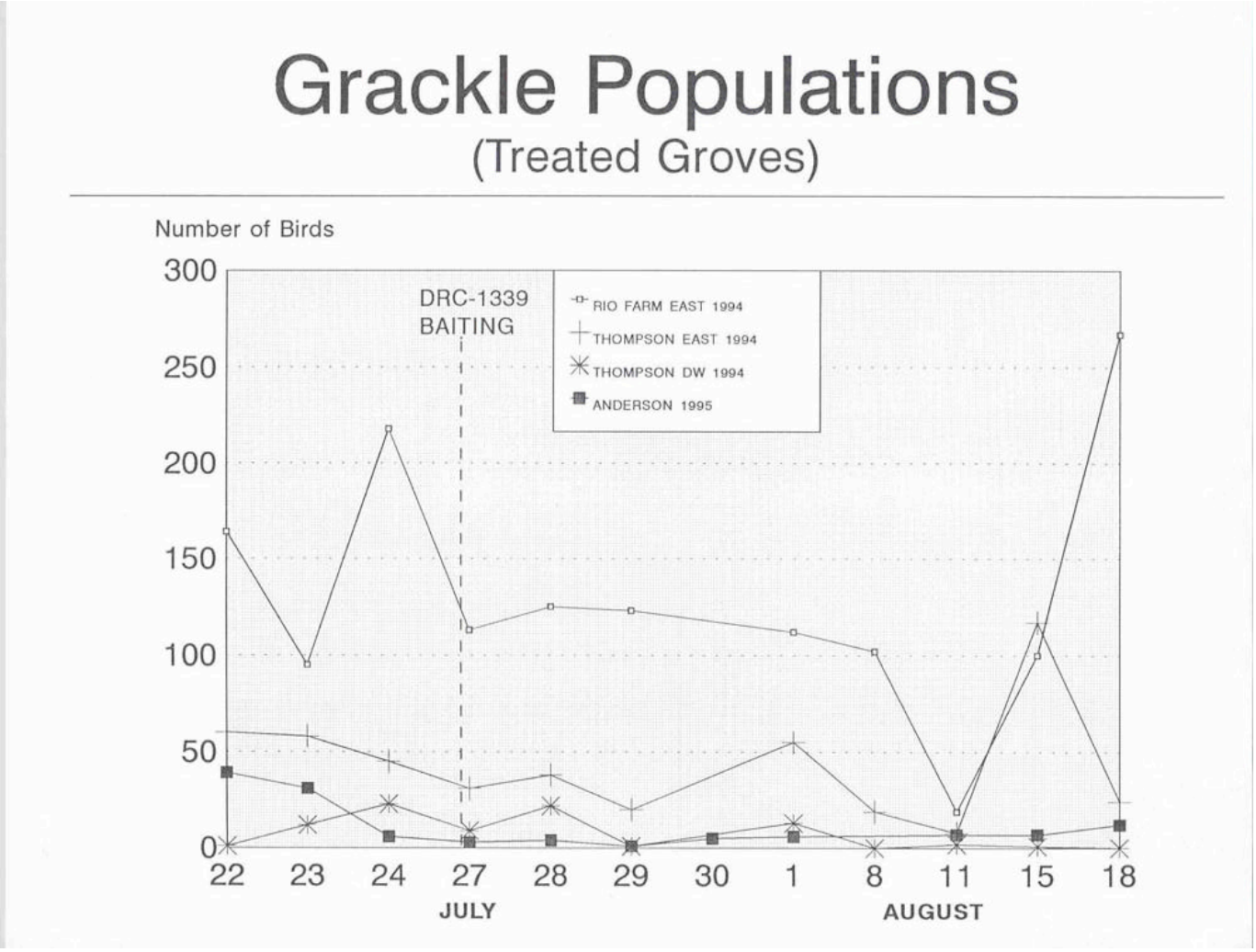


Figure 2. Mean daily population census counts of great-tailed grackle (*Quiscalus mexicanus*) at 4 citrus groves in Hidalgo County, Texas, conducted 3 consecutive days before treatment, then daily (for 3 days) and weekly (for 5 weeks) following treatment with 0.1% DRC-1339-treated watermelon during July 1994 and July 1995.

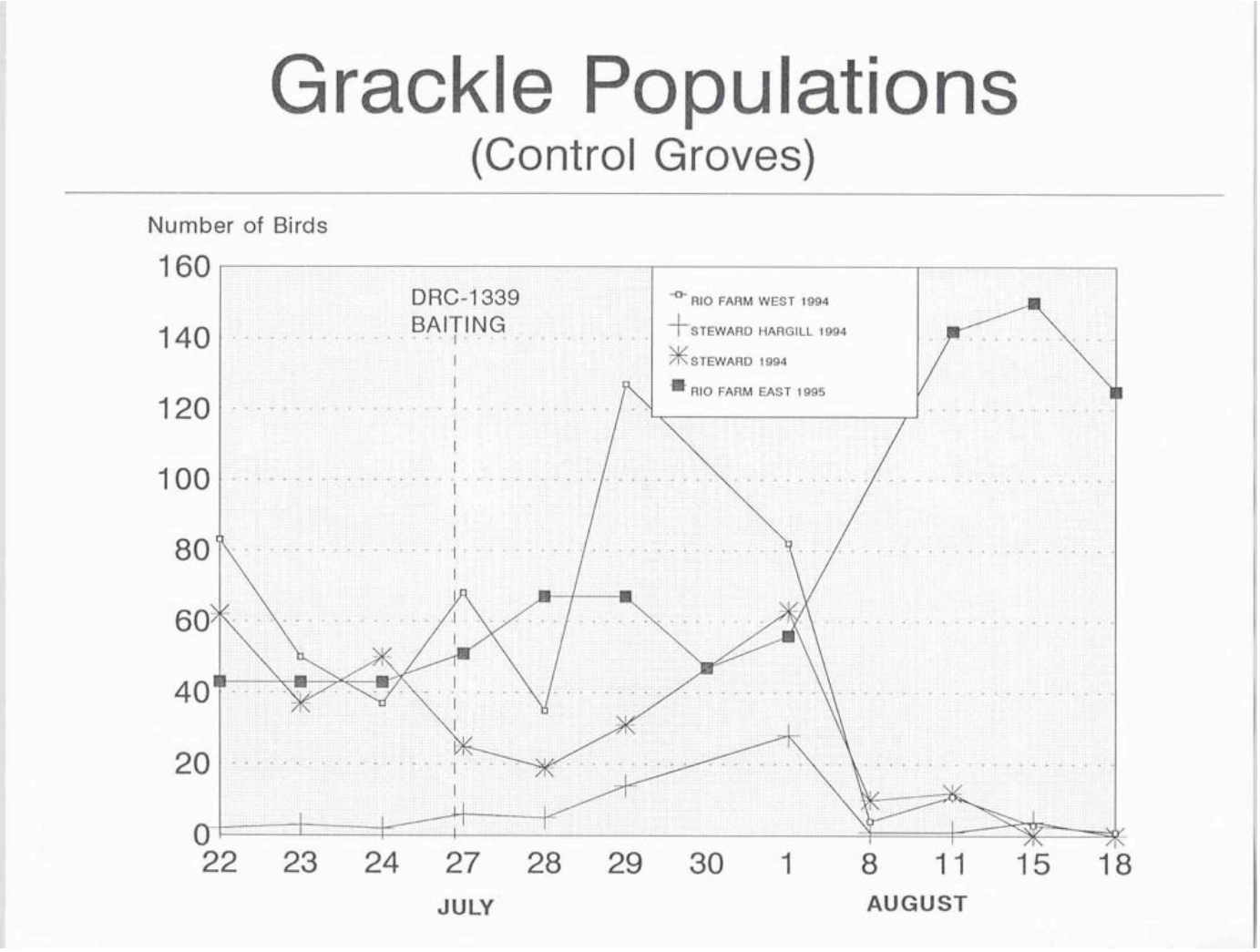


Figure 3. Mean daily great-tailed grackle (*Quiscalus mexicanus*) population estimates at 5 control (untreated) citrus groves in Hidalgo County, Texas for 3 consecutive days before treatment and at daily (for 3 days) and then weekly (for 5 weeks) intervals following treatment with 0.1% DRC-1339-treated watermelon in July of 1994 and 1995.

# DEVELOPMENT OF AN INTEGRATED CANADA GOOSE MANAGEMENT PROGRAM IN VIRGINIA

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Abstract: Wildlife managers in the State of Virginia developed an integrated Canada goose (*Branta canadensis*) damage management program in 1996 to address increasing damage caused by resident (non-migratory) Canada geese, primarily in urban/suburban areas. The previous Canada goose damage management program relied primarily on harassment and relocation. The integrated program was made available to citizens, homeowner associations, businesses, organizations, city and county governments, and state and federal agencies in 1997. The Integrated Canada Goose Management Program was developed by U.S. Department of Agriculture-Animal and Plant Health Inspection Service-Wildlife Services, Virginia Department of Agriculture and Consumer Services, Virginia Department of Game and Inland Fisheries, and the U.S. Fish and Wildlife Service. An aggregate of environmental, hunting, animal welfare, and agriculture groups, airports, golf courses, utilities, homeowner associations, federal agencies, and state and county government attended a focus group meeting and commented on the integrated Canada goose damage management plan. The plan implemented biological control, habitat alteration, harassment, exclusion, husbandry, repellents, and population management strategies. A new method, capture and euthanasia, was made available under the population management strategy. Capture and euthanasia was made available because other population management methods (i.e., hunting) were unavailable in some urban/suburban areas, relocation of resident Canada geese was unrealistic because resident Canada geese were a problem statewide, and resident Canada goose populations numbered >200,000 birds in 1996 and were growing 10-15% annually statewide. Canada geese captured in urban/suburban areas in 1997 (n=1,548) were brought alive to meat processors for processing and packaging. Hunters for the Hungry, a statewide charity, distributed processed Canada goose meat to local food banks. The entity requesting capture and euthanasia services under this program reimbursed USDA for services received.

