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STATUS OF COYOTES AND COYOTE DEPREDATIONS IN PENNSYLVANIA

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Abstract: The coyote (*Cams latrans*) population in Pennsylvania has grown in the last several decades to about 4,000. It continues to grow, despite a known annual harvest of more than 850 animals. There is a growing concern about the effects of coyotes on game and livestock populations. We discuss known and potential coyote-human conflicts in Pennsylvania and propose a program of depredation prevention and control. To be successful, the program requires cooperation, funding, research, educational materials, and training workshops.

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Almost unknown to the northeastern United States in the early 1900s, coyotes have become common in most northeastern states (Hilton 1978, Genoways 1986, Chambers 1987). Based on the number of articles in newspapers, wildlife agency magazines, and other popular literature in recent years (e.g., Hayden 1984, Schneck 1988, Wolkomir and Wolkomir 1989, Gilbert 1991), the eastern coyote is rapidly gaining the attention of the public, agencies, sportsmen, and livestock growers. Concerns are only beginning to be addressed (e.g., Chambers 1987, Slate 1987), so those of us in wildlife research, management, and control have our work cut out for us.

It is commonly assumed that the eastern coyote is filling an ecological niche vacated by several large predators, notably the eastern timber wolf (*Cams lupus*) and eastern mountain lion (*Fells concolor*) that have been extirpated from the northeastern states (McGinnis and George 1980, Martin and Blank 1986, Weeks et al. 1990). In Pennsylvania, the lynx (*Fells lynx*) has also been extirpated and the bobcat (*Fells rufus*) has become rare, although it is becoming more abundant since receiving complete legal protection in 1970, its numbers have risen.

Coyotes may fill an important ecological role in Pennsylvania, but there are growing concerns about the rapidly increasing coyote population and the implications to many human activities. Will game populations be affected? Will livestock losses increase and become an economic burden? Will coyotes increase the threat of rabies? Will pets and children be threatened? Many of these concerns have been expressed in other northeastern states (Chambers 1987). While the latter 2 questions are perhaps unwarranted, the first 2 need to be given careful consideration. It appears that the coyote situation in Pennsylvania will closely mimic what has occurred in New York (McAninch and Fargione 1987, Tomsa and Forbes 1989).

In this paper, we address the population status and distribution of coyotes in Pennsylvania, current and potential problems with coyotes, current harvest and control methods, what is being done to learn more about coyotes in Pennsylvania, and future prospects and informational needs. We have drawn our information from a variety of sources, but caution readers that there has been no definitive work on coyotes during the last

decade, although work is currently underway. Taxonomic work and preliminary natural history work on the coyote in Pennsylvania was completed by McGinnis (1979).

COYOTE STATUS IN PENNSYLVANIA

Although the fossil records indicate that coyotes were in the northeastern United States in prehistoric times, they were essentially unknown to the region before 1900 (McGinnis and George 1980). The first verified specimen in Pennsylvania was recorded in 1946 from Clearfield County (Hilton 1978). It is believed that coyotes have spread southward from Ontario, Canada (Hilton 1978, Genoways 1986), and possibly eastward from the midwestern United States (McGinnis 1979, Weeks et al. 1990). It is also possible that the range expansion of the coyote has been facilitated by intentional and unintentional releases of captive animals (McGinnis and George 1980, Genoways 1986, Hill et al. 1987).

By 1974, coyotes occupied the northern tier counties of Pennsylvania, possibly dispersing from New York, and rapidly expanded their range to include much of Pennsylvania by 1983 (Hayden 1984). By 1990, coyotes were reported in 65 of 67 counties, failing to occupy only Delaware and Philadelphia counties and the major metropolitan areas of Pittsburgh and Philadelphia.

As in several other northeastern states (e.g., Connecticut, Maine, Vermont), coyotes were slow to increase in numbers in Pennsylvania until the last several decades. Perhaps dispersing young had difficulty finding mates until a certain "critical number" occurred in the state (the so-called Allee effect, Witmer 1990). Although there may have been only about 100 coyotes in Pennsylvania in 1974, their numbers increased steadily to about 4,000 in 1990 (Table 1). This represents an annual increase of about 250 coyotes per year between 1974 and 1988. This population increase has occurred despite a concurrent increase in harvest of coyotes (Table 1).

Coyotes in Pennsylvania use virtually all habitats in the state except urban. It appears that a pair of coyotes in Pennsylvania use about 52 km². Based on sightings, damage complaints, and harvests, coyotes are considered abundant in 32

counties, of medium abundance in 20 counties, and of low abundance in 13 counties (T. Hardisky, Pa. Game Comm., unpubl. data). Higher densities have been reported in other northeastern states (Chambers 1987), so it is possible that the coyote population in Pennsylvania will continue to increase. Dispersal movements can be large (Bekoff 1982). A coyote marked in Tioga County, Pa., was killed in Ridgway, Pa., about 145 km away (A. Hayden, Pa. Game Comm., unpubl. data).