Key Words: *Branta canadensis*, Canada goose, capture, damage management, euthanasia, integrated response, Virginia

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## INTRODUCTION

Conflicts and damage between humans and wildlife are common in the State of Virginia. The United States Department

of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services (USDA-APHIS-WS), Virginia Department of Agriculture and Consumer Services, Office of Plant and Pest Services (VDACS), and Virginia Department of Game and Inland Fisheries (VDGIF) received 2,043 Canada goose damage complaints from the public from April 1, 1992 through June 30, 1996 (Lowney and Dewey 1997). Canada goose complaints were the first or second most common wildlife damage complaints reported to APHIS and VDACS each year during this period. Resident Canada geese are believed to be involved in nearly all complaints about Canada goose damage. The term "resident Canada goose" refers primarily to a locally breeding Canada goose that nests and raises its young in Virginia. Resident Canada geese do not migrate to Canada, but remain in Virginia year-round.

Canada goose complaints have been received from 53 counties and 10 independent cities in Virginia (Figure 1). The greatest number of calls has come from counties in northern Virginia, including Fairfax and Loudoun Counties. The higher densities of both Canada geese and humans in northern Virginia probably contribute to the large number of damage complaints from that region.

Historically, there was a loose agreement among VDACS, APHIS, and VDGIF on how to manage damage involving resident Canada geese. VDACS, VDGIF, and APHIS worked together or separately to capture and relocate resident Canada geese since 1979 to alleviate local damage (Table 2). VDACS and APHIS provided technical assistance, loaned propane cannons, and sold or loaned pyrotechnics to alleviate damage or conflicts involving resident Canada geese. VDGIF provided technical assistance and created hunting opportunities to alleviate damage involving resident Canada geese.

APHIS is directed by law to protect American agriculture, human health and safety, property, and natural resources from damage associated with wildlife. VDACS is directed by law to protect Virginia agriculture, property, and human health and safety from damage associated with wildlife. VDGIF is directed by law to conserve wildlife and provide recreational opportunity to hunt, fish, trap, and boat in Virginia. The U.S. Fish and Wildlife Service (USFWS) is directed by law to conserve, protect, and enhance migratory birds and threatened and endangered species.

Wildlife damage management is defined as the alleviation of damage or other problems caused by or related to the presence of wildlife. It is an integral component of wildlife management (Leopold 1933, the Wildlife Society 1990, Berryman 1991). The coalition of state and federal agencies use an Integrated Wildlife Damage Management (IWDM) approach (sometimes referred to as Integrated Pest Management, or IPM) in which a combination of methods may be used or recommended to reduce wildlife damage. IWDM is described in Chapter 1, 1-7 of *The Animal Damage Control Program Final Environmental Impact Statement* (USDA 1994).

Despite the efforts by APHIS, VDACS, and VDGIF, the number of Canada goose damage or conflict complaints and the resident Canada goose population continued to increase. APHIS, VDACS, and VDGIF believed damage to property, human health and safety, and agriculture would continue to increase, especially in urban/suburban environments, if resident Canada goose damage management strategies did not change and resident Canada goose populations continued to grow at 10-15% per year. Additionally, the public was frustrated by increasing

Canada goose damage and perceived government inaction. APHIS, VDACS, VDGIF, and USFWS formed a coalition in December 1993 to develop a resident Canada goose management plan. We will report on development of the plan, implementation of the program, and results through 1997.

**DEVELOPMENT OF THE PLAN**

Canada geese are a public resource managed by the state and federal governments on behalf of the public. The Coalition decided several types of information were needed to help explain Canada goose damage management to the public: population status and biological information about resident Canada geese, data on damage, and information about the methods available to alleviate damage. Public input was requested by the Coalition to improve the resident Canada goose management plan.

Canada Goose Biology And Population Status

Present-day populations of resident (non-migratory) Canada geese originated from birds that were released or escaped from private waterfowl collections or hunting clubs 40-50 years ago, and from birds that were moved here from other areas (Costanzo 1993). These geese were descendants from non-migratory stocks of geese and probably included a mix of several different subspecies, including, the giant (*Branta canadensis maxima*), western (*B. c. moffitti*), and interior (*B. c. interior*) races of Canada geese. Twenty years ago, the resident Canada goose population in Virginia was limited to the northern and northern piedmont regions. Since that time, the population of geese has grown and expanded statewide.

Population status of resident Canada geese in Virginia has been determined by VDGIF staff using survey data from the Atlantic Flyway Breeding Waterfowl Plot Survey since 1991 (Table 1). Local breeding populations of Canada geese in Virginia have been increasing for the last 7 years, averaging a 10-15% annual population growth (G. Costanzo, VDGIF, pers. commun.). This increase may be the result of exploitation of human-provided food resources (i.e., grass, turf; Conover and Chasko 1985) and a predator-reduced urban/suburban environment. Also, resident Canada geese that reside mainly in urban or suburban settings are afforded almost complete protection from harvest by hunting (U.S. Fish and Wildlife Service 1995).

Canada goose feeding behavior, habitat preference, breeding behavior, and adaptability to human-created environments create situations in which Canada geese and humans conflict. Canada geese feed on clover, grasses, and cereal grains. Along the Atlantic Flyway, Canada geese seem to have changed from a diet dominated by aquatic plants to a diet dominated by upland crops (Bellrose 1976). Canada geese also favor short, manicured grass, particularly near a water source, for loafing and feeding. Golf courses and other developed areas serve as adequate habitat for resident Canada geese because food, water, and protection from predators are available (Conover and Chasko 1985). Additionally, humans feeding the geese enrich the attractiveness of developed environments.

Both non-migratory (resident) and migratory Canada geese occur in Virginia. Migratory Canada geese occur in Virginia from late September through early March (G. Costanzo,VDGIF, pers. commun.). Banding studies suggest a majority of resident Canada geese remain within 20-25 miles of where captured and banded (G. Costanzo, VDGIF, pers. commun.) unless severe winter weather forces them to migrate (P. Costelli. NJ Fish and Game, pers. commun., Johnson and Castelli,

unpublished data). Ninety-five percent of resident Canada geese observed wintering in the Chesapeake Bay region (Delaware, Maryland, and Virginia) did not migrate (Hestbeck 1995).

Resident Canada geese nest from March through June in Virginia. Eggs hatch in approximately 30 days. Parent geese are very protective and aggressive in defense of the nest and young.

Canada Goose Damage

Canada goose damage/conflicts affect several types of resources in Virginia, including property, human health and safety, agriculture, and natural resources (Table 2). Property damage most often involves landscaping and walkways, usually on golf courses and water front property. Geese graze turf, and also feed by pulling grass plugs from golf greens in summer.

Canada geese negatively impact human health and safety in several ways. First, fecal matter is a disease concern (i.e., Salmonella) to humans by contact with hands and then eyes, nose, and mouth. Canada goose presence on and around airports creates a threat to aviation and human safety. Canada geese have been involved in aircraft strikes in Virginia, resulting in costly repairs to airplanes. These geese also act aggressively to small children during nesting and brood rearing, resulting in children being bitten and beaten with wings. Additionally, traffic hazards are created when Canada geese walk across streets and other roadways.

Agricultural resources damaged by Canada geese include grain crops and possibly livestock. Grazing of pastures and alfalfa meadows can deprive livestock of food and impose economic hardships on livestock producers. Geese have grazed a variety of crops in Virginia: barley, wheat, rye, oats, corn, and peanuts.

Geese are suspected of affecting the health of livestock by contaminating drinking water and pastures. Salmonella has been detected in cattle herds in northern Virginia. State veterinarians suspect Canada geese are the most likely source in transmission of salmonella to affected cattle (Dr. Lisa Crofton, Dr. Joe Garvin, Dr. Robert Ruth, and Dr. Ronald King, VDACS, pers. commun.) and that Canada geese are a risk factor to cattle for salmonella (Dr. Lauren Worneck, VA Tech, pers. commun. to Dr. Lynn Tobias, USDA-APHIS-Veterinary Services). Salmonella causes shedding of the intestinal lining and severe diarrhea in cattle. If undetected and untreated, salmonella can kill cattle and calves. Cattle producers are concerned about the health of livestock drinking from ponds contaminated with large quantities of goose droppings.

Canada geese negatively impact Virginia's natural resources. Excessive numbers of Canada geese have affected water quality around beaches and wetlands. Accumulated droppings in swimming areas are considered unhealthy by resorts and swimmers. Sewage treatment plants in Virginia are required to test effluent water quality before release from finishing ponds into the environment. Sewage treatment plants find coliform bacteria counts increase when Canada geese are present and decline when the geese are removed (R. Pennington, Upper Occoquan Sewage Authority, pers. commun.; Amy Pratt, Upper Occoquan Sewage Authority, unpublished data).

The majority of Canada goose damage occurred March through October, with 40% of damage reported during June and July (Table 3). Canada goose damage has occurred in many forms, with a majority of the complaints (83%) involving droppings or feeding/grazing (Table 4).

## METHODS AVAILABLE TO REDUCE CANADA GOOSE DAMAGE

The scientific literature and experience of the Coalition were used to identify strategies and methods that had the best potential to reduce damage caused by Canada geese. Methods are components of a strategy. Methods such as unregistered toxicants and drugs, experimental contraceptive drugs, effigies (scarecrows), and lure crops were determined to be harmful to the environment, illegal, or ineffective, and were removed from consideration (Lowney and Dewey 1997). Further, a method initially considered (biological control: mute swans) was removed from consideration after analysis determined this method was harmful to the environment and ineffective (Lowney and Dewey 1997). The following methods were considered viable means to alleviate damage caused by Canada geese: a) harassment (distress calls, pyrotechnics, reflective tape, flags), b) biological control (dogs), c) exclusion, d) habitat alteration, e) husbandry (stop artificial feeding, remove domestic or feral waterfowl), f) repellents, and g) population management (hunting, relocation, harassment and supplemental shooting, nest/egg destruction, euthanasia). Lowney and Dewey (1997) discuss the effectiveness of the methods available to alleviate damage caused by Canada geese.

## PUBLIC INPUT

Federal agencies are required by the National Environmental Policy Act (NEPA) to seek public involvement when significant federal actions are considered or may be taken. Federal agencies also may elect to write environmental assessments (EA) as communication and decision documents even though the federal action categorically may be excluded by NEPA. The Coalition chose to request public involvement to improve the plan and to use the EA as a communication document.

Public involvement was solicited 3 ways. A legal notice was placed in the *Richmond Times Dispatch* and *Roanoke Times* for 5 days requesting comments on a proposed EA to manage damage and conflicts associated with non-migratory (resident) Canada geese. Additionally, 76 letters describing the scoping process were mailed to affected groups: homeowner associations, golf courses, county government, federal agencies, state agencies, environmental advocates, animal welfare advocates, hunters, business, universities, schools, and waterfront property owners. Finally, 30 representatives of the above groups were invited to a group meeting to discuss Canada goose biology and population status, damage in Virginia, and alternatives to alleviate damage. At all stages of the public input process, comments were solicited and appropriate changes made to the EA.

## IMPLEMENTATION OF THE PROGRAM

The Integrated Canada Goose Management Program was implemented in steps within each federal and state agency's authority until the complete program could be implemented in 1997. The cumulative impacts of the integrated Canada goose management program would be expected to slow the population growth rate of resident Canada geese and reduce the number of complaints coming from the same local areas. The Coalition looked at which strategies could be implemented by citizens coping with goose damage and which strategies could be implemented by federal and state agencies (Table 5). We report here on strategies and methods that were implemented by state and federal agencies.

Removal of problem waterfowl would be expected to alleviate damage. And, other Canada geese would be expected to fill the

vacant habitat over time. The amount of time to reoccupy the vacant habitat could range from months to years (Table 6). It would be expected to take years for waterfowl to return to the population levels that existed before relocation, nest/egg destruction, hunting, and capture and euthanasia were implemented. The reduction of Canada goose damage would be expected to be satisfactory to most affected citizens.

Hunting

VDGIF has regulatory authority to set hunting seasons for resident Canada geese within a framework established by the USFWS. A September hunting season for resident Canada geese was initiated in 1993 to help control the population growth rate of resident Canada geese and provide recreational opportunity (Costanzo 1994) (Table 7). A regular November-January hunting season prior to 1995 allowed for the harvest of resident and migratory Canada geese. However, the November-January hunting season on Canada geese was closed in 1995 due to declining numbers of migratory Canada geese (*Branta canadensis interior*) caused by successive years of poor nesting conditions in the Arctic. A special late winter hunting season was initiated in 1997 from January 15-February 8 to help control the growth rate of resident Canada geese while the regular season was closed. The late winter hunting season was allowed west of Interstate 95 to minimize potential harvest of migratory Canada geese that winter primarily east of Interstate 95.

Relocation

Relocation of problem waterfowl was an acceptable option to most people. Only state and federal agencies were permitted to relocate waterfowl in Virginia. VDACS and APHIS, assisted by VDGIF, captured and relocated 9,844 resident Canada geese from 1979 through 1996 to alleviate local damage in Virginia. Canada geese were captured in 30 counties and relocated to rural areas. Fifty-seven percent of the resident Canada geese were captured in Fairfax, Albemarle, James City, and Prince William counties. Relocation temporarily alleviated damage in one location, but likely stimulated future damage in another location.

Factors limiting relocation of wild animals are disease transmission, funding, food, shelter, water, and intra- and interspecific competition (Nielsen 1988). Relocation successfully has resolved many urban/suburban Canada goose problems in Virginia (Lowney and Dewey 1997). However, the availability of release sites limits relocation of waterfowl (Fairaizl 1992), and the availability of release sites in Virginia was approaching zero. Release sites for Canada geese were identified as having adequate water and grass at least 25 miles away from golf courses, office parks with retention ponds, city, county, or state parks, and recreational areas.

Nest/Egg Destruction

Egg addling, oiling, freezing, and puncturing would be effective at reducing Canada goose recruitment into the local population (Christens et al. 1995). However, the aggressive behavior of nesting Canada geese could intimidate some people and result in eggs not being treated as recommended. VDACS and APHIS would treat or remove eggs/nests when requested and resources allowed. Canada geese that had eggs oiled in successive years learned to nest away from the water, making it more time consuming to find nests (R. Thomas, VDACS, pers. commun.).

The expected results of nest/egg destruction were that damage would continue if the method was used alone. Damage would continue because Canada geese are long-lived birds and population levels were exceptionally high in some

regions of Virginia. The number of geese recruited into the local population would be less than if nest/egg destruction did not occur. Adult populations of Canada geese would be expected to remain stable until other birds immigrated into the local area.

Euthanasia

Resident Canada geese causing conflicts would be captured primarily with panel traps during the summer molting period. Geese could be captured with rocket nets, swim-in and decoy traps, dip nets, and by hand. Alpha chloralose (Investigational New Animal Drug-6602) also could be used to capture Canada geese. Resident Canada geese captured from March 21 through August 31 would be processed for human consumption and donated to charity. Birds captured with alpha chloralose would be unavailable for human consumption for 30 days pursuant to Food and Drug Administration (FDA) restrictions. Only APHIS employees would be allowed to use alpha chloralose, per FDA restrictions.

Canada geese would be captured from September 1 through March 20 and euthanized to protect human health and safety only. Resident Canada geese would be processed for human consumption and donated to charity. Because migrant Canada geese could be present during the September 1 through March 20 time frame, the USFWS and VDGIF have requested that capture and euthanasia of migrant Canada geese be avoided.

Captured geese would be processed by meat/poultry packers. A statewide charity, Hunters for the Hungry, would be used to notify local food banks of the availability of processed Canada goose meat. State and local prisons/jails could be recipients of processed waterfowl. The cost of processing waterfowl would be born by the citizens, organizations, or local governments requesting removal of the problem Canada geese.

Waterfowl captured from industrial sites would not be used for human consumption because chemical residues may be presented in the tissue of Canada geese (Amundson 1988, cited from Cooper 1995). There is no evidence in the literature to indicate that geese captured on golf courses, parks, or other turf areas are unfit for human consumption (Cooper 1995). New York Department of Environmental Conservation (DEC) tested for pesticide residue and heavy metals in Canada geese from Clarkstown, NY, in 1997 and found no pesticide residues (B. Swift, NYDEC, pers. commun.) and lead was below Environmental Protection Agency limits established for fish (Dr. Tripathi, VA Department of Health, pers. commun.). The Michigan Department of Agriculture analyzed Canada goose tissue for heavy metals and pesticides in 1997 and found results similar to those of NYDEC.

The capture and euthanasia of resident Canada geese normally would be conducted by APHIS when other alternatives were demonstrated to be ineffective or impractical. Additionally, artificial feeding would be stopped to the extent possible and "Do Not Feed the Waterfowl" signs would be posted by affected property owners, as appropriate. Domestic waterfowl would be removed from the area by APHIS, VDACS, another agent, or the property owner. An egg addling, oiling, puncturing, or freezing program would be conducted by APHIS, VDACS, another agent, or by the property owner to minimize the number of birds to be euthanized in appropriate situations.

Harassment, exclusion, removal of domestic waterfowl, and shooting to supplement harassment would be implemented by government agencies, if requested and resources allowed. Harassment, exclusion, and shooting to supplement harassment would be

implemented by the government agencies using the same techniques as a private citizen or company managing Canada goose damage. The removal of domestic waterfowl most would likely be done with alpha chloralose. All methods implemented by APHIS would be reimbursed by the entity requesting assistance.

**RESULTS OF INTEGRATED PLAN IN 1997**

The Integrated Canada Goose Management Program was implemented in 1997 to reduce damage caused by resident Canada geese by integrating methods incorporating harassment, biological control, exclusion, habitat alteration, husbandry, repellents, hunting, relocation, shooting to supplement harassment, nest and or egg destruction, and euthanasia.

Technical assistance on alleviating damage caused by Canada geese was provided by VDACS, VDGIF, and APHIS in 1997. VDACS and APHIS received 331 requests to provide technical assistance to citizens in 34 counties and 9 independent cities in Virginia between July 1, 1996 and June 30, 1997. APHIS responded to 121 of the 331 requests for technical assistance during this 1-year time frame and made recommendations to alleviate damage involving Canada geese (Table 8).

Between July 1, 1996 and June 30, 1997, APHIS recommended 8 individuals apply for a Migratory Bird Depredation Permit to harass and shoot Canada geese to supplement harassment. The USFWS reviewed the permit applications and sent permits to VDGIF for review, signature, and issuance to the applicant.