CURRENT AND POTENTIAL PROBLEMS

Most studies have found coyotes to be opportunistic feeders, consuming a wide variety of food items with seasonal shifts in primary food items, dependent upon availability (Bekoff 1982, DeGraaf and Rudis 1986). This is also the situation in Pennsylvania. Prey species that are active throughout the year (i.e., voles [*Microtus* spp.], mice, lagomorphs, and some birds), may occur in the diet at any time. There are distinct shifts in the diet, however, as coyotes take advantage of seasonal foods. Deer (*Odocoileus virginianus*) are taken in late fall through early spring, woodchucks (*Marmota monax*) after spring emergence from hibernation, and insects and fruits during summer and fall (McGinnis 1979, Hayden 1984, Merritt 1987). Scat analyses currently underway will better define these patterns.

Sportsmen have begun expressing concern at Pennsylvania Game Commission (PGC) public meetings that the growing coyote population may be affecting game populations. While some medium-sized game species (e.g., lagomorphs, grouse [*Bonasa umbellus*]) show up in food habit studies, their numbers (as a frequency of occurrence) in the diversified diet of the coyote are no cause for alarm. In Pennsylvania, many game populations (rabbit [*Sylvilagus* spp.], turkey [*Meleagris gallopavo*], deer) are stable or increasing, despite the growing coyote population (A. Hayden, Pa. Game Comm., unpubl.

data). This has been noted for deer in other northeastern (Ellingwood and Caturano 1988). We believe that determinant for these game populations is the quantity of available habitat, not coyote density.

On the other hand, deer occur in substantial frequency the winter diets of coyotes. Various studies have indicated most of this is from carrion (e.g., animals killed by hunters, or winter conditions). Although the eastern coyote animal (several harvested in Pennsylvania have weighed 27 kg), they do not often take healthy, adult deer (Ogle 1981). It is possible that, as the density of coyotes increases in Pennsylvania, coyotes will begin to consume a substantial number of fawns. Again, scat analyses currently underway may clarify this situation. It should be noted, however, that Pennsylvania deer population is well over goal density in counties, causing substantial economic problems (see Wi and deCalesta, this volume). Consequently, the growing coyote population may ultimately help control a game population that hunters have not been able to regulate under existing regulations.

It can be anticipated that as the coyote population creases, the grey (*Urocyon cinereoargenteus*) and, especially red fox (*Vulpes vulpes*) populations will decline (Wolkomiran and Wolkomir 1989). Several Wildlife Conservation Officers' Pennsylvania have already mentioned to us that this appears to be occurring. This usually happens because coyotes can outcompete, displace, and kill foxes. Foxes are an important furbearer in Pennsylvania with about 60,000 pelts harvest annually. Fox harvests have remained fairly stable in Pennsylvania despite the growing coyote population. Trends are difficult to interpret because the harvest is correlated to fluctuating number of trappers and pelt prices.

Table 1. Trends in coyote population, harvest, damage complaints, sheep killed, claims filed, and claims paid in Pennsylvania, 1974-1991.

Year	Population Amt. Paid	Harvest	Complaints	Sheep Received'	Claims Killed°
1974	100°		<50°	NEdNE	NA°
1983	1,000-2,000°	>200°	NE	NE	NA
1988	2,000-3,000E	>300f	12	75	5
1989	NE	NE	26	82	12
1990	4,000'	>850,	60	77	14
1991	NE	NE	NE	NE	15+

' A. Hayden, Pa. Game Comm., unpubl. data; data for 1988 and 1989 were incomplete. ° M. Berandone, Pennsylvania Dog Control Program, unpubl. data; 1991 data is only January-July.

From Hayden 1984. d NE = No estimate for that year.

NA = Not applicable; claims program began in 1988. f A. Hayden, Pa. Game Comm., unpubl. estimate.

Another important concern that relates to coyotes is the transmission of rabies. Coyotes, like most mammalian species, are susceptible to rabies. The mid-Atlantic rabies outbreak began in Virginia and West Virginia in 1979-80, but has spread throughout much of eastern and southern Pennsylvania. There were 702 confirmed cases of rabies in animals in Pennsylvania in 1989 (up from 543 cases in 1988), with 493 of the cases involving raccoons (Iampietro 1990). It is possible that rabies will restrict the growth of the coyote population. However, the few coyotes that have been tested for rabies have all been negative (Iampietro 1990). It is possible that, by reducing fox, raccoon, **and free-ranging dog and cat** populations, coyotes may actually slow or reduce the spread of rabies in the state. Indeed, Wildlife Conservation Officers have noted that they are observing fewer free-ranging dogs and cats in recent years.