Two nests of Canada geese were removed by APHIS because the geese were attacking people at a business and a nest was blocking construction at a park. In the business case, the geese nested next to the main entrance of the business. Eggs were oiled by APHIS at 3 locations, resulting in 285 eggs being treated. Between July 1, 1996 and June 30, 1997, 10 individuals applied after APHIS' recommendation to USFWS for a Migratory Bird Depredation Permit to oil, addle, puncture, or freeze eggs. These permit applications were reviewed by USFWS and sent to VDGIF for review, signature, and issuance to the applicant.

Sixteen locations in northern, central, southwestern, and eastern Virginia had 1,760 Canada geese captured during the molt occurring in mid-June through mid-July. Canada geese were captured at airports, homeowner associations, a theme park, businesses, a sewage treatment plant, public and private recreational parks, a military base, and golf courses by APHIS, VDACS, and VDGIF employees working together. Two processors were contracted by APHIS to process 1,548 Canada geese for human consumption. Hunters for the Hungry, a statewide charity, distributed the Canada geese products to local food banks. One hundred twenty-eight juvenile Canada geese were relocated because of the goslings' size and age. Eighty-four Canada geese involved in a research project also were released unharmed.

Two locations in Virginia had 103 Canada geese captured and euthanized to protect human health and safety. Alpha chloralose was used because the projects were conducted when the geese could fly. The geese were buried in accordance with federal regulation and *Alpha Chloralose Use Guidelines and Handbook*.

Hunting seasons for resident Canada geese were established to reduce damage and provide recreational opportunity for hunters. A special September season was initiated in a 22-county area in 1993. In

the first season, 2,523 hunters participated and harvested 2,316 geese (Table 7). The hunt zone was expanded to include the entire state in 1995 and the number of hunting days increased each year thereafter (Table 9). Interest also has grown during the past 4 years as the number of hunters participating in 1996 increased to 8,400 and the harvest increased to 9,200 geese.

The special late season initiated in 1997 also was successful in terms of hunter participation and goose harvest. Approximately, 5,500 hunters took >12,000 geese, predominately resident geese, during this 22-day season (Table 7). There is potential to add additional days and increase the bag limit during this late season in future years. Combined, the special hunting seasons for resident Canada geese in 1996-1997 harvested >21,000 geese.

APHIS and VDACS were not requested to harass, exclude, shoot to supplement harassment, or remove domestic waterfowl as part of the Integrated Canada Goose Damage Management Program in 1997.

Public reaction to the capture and euthanasia of Canada geese in 1997 was variable and became a public issue after the *Washington Post* published an article on July 9. 1997. All publics directly affected by resident Canada geese appreciated having the geese removed from the local environment. Over 300 individuals who wanted more information about the Canada goose program and 9 individuals who voiced opposition to the Canada goose program contacted APHIS within 1 week following the article in the *Washington Post* about the removal of resident Canada geese. However, once the Integrated Canada Goose Management Program was explained, only 3 citizens remained opposed. One opposed citizen was adamant that Canada geese were an endangered species and another was a representative to Friends of Animals, an international animal protection organization. The article in the *Washington Post* generated 15 additional requests to remove Canada geese from properties. Citizens requested that Canada geese at the additional locations be captured; because the requests came after the molt, APHIS recommended other alternatives.

## DISCUSSION

Effectiveness Of Removing Canada Geese

Several measures were implemented to determine if removal of Canada geese alleviated damage over the short and long term. Although our analysis was quantitative, our clients' analysis was qualitative. Capture data over multiple years at several locations were analyzed to measure efficacy of removing geese. The return rate to the capture site by relocated leg-banded adult resident Canada geese was 12.1% when geese were relocated <100 miles from the capture site, 2.9% when geese were relocated >100 miles from the capture site, and 0% when geese were relocated ≥300 miles from the capture site; all geese were released at locations where adequate grass and water were available (J. May, VDACS, unpublished data). Also, 2.5% of leg-banded juvenile Canada geese released at a rural eastern Virginia location were recaptured in future years at urban locations reporting damage (J. May, VDACS, unpublished data).

Converse (1985), using computer banding records data from Patuxent Wildlife Research Center, reported 0.3-2.2% of all Canada geese relocated from Connecticut to Maine, New York, Rhode Island, Georgia, and West Virginia returned to the original capture site. Also, Cooper and Keefe (1997) reported 4% of juvenile Canada geese relocated 80+ km from the capture site and 4% of juveniles relocated to Oklahoma from Minnesota returned to

the Twin Cities area in subsequent years. Cooper and Keefe (1997) reported 42%, 80%, and 42% of adult Canada geese relocated from Minnesota to Oklahoma in 1982, 1984, and 1985 returned to Minnesota. Because of mortality and the lower probability of leg bands being detected versus neck collars, the reported number of birds returning to the capture site would be underestimated in Connecticut and Virginia. Moreover, to calculate the percentage of relocated geese returning to the capture area, one assumes that all relocated geese returning to the capture area are encountered (Cooper and Keefe 1997).

Furthermore, of the 1,519 juvenile Canada geese released between 1985-1996 in eastern Virginia, 8.5% were reported being killed by hunters within 15 miles of the release site (J. May, VDACS, unpublished data). A troubling issue in reporting on the recapture or reports of banded geese was several thousand Canada geese were released in Nottoway and Lunenburg Counties, Virginia, and no band returns have been reported or recaptured, yet none of the relocated geese remained on the ponds where released.

Efficacy of removing resident Canada geese was measured using the number of geese present during the molt in the year following initial removal (Table 6). The number of Canada geese removed from 4 representative locations was largest in the first year and significantly smaller in subsequent years (Table 6). Overall, the number of Canada geese declined in subsequent years at most locations even though the resident Canada goose population in Virginia was growing (Table 1) (APHIS and J. May, VDACS, unpublished data). The degree of long-term benefit in alleviating goose damage is best demonstrated at Dulles International and National Airports, where a more integrated Canada goose damage management program was implemented. Here Canada geese were removed during the molt and eggs were addled and oiled each year (Table 6). In contrast, Little Keswick School showed a large, increasing population of resident Canada geese in 1996 and 1997, which was comprised of >70% juvenile geese because no egg/nest destruction occurred. Initially, Occoquan showed a declining trend in resident Canada geese, then an increasing trend. Eggs/nests at Occoquan were oiled in 1997 for the first time. The increasing population of resident Canada geese in Virginia, residual geese left at Occoquan after each roundup, and immigration of geese from surrounding areas into Occoquan, most likely contributed to the increasing population growth trend in recent years.

Clients measured success of the program in qualitative terms. Even though all clients were informed verbally and in writing that new resident Canada geese would occupy the vacant habitat, clients were willing to have geese removed. All clients were grateful to have the geese removed or at least substantially reduced in number. Golf courses, office parks, beaches, and homeowner associations reported effectiveness as a reduction in droppings, an ability to grow grass, less grazing damage to ornamental plants and grass, and a reduction in shoreline erosion. A less frequent qualitative measure of alleviating damage was the reduction in molted bird feathers. Airports measured effectiveness by a lowered potential for an aircraft strike due to fewer geese feeding and flying locally on the airport. Clients usually reported damage as being reduced in subsequent years after the initial removal of resident Canada geese.

Few clients provided monetary estimates of damage because few accumulated such information. Qualitatively, clients reported spending less labor cleaning

droppings and feathers from property, repairing turf and golf greens, and tending gardens after resident Canada geese were removed from a property. The number of geese in subsequent years was reduced (Table 6) and clients believed they had less damage in subsequent years when Canada geese were removed.

Effectiveness of Hunting

Hunting was an integral and important part of the Integrated Canada Goose Management Program, especially for rural Virginia. Hunting seasons estab-lished during the past several years for resident Canada geese have helped control populations growth, resolve some damage complaints, and also provided recreational opportunity for Virginia sportsmen. A benefit of increasing hunt-ing days was a 52% reduction in damage complaints involving agricultural crops and livestock in 1997 over 1996 (APHIS, unpublished data). Hunting will continue to be an integral and effective means of managing resident Canada goose popu-lations, especially where it is allowed.

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Table 1. Estimated population of resident Canada geese in Virginia from the Atlantic Flyway Breeding Waterfowl Plot Survey, 1991-1997. Survey conducted by Virginia Department of Game and Inland Fisheries.

| Year | Number of Canada geese |
|---|---|
| 1991 | 66,169 ± 88% |
| 1992 | 121,225 ± 74% |
| 1993 | 128,603 ± 82% |
| 1994 | 129,409 ± 73% |
| 1995 | 202,602 ± 85% |
| 1996 | 208,146 ± 72% |
| 1997 | 301,416 ± 85% |

Table 2. Number of incidents by resource category involving Canada geese damage reported to the USDA-APHIS-Wildlife Services (APHIS) from April 1992 through June 1997, to the Virginia Department of Agriculture and Consumer Services (VDACS) from January 1992 through June 1997, and to the Virginia Department of Game and Inland Fisheries (VDGIF) from January 1992 through June 1996.

| | | Number of incidents | | |
|---|---|---|---|---|
| Resource Category | Resource Subcategory | Reported to APHIS | Reported to VDACS[1] | Reported to VDGIF[1] |
| Property | Animal | 4 | | |
| | Equipment | 5 | | |
| | Landscaping | 510 | | |
| | Structures | 8 | | |
| | Other | 3 | 1,037 | 250 |
| Agriculture | Aquaculture | 3 | | |
| | Field crops | 44 | | 40 |
| | Livestock | 15 | | 5 |
| | Range/pasture | 18 | | |
| | Other | 3 | 158 | |
| Human Health and Safety | Human | 260 | 54 | 10 |
| | Aviation | 30 | | |
| Natural Resources | Other | 8 | - | 25 |
| TOTAL | | 913 | 1,249 | 330 |

[1] VDGIF and VDACS track damage data by broad Resource Category only.