The greatest potential for economic impact by coyotes in Pennsylvania involves the livestock industry, and in particular, sheepgrowers. There are over 2,700 sheepgrowers in Pennsylvania with a combined total of 134,000 sheep (up from 88,000 sheep in 1988). Although records on sheep losses to coyote predation are incomplete, it appears that, on average, at least 100 sheep are reported killed each year (Table 1). Actual losses could be considerably higher. For comparison, at least twice as many sheep are reported killed by domestic dogs annually. In any given year, most of the known losses occur on one or a few farms where one or a few coyotes kill many sheep. Foreexample, one farm in Clearfield County reported 112 sheep killed by coyotes in 1986. In Greene County, 4 nearby farms reported 80 sheep killed by coyotes during a 10-month period in 1987-88. An extensive survey of sheepgrowers in Pennsylvania is planned for this fall to better document the extent of losses. With a growing coyote population, these occurrences can be expected to increase unless an effective prevention and control program is implemented.

CURRENT COYOTE HARVEST AND CONTROL

The harvest of coyotes in Pennsylvania has increased steadily from 1978 (<50 per year) to 1990 (>850 per year, Table 1). We believe that the annual harvest may be as high as 1,500 per year when the number killed by deer hunters is included. A 1990 survey indicated 850 coyotes were harvested by those persons buying a furtaker license. A gametake survey that includes the number of coyotes harvested by deer hunters is currently underway. The regulations for harvesting coyotes in Pennsylvania are quite liberal. There is no bag limit, and coyotes can be trapped during a lengthy furbearer season (Nov/Feb). Coyotes may also be shot by any licensed hunter or furtaker on a year-round basis. The only restrictions are that coyotes cannot be killed during deer season by hunters who have successfully harvested a deer, nor can a coyote be killed during the open hours of spring turkey season.

substantial harvest of coyotes. Furtakers took about 850 coyotes in 1990, either purposefully or incidently in sets for other furbearers such as foxes. Interest in harvesting coyotes is increasing, but poor quality of pelts, low pelt prices, low densities of coyotes, the wiliness of coyotes, and the inexperience of many trappers suppresses the potential annual take.

Other mortality factors for coyotes in Pennsylvania include vehicle strikes and disease/parasite problems. Coyotes are known to be susceptible to tularemia, distemper, rabies, bubonic plague, and sarcoptic mange. Of these agents, only sarcoptic mange is known to be common in coyotes in Pennsylvania. We have no current data on the extent of coyote mortality resulting from vehicle strikes and mange, but these agents were estimated to be the cause of about 10% of known coyote mortalities prior to 1978 (McGinnis 1979). She also reported that hunters pursuing other game accounted for 50% of known mortalities, and trappers for about 40%.

A relatively small portion (<10%) of the coyote harvest in Pennsylvania is for animal damage control (Chambers 1987). Animals are shot or trapped, usually by farmers, their workers, or private-sector persons contracted to resolve a problem. The federal U. S. Department of Agriculture, Animal and Plant Health Inspection Service, Animal Damage Control (ADC) staff provide only technical advice. The Pennsylvania Bureau of Dog Law Enforcement has operated a compensation program for livestock losses to coyotes since 1988. State dog wardens do not trap or remove problem coyotes, but merely verify claims. The number of claims made and compensation paid has increased annually, but the program is currently limited to a maximum outlay of \$20,000 per year in compensation for coyote depredations (Table 1).

It is possible to make an estimate of the recruitment capacity of the Pennsylvania coyote population based on current population numbers and conservative assumptions of pregnancy, birth, and mortality rates from the published literature (e.g., Beckoff 1982). If about 30% of a coyote population of 4,000 are adult females, and 60% of those produce an annual litter of 5 pups, about 3,600 coyotes would be born in Pennsylvania each year. If 50% of these young survive their first year, 1,800 coyotes would be recruited into the population annually. Because human-caused mortality of coyotes in Pennsylvania probably does not exceed 1,500 animals per year, the statewide population can be expected to increase by 200300 coyotes per year. This estimated rate of increase is comparable to what has occurred during the 1970s and 1980s. Because current harvest and mortality rates will probably not stabilize the growing coyote population in Pennsylvania, we anticipate increased human-coyote conflicts. Coyote populations are increasing in many other northeastern states as well (Slate 1987). On the other hand, the harvest of coyotes in Pennsylvania has been increasing and if it increases by another 20% the population may be stabilized. There may be little incentive to harvest additional coyotes in Pennsylvania. How

Most harvested coyotes are shot by hunters afield for other game. In Pennsylvania, over a million deer hunters are afield in portions of November and December, which results in a

ever, we suggest most coyote harvest is incidental, especially during deer season. The number of deer hunters has stabilized in recent years in Pennsylvania.