Table 3. Number of requests for technical assistance received by the U. S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services to alleviate Canada goose damage in Virginia from April 1, 1992 through June 30, 1997.

| Month | Number of requests | Percent of total |
|---|---|---|
| January | 21 | 4 |
| February | 32 | 6 |
| March | 39 | 7 |
| April | 45 | 8 |
| May | 50 | 9 |
| June | 114 | 21 |
| July | 103 | 19 |
| August | 48 | 9 |
| September | 26 | 5 |
| October | 31 | 6 |
| November | 11 | 2 |
| December | 21 | 4 |
| | 541 | 100 |

Table 4. Number of incidents of Canada goose damage by damage type reported to U. S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services in Virginia, April 1992 through June 1997.

| Damage type | Number of incidents | Percent of total |
|---|---|---|
| droppings | 568 | 62 |
| feeding/grazing | 196 | 21 |
| human health & safety | 58 | 6 |
| damage threat | 8 | 1 |
| aircraft strike or threat | 31 | 3 |
| animal disease or threat of | 17 | 2 |
| nuisance | 11 | 1 |
| consumption/contamination | 7 | 1 |
| other | 17 | 2 |
| TOTAL | 913 | 100 |

Table 5. Integrated wildlife damage management strategies and methods which could be used to alleviate damage involving resident Canada geese in Virginia.

| Method | Citizen | VDACS[1] | APHIS[3] |
|---|---|---|---|
| Harassment | X | X | X |
| Exclusion | X | M | X |
| Habitat alteration | X | | |
| Husbandry - | | | |
| No feeding waterfowl | X | | |
| Remove domestic waterfowl | X | X | X |
| Repellents | X | | |
| Hunting[2] | X | | |
| Relocation | | X | X |
| Shoot to supplement harassment | X | M | X |
| Nest/egg destruction | X | X | X |
| Euthanasia | | M | X |

[1] Virginia Department of Agriculture and Consumer Services
[2] Virginia Department of Game and Inland Fisheries would establish hunting programs.
[3] U. S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services
M = actions may be conducted if permitted or resources are available.

Table 6. Changes in local resident Canada goose populations at locations in Virginia where Canada geese were captured during the molt and relocated or euthanized. Canada geese were caught by the U. S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, and Virginia Department of Agriculture and Consumer Services, Office of Plant Protection and Pest Services. Eggs of Canada geese were oiled at both airports in all years and Occoquan in 1997 to reduce recruitment.

| Location | Year | # Canada geese present | # Canada geese captured | Disposition |
|---|---|---|---|---|
| Dulles International Airport | 1997 | 63 | 63 | Euthanized |
| | 1995 | 257 | 249 | Euthanized |
| National Airport | 1997 | 45 | 44 | Euthanized |
| | 1996 | 0 | 0 | |
| | 1995 | 69 | 69 | Euthanized |
| | 1994 | 0 | 0 | |
| | 1993 | 4 | 0 | |
| | 1992 | 94 | 94 | Relocated |
| Upper Occoquan Sewage Treatment Plant | 1997 | 525 | 381 | Euthanized |
| | 1996 | 496 | 346 | Relocated |
| | 1995 | 473 | 258 | Relocated |
| | 1994 | 451 | 331 | Relocated |
| | 1993 | 630 | 580 | Relocated |
| Little Keswick School | 1997 | 30 | 0 | |
| | 1996 | 22 | 20 | Relocated |
| | 1995 | 2 | 0 | |
| | 1994 | 60 | 60 | Relocated |

Table 7. Number of Canada geese harvested during the September, November through January, and January through February hunting seasons in Virginia, 1993-1997. Data provided by Virginia Department of Game and Inland Fisheries.

| Year | September | November-January | January-February |
|---|---|---|---|
| 1993 | 2,316 | 11,484 | 0 |
| 1994 | 3,464 | 12,136 | 0 |
| 1995 | 5,500 | Season closed | 0 |
| 1996 | 9,200 | Season closed | 0 |
| 1997 | | | 12,020 |

Table 8. Recommendations made by the U. S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, or implemented by citizens to alleviate damage involving Canada geese in Virginia in 1997. APHIS received 121 requests for technical assistance with Canada goose damage between July 1, 1996 and June 30, 1997.

| Method | Number of times recommendation made |
|---|---|
| Do nothing | 2 |
| Husbandry, change crop | 1 |
| Husbandry, stop artificial feeding | 7 |
| Husbandry, lure crop | 1 |
| Alter vegetation | 5 |
| Exclusion | 2 |
| Exclusion, overhead wire grids | 15 |
| Exclusion, perimeter fencing | 18 |
| Harassment, balloons | 1 |
| Harassment, pyrotechnics | 74 |
| Harassment, propane cannons | 5 |
| Harassment, distress calls | 2 |
| Harassment, reflective mylar tape | 20 |
| Harassment, flags | 4 |
| Harassment/shooting | 2 |
| Harassment, chase with vehicle (car, ATV, cart) | 13 |
| Biological control, dogs | 13 |
| Repellents, ReJeX-It® | 6 |
| Population Management, hunting | 32 |
| Population Management, nest/egg destruction | 54 |
| Population Management, harassment w/supplemental shooting | 8 |
| Population Management, euthanasia or relocation | 18 |

Table 9. Number of days of Canada goose hunting offered by Virginia Department of Game and Inland Fisheries.

| Year | Seasons and daily bag limits | | | | | |
|---|---|---|---|---|---|---|
| | September | | November-January | | January-February | |
| | Days | Bag limit | Days | Bag limit | Days | Bag limit |
| 1997 | 21 | 5 | - | - | 22 | 3 |
| 1996 | 17 | 5 | 0 | - | - | - |
| 1995 | 10 | 5 | 0 | - | - | - |
| 1994 | 10 | 5 | 26 | 1 | - | - |
| 1993 | 7 | 3 | 26 | 1 | - | - |

# EFFICACY OF DEER STOPPER™ REPELLENT FOR REDUCING WHITE-TAILED DEER DAMAGE TO ORNAMENTAL PLANTINGS

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Abstract: A 2-year study was undertaken to assess the efficacy of Deer Stopper™ repellent for reducing white-tailed deer damage to ornamental plantings. Efficacy testing was conducted on a captive deer herd at Auburn University's White-tailed Deer Research Facility and the Stimpson Wildlife Sanctuary, Jackson, AL. Japanese Holly (Ilex crenata), a highly preferred browse species in this area, was used as the test plant at all study sites. Plants were arranged randomly between treatment and control. Treatment plants were sprayed with prescribed applications of Deer Stopper™ and percent defoliation and browsing estimated for each plant. Repeated measures analysis of variance was used to compare effectiveness of treatments. During the first 3 months of the study, deer became acclimated to the plants with little browsing pressure to either treatment or control plants. Once deer began to browse on the shrubs consistently, the mean number of leaves on treatment plants was significantly higher (df=26,1; $F$=22.11; $P$=.000) than the mean number of leaves on control plants. Preliminary analyses of these data suggest that Deer Stopper™ was effective in reducing browsing damage to Japanese Holly.

Key Words: Deer Stopper™, repellent, white-tailed deer

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Deer management has undergone a paradigm shift in recent years. As deer populations have increased, concern over their effect on native habitats and human-altered landscapes is increasing. Traditional management objectives of enhancing deer populations for consumptive uses are being modified to include ways to reduce deer damage to agricultural and ornamental vegetation (Warren 1997). The widespread nature of concern is evidenced by the recent special issue of the *Wildlife Society Bulletin* (Vol. 25:2), a 1995 symposium held in Missouri and dedicated to urban deer manage-ment, many articles in the newsletter of the National Animal Damage Control Association, and many papers presented at various symposia dedicated to wildlife damage management. Recent journal articles have focused on biological aspects such as population dynamics (deCalesta and Stout 1997, Miller 1997), control techniques (DeNicola et al. 1997a), and sociological aspects such as conflict resolution (Stout et al. 1992, Curtis et al. 1995) and public attitudes (Fritzell et al. 1997, King 1995) of managing deer damage.

Among wildlife managers, there is much debate over the efficacy of various control

techniques. Control measures include exclosures (Owen et al. 1995), repellents (Fargione and Richmond 1995, Lewison et al.1995), immunocontraceptives (Warren et al. 1995, DeNicola et al. 1997b), and alternative harvest regimes (Ver Steeg et al. 1995, Horton and Craven 1997).

The objective of this study was to determine the effectiveness of Deer Stopper™ repellent for reducing white-tailed deer damage to ornamental plantings. We wish to thank Frank Boyd, Ashley Rossi, and Ralph Mirarchi for review of this manuscript. We express our appreciation to Traci O'Brien and Jami Armstrong for their assistance in project construction and data collection.

**METHODS**

Studies were conducted at the Stimpson Wildlife Sanctuary located in Clarke County in southwest Alabama and managed by the Alabama Game and Fish Division. Stimpson Sanctuary is not open to hunting and is noted for having an excessive deer population. This area was selected because of the history of deer damage on the site.

Initial testing was conducted using captive deer at the Auburn University White-tailed Deer Research Facilities. Deer at the facility were given access to potted Japanese holly (*Ilex crenata*) to verify browsing pressure and measure-ment techniques. Japanese holly was used for the study based on recom-mendations from Extension horticulture specialists who deal with deer damage complaints in ornamental plantings.

Once we verified that white-tailed deer will browse Japanese holly, we moved our investigation to the Stimpson sanctuary. Japanese Holly plants were arranged randomly between treatment and control, resulting in 41 pairs for comparison. Treatment plants were sprayed with prescribed applications of Deer Stopper™. Damage was assessed by counting the number leaves on selected dominant stems. Plants were measured and repellent applied each month from January 1995 through December 1995. Monthly re-application of the repellent followed the manufacturer's recom-mendation. Results of a t-test analysis assured us that treatment and control plants were similar (df=40, $t$=-0.36, $p$=0.721) prior to any browsing. Then, repeated measures analysis of variance (ANOVA) (Norusis 1993) was used to detect differences in effectiveness bet-ween treatments.

**RESULTS AND DISCUSSION**

During the first 3 months of the study, little browsing occurred on either treatment or control plants (Table 1). Apparently, this was a neophobic response by deer to the new plants in the area. However, once deer began to browse shrubs consistently, the mean number of leaves on treatment plants generally was higher than the mean number of leaves on control plants (df=26,1; $F$=22.11; $p$=0.000). The overall mean number of leaves for the treatment group was 518.8 as compared to 333.6 for the control group. The largest difference in leaf counts between treatment and control plants occurred in April (130.8 and 30.3, respectively).

A potentially confounding event occurred in May when leaf counts between treatment and control plants again approached equality. The terrain on the study site sloped slightly away from the middle of the plot. Soils in this area are sandy and well-drained. Apparently the stress of drought caused some mortality in study plants on these well-drained soils. Also, treatment plants appeared to be less drought resistant and dropped their leaves more rapidly than control plants. This mortality eventually resulted in the loss of

several treatment and control plants.

Table 1. Mean number of leaves on Japanese Holly (*Ilex crenata*) plants treated with Deer Stopper™ repellent (treatment) versus untreated plants (control) at the Stimpson Wildlife Sanctuary , Jackson, AL, as recorded each month during 1995.

| Month | Treatment | Control |
|---|---|---|
| January | 148.5 | 154.8 |
| February | 144.5 | 160.3 |
| March | 140.8 | 144.9 |
| April | 130.8 | 30.3 |
| May | 139.9 | 130.1 |
| June | 161.9 | 113.9 |
| July | 176.3 | 78.9 |
| August | 182.1 | 78.7 |
| September | 187.8 | 78.6 |
| October | 133.5 | 58.7 |
| November | 124.7 | 60.3 |
| December | 126.1 | 66.1 |

An examination of leaf counts from June through December indicates that browsing pressure on control plants remained relatively constant. Leaf counts on treatment plants during this period continued to decline. One might speculate that deer continued to browse these plants as natural food sources became more scarce. This would reduce the differential in leaf numbers between treatment and control plants.

## MANAGEMENT IMPLICATIONS

Complaints of deer damage in residential areas are common. Within residential areas, use of electric fencing or traditional deer harvests is not conducive, thus alternative ways to reduce damage must be explored. Analyses of our data suggest that Deer Stopper™ repellent was effective in reducing browsing damage to Japanese Holly when applied every 30 days. We believe that ornamental plantings near homes likely would not be as susceptible to drought stress as the treatment plants in our study. Although no repellent has yet been 100% effective in stopping browsing damage, DeerStopper™ seems to be effective in reducing damage to a tolerable level.

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# ENHANCEMENT OF DEER REPELLENT EFFICACY WITH VISUAL CUES

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Abstract: Previous research on deer repellents by the authors suggest that visual cues (warnings) coupled with application of an effective repellent may enhance the protection afforded by the repellent. We report the results of 2 separate experiments designed to evaluate and partition the effects of such visual cues in practical applications of 3 candidate repellents. In the first experiment, we established 1-ha plots in late succession old fields in Warren County, New Jersey. Plots were treated with bobcat urine, Deer Stopper®, water, and no treatment. Treatment application was made to 5-cm strips of cotton cloth attached to ¼-in cotton rope that encircled the entire plot. Strips were placed at 10-cm intervals. Browsing by deer in these plots was monitored for 1 year. The proportion of stems browsed relative to those available was recorded from randomly chosen 1-m x 100-m sample strips (2 per plot per month). Red maple (*Acer rubrum*), blueberry (*Vaccinium* spp.), and black gum (*Nyssa sylvatica*) predominated in a mix of 16 woody species. Overall, browsing rates showed little seasonal change, but were affected by treatments: control (no treatment)-31%; rope only-18%; bobcat urine-10%; and Deer Stopper® -2%. Duncan's multiple range test indicates a difference between all treatment except bobcat urine and Deer Stopper®. In the second experiment, using Big Game Repellent® (BGR) and Deer Stopper®, these results were confirmed and extended. In situations where deer can make an association of the repellent with a visual cue, they do so. The effect of the combination is both desirable and measurable.

Key Words: repellents, *Odocoileus virginianus*, white-tailed deer

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# COST COMPARISONS FOR WHITE-TAILED DEER LIVE CAPTURE TECHNIQUES

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Abstract: During March 13 - July 16, 1996, we captured 75 white-tailed deer (*Odocoileus virginianus*) using dart guns, rocket nets, and Clover traps on the Seneca Army Depot in Romulus, New York. We compared the labor and cost efficiency of these trapping techniques and reported on mortalities. Darting from a vehicle ($196/deer), and rocket-netting ($172/deer) were similar in time and cost efficiency. Darting from a blind was more costly ($358/deer) due to minimal time devoted to the technique and a high initial material investment. Clover traps were relatively inefficient (15.2 hours/deer) and costly ($895/deer), primarily due to a lack of snow. Materials comprised most of the total cost for all methods. Darting from a vehicle had the highest mortality (9.5%, $n$ = 2 of 21). Cost efficiency for all trapping techniques was poorly represented in the literature.

Key Words: capture, Clover trap, dart gun, *Odocoileus virginianus*, rocket netting, trapping, white-tailed deer

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Live capture of white-tailed deer (*Odocoileus virginianus*) can be a costly, time consuming process (Rongstad and McCabe 1984). Boyer and Brown (1988) reported that cost, labor needs, and available funding were the most common reasons state agencies did not live trap and translocate wildlife more frequently. However, as human and deer populations continue to expand, increasing deer-human conflicts dictate the need for live capture of deer for research and management purposes.

Several studies have reported person-hours required for live-deer-removal techniques, yet few have described the cost efficiency breakdown. Six state agencies averaged $142/deer captured and translocated, with costs ranging from $70-$200/deer (Boyer and Brown 1988). Jordan et. al (1995) reported an average of $117/deer over 2 years with Clover traps. Ishmael and Rongstad (1984) reported that a dart gun was their most time efficient technique at 20.5 hours/ deer, whereas the Clover trap was least cost effective at $570/deer. Our objective was to critically examine the time and cost efficiency and reported mortality rates for rocket nets (Hawkins et al. 1968), Clover traps (Clover 1954), and dart guns used to capture 75 white-tailed deer from March 13-July 16, 1996, at Seneca Army Depot (SAD) in Romulus, New York.

We thank the SAD for use of their grounds, and especially Colonel M. Stofka for assistance with military regulations and background information. We also thank the volunteers who helped with deer trapping, the New York State Department of Environmental Conser-vation (NYSDEC) for use of their equipment and

technical advice. P.F. Moon at the Cornell College of Veterinary Medicine provided immobilizing drugs. This research was conducted by the Department of Natural Resources at Cornell University in conjunction with the NYSDEC and SUNY-College of Environmental Science and Forestry. We are grateful to A.N. Moen, J.P. O'Pezio, and R.J. Warren for reviewing an early draft of this manuscript.

**STUDY AREA**

The 3,997-ha SAD is located in Seneca County near the Village of Romulus, New York, and was established in 1942 for the storage of munitions. The former farmland site is enclosed by a 2.4-m security fence and contains 79% natural habitat and 21% paved roads, railroads, housing, storage and administrative buildings. The natural habitat consists of 6.4% wetlands, 15% mature woodlots (*Quercus* spp., *Acer* spp., *Tilia americana*, *Carya* spp.), and 78.6% grass or shrub lands, including dense thickets (*Cornus racemosa*) and hundreds of grass-covered, earthen-berm, storage bunkers. The area is dissected by roads and drainage ditches surrounded by mowed strips that attract deer during spring green-up. Ambient air temperature during captures ranged from -7° to 26° C.

The SAD deer population grew from the original 20-40 deer enclosed within the fence in 1942 to an estimated 2,500-3,000 deer in 1957. Live-trapping removed 318 deer in 1954 and 1955, however, this failed to significantly slow deer population growth (Bromley and Severinhaus 1956). Hunting was first used as a management tool in 1957, and since has been used successfully to maintain deer densities on SAD close to NYSDEC recommendations. Hunters (307) using guns harvested 275 deer during 5 days in fall 1995, whereas 81 bow hunters killed an additional 31 deer from mid-October to mid-November.

**METHODS**

Live-capture methods employed during March 13 - July 16, 1996, included rocket nets, single-gate Clover traps, darting over bait, and darting from a vehicle. Seventy-five deer were captured and translocated 0-14.5 km via pickup truck to the enclosed 263-ha quarantine area (QA) of the SAD. Bait sites were chosen based on safety relative to explosives stored in nearby bunkers, accessibility from roads, and deer travel patterns. Sites were baited with apples, apple pumice, cracked corn, and salt. Trapping and translocation was accomplished by 1 person for 166 out of 215 (77%) trapping occasions. Volunteers (1-5) helped during the remaining 49 occasions. Deer processing included the attachment of numbered, color-coded collars, 21 of which contained solar-powered transmitters (Telemetry Systems Inc., Mequon, Wis.) with motion-sensitive mortality switches, and aluminum ear tags; collecting weights and blood samples; assessing animal condition; and aging deer by noting body size as a fawn (<1 yr.) or adult (≥1 yr.). A leverage system with spring-loaded scales permitted weighing of deer by 1 person. Mortality rate calculations included the number of deer dying at the release site, and the number of radio-collared deer dying within 1 month of release.