FUTURE PROSPECTS AND NEEDS

The coyote is perhaps the most recent addition to Pennsylvania's wild vertebrate fauna. It is the largest predator in the state (if we exclude the primarily omnivorous black bear [*Ursus americanus*]), and has readily filled an ecological niche statewide. The coyote population is growing and increased conflicts with humans, their property, and their objectives can be anticipated. Hence, the state must develop effective methods to reduce conflicts and to control coyotes in those situations where conflicts occur. Although a variety of coyote control methods exists (Wade 1983), this will not be an easy task. Coyote control in eastern states is more difficult than in western states (Owens 1987), and even in western states coyote control has been difficult and controversial (Bekoff 1982, Wagner 1988).

The fact that a compensation program has been initiated in Pennsylvania should not lull people into a false sense of security and inaction. The program does not deal with problem coyotes, and assumes only a limited financial burden that could be exceeded within a few years. Compensation programs are popular, however, and exist in most northeastern states for livestock losses to dogs, although less commonly for coyote depredation (Slate 1987).

The problem of coyote depredations can be greatly lessened by the development and implementation of a preventative livestock depredation program. This program would involve the implementation on farms of one or (preferably) more preventative measures (e.g., guard dogs or mules, electric fences, carrion removal and pasture mowing, frightening devices, and better animal husbandry practices such as the use of lambing sheds and night confinement) known to reduce sheep losses to coyotes (Martin and Blank 1986, Coppinger et al. 1987, McAninch and Fargione 1987, Green 1989, Tomsa and Forbes 1989). Appropriate education and technical assistance must be provided to sheep-growers, especially because many sheepgrowers are hesitant to change their husbandry practices. We believe that there is a general lack of informational materials and educational opportunities available to sheepgrowers in Pennsylvania at this time. A concerted and cooperative effort is needed between the federal (ADC), state (PGC, Pa. Dep. of Agric., Pa. State Coop. Ext. Serv.), and private sectors (Pa. Sheep and Woolgrowers Assoc., Pa. Trappers Assoc.) to help develop and implement a successful preventative livestock depredation program. The initial success of the cooperative program implemented in New York certainly provides grounds for optimism (Tomsa and Forbes 1989).

In addition to providing educational materials and technical advice to sheepgrowers, the state should consider a costsharing program to help purchase and erect electric fencing and

acquire guard dogs. Similar programs already exist prevent bear, deer, and elk (*Cervus elaphus*) damage culture and forestry (Pa. Game Comm. 1987). Such efforts are probably better spent than those of a growing station program that does nothing to resolve the cause problem.

Even with a preventative program, coyote depredation will occur. Hence, an effective coyote ADC program should be established in Pennsylvania. This program should include several elements. First, we need to develop a roster of licensed coyote trappers across Pennsylvania. Because current Pennsylvania trappers are inexperienced with trapping, workshops could be developed and conducted by appropriate state and federal agencies and the Pennsylvania Trappers Association. Relevant techniques include not setting traps for coyotes, but calling in and shooting coyotes well. Regional lists of qualified coyote trappers could be made available to sheepgrowers or perhaps published, distributed, and periodically updated by the Pennsylvania Sheep Woolgrowers Association. Secondly, we need more basic applied research on the ecology of coyotes and coyote control in Pennsylvania. Much of our knowledge of the eastern coyote comes from research in Maine (e.g., Arthur and Krohn 1988) but this knowledge may not apply in Pennsylvania when; climate, vegetation, and available prey differ from that of Maine. We also need the development of effective techniques for the capturing or repelling of eastern coyotes near livestock operations. The eastern coyote is very wary around human habitations and a quick learner. Trappers and Wildlife Conservation Officers tell us that if you do not get the problem coyote on your first attempt, it will be much more difficult, if impossible, thereafter. Traditional dirt hole and snare sets do not seem to be very effective for capturing eastern coyotes. Hence, we need to develop and publicize new types of sets and effective attractants/lures. These methods must be selective for coyotes to reduce the capture of nontarget wildlife and domestic animals, a common problem in eastern states (Martin and Blank 1986, Tomsa and Forbes 1989).

The eastern coyote presents many challenges to wildlife biologists, resource managers, livestock growers, landowner and sportsmen. We are confident that a cooperative, concerted effort by these parties can prevent coyote-human conflicts from becoming a serious problem in Pennsylvania.

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