Two rocket net set-ups were used from March 22 - June 13, 1996. The nets (12.2 x 18.3 m, and 13.1 x 17.4 m, with 15.2 x 15.2-cm nylon mesh) each were launched by 4 rockets mounted on 1.8-m steel rods. Circuit continuity was checked with a blasting ohmmeter and rockets were detonated with a capacitor-discharge blaster from a canvas blind 36-73 m from the bait site. Deer were captured at rocket sites around dawn and dusk. Pure xylazine hydrochloride (Rompun, Miles Laboratories, Shawnee Mission, KS) was administered intramuscularly at 2.2 mg/kg to deer while under the net. The antagonist yohimbine hydrochloride (Yobine, Lloyd Laboratories, Shenandoah, IA) was administered intravenously at 0.11 mg/kg upon release of deer in the

QA (Mech et al. 1985).

Modified Clover traps (McCullough 1975) were used from March 13-April 9, 1996. Five, single-gate Clover traps (0.91 x 0.91 x 2.1 m) were set in mowed areas near storage bunkers. Traps were checked 1-2 hours after sunrise each day. Traps were collapsed on deer and drugs administered as in the rocket nets.

Darting with a scoped, Model 193 dart gun (Pneu Dart Inc., Williamsport, Penn.) occurred from a vehicle during March 15-July 16. Between March 16-March 23, and June 12-June 20, darting was conducted from a blind over bait. Disposable 2-cc darts with 1.9-cm needles and gelatin collars injected pure xylazine or a mixture of xylazine, ketamine hydrochloride (Ketaset, Fort Dodge Laboratories, Fort Dodge, IA), and tiletamine and zolazepam hydrochlorides (Telazol, Fort Dodge Labs, Fort Dodge, IA) at 2.2 mg/kg. No antagonist was administered when the Telazol mixture was used. Shots were made from the blind at <35 m at dawn and dusk. While darting from the vehicle, shots ranged from 14-45 m, and involved driving the SAD roads during hours of peak deer activity. After dark, darting was aided by a 1,000,000-candlepower spotlight. To ensure that deer were immobilized, we waited >15 minutes prior to initiating a search, and allocated 1.0-1.5 hours/ search. Capture methods were approved by the Cornell University Institutional Animal Care and Use Committee.

Cost calculations for materials included 2 new dart guns; 2 blinds; 1 rocket net set-up, including charges, drugs, bait; and the cost for renovating 5 Clover traps. These figures did not include 1 borrowed rocket net set-up. No transport crates were needed.

**RESULTS**

Depending on the capture method used, trapping efficiency varied with small mammal density, habitat type, time of year (availability of alternative foods), weather, individual deer wariness, light conditions, and capture mortality. Seventy-five deer were captured and translocated to the QA; we had an estimated mortality of 5.3% (Table 1). Combining data for all capture methods, time and costs averaged 8.28 hours/deer and $203/deer, respectively. Overall, trapping was most successful from March 13-April 23, when 72% of all deer were captured. Rocket nets and darting from a vehicle had similar labor and cost efficiency whereas Clover traps were most labor intensive (15.2 hrs/deer) and costly ($895/deer), with 1 deer captured in 105 trap nights. Cost of materials accounted for the majority of the total cost for all capture methods (Table 1).

Darting from a vehicle was most influenced by habitat type, light conditions, time of year, and mortality. Deer darted along roads frequently would disappear immediately into thickets, making prolonged visual contact impossible and confounding the recovery process. This resulted in a 43.8% ($n$=21 of 48) recovery rate. Only 34.8% ($n$=8 of 23) of the deer darted after dark were recovered, whereas 52.0% ($n$=13 of 25) darted during daylight were recovered. Darting was most successful (19 of 21 deer captured) immediately after roadside green-up in mid-April. Darting from a vehicle had the highest mortality (9.5%, $n$=2 of 21), with 1 death due to shot placement and the other due to excessive shot penetration in the hindquarters.

Trapping efficiency for rocket nets was influenced most by time of year and availability of alternative foods. Rocket nets were most successful during March 22-April 23, when 83% ($n$=39 of 47) of the deer were captured (for an average of 4.68 hrs/deer and $126/deer). After April 23, spring green-up and the break-up of deer family groups resulted in fewer animals visiting bait and more incidences of single

deer visiting the trap sites.

Minimal time was devoted to darting from a blind due to availability of rocket net equipment. All 6 deer successfully darted over bait were captured during March 15-19. Alternative natural food was available during the second period of darting over bait (mid-June), and no deer were caught. The overall recovery rate during March was 85.7% (6 of 7 search attempts). Five of 6 deer darted in daylight were recovered (83.3%), and 1 of 2 were recovered after dark (50%).

Clover-trap success was influenced by small mammal density and weather. Raccoons (*Procyon lotor*), opossums (*Didelphis marsupialis*), and gray squirrels (*Sciurus carolinensis*) frequently set traps off prematurely. The only useable deer captured was trapped immediately after a late-season snow storm. Jordan et al. (1995) and Beringer et al. (1996) also noted the influence of snow on Clover-trap success.

## DISCUSSION

Labor Efficiency

Comparisons of labor efficiency for dart-gun, rocket-net, and Clover-trap methods indicated that our time/deer was similar to figures reported elsewhere, while our mortality rate was lower. Hawkins et al. (1967) used 2-person crews during both daylight and dark hours to dart 1 deer from a vehicle every 7.5 hours, with a 20% mortality rate ($n$=75). Palmer et al. (1980) reported 4.1 hrs/deer captured in daylight, with a 13.6% mortality rate ($n$=44). Ishmael and Rongstad (1984) noted that darting from vehicles was their most time-efficient capture technique at 20.5 hrs/deer ($n$=6), and only 2 animals died;.no report of trapping crew size or light conditions was provided. The increased mortality rates reported in these studies compared to that at SAD may have been due, in part, to im-provements in immobilization drugs, and to a lack of post-release mortality factors (i.e., high vehicle traffic and predators) at SAD, which are thought to affect short-term survival of white-tails (Jones and Witham 1990).

Palmer et al. (1980) used rocket nets with 1-2 people, and reported 6.9 hrs/deer ($n$=17) and a 23.5% mortality rate. Anderson and Stroebe (1973) used 3-4 people, resulting in 21.6 hrs/deer captured ($n$=11). Jones and Witham (1995) averaged 2.83 hrs/deer caught ($n$=24) during 2 days of mid-winter trapping. Beringer et al. (1996) indicated that rocket nets were more efficient than Clover traps at their study site. They noted deer mortality during rocket-net attempts was 2.6%, whereas loss due to capture myopathy was 11.2%.

Nielson (1982) darted 22 deer over bait without a mortality; however, no hours/deer were reported. Diehl (1988) noted this effort likely was less efficient than Pisgah-Clover traps used during 1985-86 at the same site. Kilpatrick et al. (1996) darted deer during day and night using 3 people and reported an average capture success of 20.5 hrs/deer ($n$=23) and a 52% recovery rate (no mortality was indicated). They were able to reduce average capture time to 4.0 hours/deer ($n$=15) and increase the recovery rate to 100% by using transmitter darts.

Diehl (1988) reported no mortalities and an average of 4.0 hrs/deer captured ($n$=20) using 2-6 people and Pisgah-Clover traps. Ishmael and Rongstad (1984) captured 2 deer in 179 winter trap nights (43.9 hrs/deer) and cited the Clover trap's proximity to unrestricted bait piles as a reason for the inefficiency. Jordan et al. (1995) reported that their Clover traps captured 451 deer in 3,269 trap-nights during 1991-1993. Beringer et al. (1996) had a 5.1% mortality rate from accidents and none from myopathy while capturing 115 deer with Clover traps.

Cost Efficiency

Few reports of cost/deer or cost breakdowns for darting, rocket-netting, or Clover traps were found in the literature. Ishmael and Rongstad (1984) reported $179/deer (*n*=6) while darting from a vehicle; labor (41.8%) and materials (36.8%) comprised most of the total cost ($1,074). Adjusting Ishmael and Rongstad's figures to current (1996) prices increased the cost/deer to $289, and the total cost to $6,274. They also spent $1,424 during rocket netting (including 79% on materials and 13% on labor), but were unsuccessful in capturing a single deer.

No costs/deer were available in the literature for darting over bait, although Diehl (1988) noted that 4 hrs/deer captured in Pisgah-Clover traps repre-sented a significant reduction in time, and therefore money expended/deer, compared with darting over bait for the same area. Kilpatrick et al. (1996) noted costs of darting over bait were reduced when transmitter darts were used over standard darts due to reduced search times/darted deer.

Jordan et al. (1995), using mainly Clover traps, reported an average of $117/deer captured (*n*=292) and a total of $32,245 during 1991-1992. These prices included labor and vehicle operations as the largest expenditures. Ishmael and Rongstad (1984) captured 2 deer in Clover traps at $570/deer ($921/deer in 1996 prices); materials (46.0%) and labor (28.1%) accounted for most of the total cost ($1,139).

Bromley and Severinghaus (1956) reported $28.93/deer (*n*=318) for 12 box traps on the SAD from 1954-1956. The total cost ($9,200) included labor (83.0%), travel (11.0%, including 200 mile transport distance), and materials (6.0%). Adjusting for inflation increases the cost/deer to $169, which is lower than Clover traps ($895/deer) and combined cost/deer ($203) on SAD in 1996. Bromley and Severinghaus adjusted for trap depreciation over time, accounting for decreased material costs, resulting in the lower cost/deer.

All cost estimates for capturing deer during this study at SAD should be considered minimum values. Employing only 1 person, leaving the vehicle parked on site when not in use to reduce travel time, and borrowing some equipment, helped reduce total costs. Our calcula-tions did not include vehicle or equipment depreciation.

With limited funds and labor being a current reality for most wildlife managers and researchers, and with the increasing need to resolve deer-human conflicts, precise planning for the most productive use of available resources is of ever-increasing importance. Comparable re-ports of cost efficiency can help facilitate this process.

In summary, rocket-netting prior to spring green-up, and darting from a vehicle immediately after spring green-up, were our most cost-efficient deer-trapping methods. A mild winter with minimal snowfall limited the efficacy of Clover traps at SAD. Also, we did not evaluate fully the cost-efficiency of darting from a blind because of increased reliability of capturing deer with rocket-nets at bait sites while snow cover was present.

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Table 1. Cost- and time-efficiency of deer trapping methods used at the Seneca Army Depot, Romulus, New York during March through July, 1996.

| Trapping method | No. deer | Mortality (n) | Person hours/ deer | % of Total Cost materials | fuel | labor | Total cost | Cost/ deer ($) |
|---|---|---|---|---|---|---|---|---|
| Rocket nets | 47 | 2 | 8.3 | 50.4 | 1.7 | 47.9 | 8,092 | 172 |
| Clover traps | 1 | 0 | 15.2 | 78.8 | 4.3 | 17.0 | 895 | 895 |
| Dart/vehicle | 21 | 2 | 7.7 | 56.8 | 4.2 | 39.1 | 4,111 | 196 |
| Dart/blind | 6 | 0 | 9.5 | 72.3 | 1.3 | 26.4 | 2,151 | 358 |

# CONFERENCE SUMMARY

## What Have We Learned?--Where Do We Go From Here?

JAMES E. MILLER, National Program Leader, Fish and Wildlife, USDA/CSREES, Natural Resources and Environment Unit, Washington, D.C.

Since I am charged with providing some closing comments this morning, let me begin by having those of you who are still with us to join me in providing a round of applause to Jim Parkhurst, Phil Eggborn, and Martin Lowney, the Conference Planning Committee, and to those on the Conference Program Committee; to the sponsors, exhibitors, speakers, session moderators; and to all of you as participants who helped make this 8th Eastern Wildlife Damage Management Conference so successful. And, as most of you know who have ever planned and conducted such a conference, there are always a number of people who work behind the scenes to help make everything go smoothly; we want to be sure to express our appreciation to them as well. Thanks to Barbara Falls, from Virginia Tech, and to her husband, who pitched in to help prepare the barbecue and serve all of us who participated in the field trip Friday afternoon and evening. Barbara did an exemplary job in handling reservations, coordinating with the hotel on rooms and arrangements, and helping Jim Parkhurst with other conference functions and activities.

I also want to express my appreciation to those students who presented papers at this conference. You all did a great job, and I commend you for your great preparation and delivery. As one who has been around for a long time and attended many such conferences, I appreciate your interest, your effort, and your commitment, and I am pleased to see the growing interest among students in the area of wildlife damage management. I won't attempt to speak for each of you in the audience, but the professionalism demonstrated by the students attending this conference helps me to continue to feel confident about the future of the wildlife profession.

I'm not going to attempt in these brief closing minutes of this very successful conference to reiterate the important points or highlights from the presentations made here over the past few days, each of you can do that for yourself, and we would probably not all agree what these were anyway. Rather, although I have taken extensive notes for my own use and edification, let me try to summarize briefly some things I think we have heard, and hopefully absorbed, that may be useful to us now and in the future.

But first, let me ask a question. How many of you are members of The Wildlife Society? Please raise your hands. For those of you who are not, I have about 25 copies of the application form, and I encourage you and welcome you to take one, fill it out, put a check with it and send it in, become a member of The Wildlife Society's very active Wildlife Damage Management (WDM) Working Group, and help us lead the profession. Currently, the WDM Working Group has sponsored and conducted excellent technical sessions at each of the Society's four Annual Meetings and has submitted a proposal to host yet another session at the Annual Meeting in Buffalo next fall. Join up, get involved, and help us change and improve the profession. If you don't like something that is happening within The Wildlife Society or in our related areas of the profession, don't sit on the sidelines and

bitch and gripe. Get involved and help us make positive changes. It is surprising how much better you will feel about yourself if you know you've given your best, even if your perspective changes once you've gotten involved or if your suggested changes are not always endorsed and/or adopted.

Now to my suggestions for consideration about some of the things we may have learned from our participation at this conference and how we can use what we have learned to move forward. Let me just list a few of these for your consideration based on my observations:

1) Remind yourself often of what brought you to this profession. I can't speak for you, but, for me, it was a deep and abiding love for wild, living resources, and a call for wise stewardship. After a 35-year career as a professional resource manager, that love and respect and striving to be a wise steward is stronger than ever. If you do not have this love or commitment or striving, you may be in the wrong profession. If you doubt that we are all charged with being wise stewards of the wild, living resources God has blessed us with, I urge you to read Psalms, Chapter 8.

2) Recognize that our profession is still young and growing and will continue to change, hopefully with your involvement and help. I can sure tell you that it has changed during my 35-year professional career. As Dr. San Julian mentioned in his keynote remarks, I can remember when The Wildlife Society leadership viewed what we call wildlife damage management as black hat and hardly worthy of consideration as a recognized area of the wildlife profession. Has that changed? Absolutely, and we have predecessors, like Jack Berryman, John Gottschalk, and others who were persistent and eloquent and effective in changing those misperceptions. Not only is wildlife damage management well recognized in The Wildlife Society today, it has become one of the largest and most effective working groups in TWS and its sessions at the annual meeting have all been well attended. The Wildlife Society Southeastern Section and the TWS Council approved and provided support for this Conference we're attending. To me, that is clear and substantive evidence that the WDM area of the wildlife profession is recognized as an important and integral element to be incorporated into future wildlife management/planning and programs.

Don't fight change—it is inevitable. You can expend all your energy and creative juices being negative and defensive. Embrace change and work in a positive, progressive manner to make the change compatible with where you want to go and what you want to do with your life and what you care passionately about. If you can't do this, you will be miserable and probably should look for a different line of work. I can vouch for the difficulty I and others of us experienced over the years, trying to be proactive, yet patient, understanding, and positive in effecting a changing, more positive image of WDM within our profession. Constructive change does not often happen overnight and often requires strong partnerships and great persistence.

3) Be aware that some of the current and future changes that are being affected will definitely change the way we do business, who our clientele are, and how we will have to change to be more effective in serving them. For example, demographic trends are toward an even more urban society, one that is progressively more diverse, not only in racial composition, but in objectives and cultures. In addi-tion, even though private land-owners and managers still control almost 2/3 of the land base in the contiguous U.S., the size of ownership is decreasing and urban sprawl is growing faster than ever. Increasingly, the majority of the public will become farther removed from the land and any understanding of the land ethic. We must work toward finding innovative solu-tions to future wildlife manage-ment problems and needs. We must add and embrace the social and human dimensions research and education knowledge to our bag of tools and techniques, as well as to monitor new and developing technologies so that we might adopt and implement those that are efficacious and use them to help us do our job more efficiently. I'll have to admit to you that I am electronically challenged and intimidated by computers, but I have learned to utilize some limited capabilities to help me, and will continue to learn.

4) We will not and should not be apologetic for the work we do. It is important, challenging, stimu-lating, and will become even more so in the future. Strive to give it your very best every day, and I am confident you will feel good about what you do and who you serve. We can and should be positive and proud of the work we do and the resources we care about and strive to be wise stewards of.

5) Remember that the future of wildlife conservation in America depends on land-use decisions of private landowners, public land managers, and policy-makers at the community, state, and federal levels. Decisions that these people make will benefit wild, living things only if they have the proper knowledge, incentives, and assistance from wildlife professionals, natural resources agencies, and govern-ment. It will require trust, confidence, and partnerships. I am confident that by striving for excellence and progressive part-nerships, we can meet the challenges and changes of the future and proactively ensure the sustainability of wild, living resources for present and future generations of Americans to use and enjoy.

Regarding where and when the next of these Eastern Conferences will be held, at present that is undecided. If any of you from other states would like to host this 9th Eastern Wildlife Damage Management Conference in your state in 1999 or 2000, please contact Dr. Jim Parkhurst or me as soon as possible. We do have some guidelines that we will be glad to share with you, and there is likely to be some available up-front money for your use in planning and conducting such a conference.

If you haven't yet completed and turned in your evaluation and "What's Your Opinion" sheets, please take the time to do so before you leave. Your input is valuable and needed for the current and future

program committees. I hope you all have a safe trip home, it has been a pleasure to see and visit with friends and professional colleagues, to meet new friends, and to continue to learn more about this complex and controversial profession we have chosen as our life's work. I look forward to seeing many of you at other future meetings and conferences and at this conference, whether it is held in 1999 or 2000. To this point, I have been fortunate to have been involved in all eight of these Eastern Conferences beginning back in 1983 in New York, and I look forward to attending at least one more, God willing.

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