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REPORT TO THE 117TH MAINE LEGISLATURE
PURSUANT TO LD 793 12 MRSA

A STUDY OF EASTERN COYOTES AND THEIR IMPACT
ON WHITE-TAILED DEER IN MAINE

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EXECUTIVE SUMMARY

This report was compiled as mandated by LD 793, which required the Department of Inland Fisheries and Wildlife (IF&W) to "conduct a study to determine the impact that coyotes have on deer, and to propose recommendations to encourage the harvest of coyotes".

The eastern coyote became established throughout Maine during the 1960's and 1970's, as part of an eastward population expansion from states and provinces to the west. Slightly larger than their western U.S. counterparts, coyotes inhabiting Maine average 30 to 45 lbs. as adults, with maximum weights of about 65 lbs. occurring rarely. Maine's coyote population is roughly 10,000 to 16,000; they average 11 to 18 per township at maximum density. Social organization among eastern coyotes centers around the adult breeding pair, their current-year offspring and, sporadically, other un-related associates. The adult breeding pair is monogamous, and they defend an annual home range averaging 20 mi² in Maine. Breeding takes place in February, 2-10 pups are born in April, and these young are tended in dens until early July. Reproductive rates are highly flexible among coyotes, depending on food availability, and/or availability of vacant breeding territories.

Prey selection by coyotes is opportunistic: they will consume whatever food is currently available, including carrion and fruits. White-tailed deer comprise a significant proportion of coyote diets in Maine, particularly during winter and the spring denning period. Under the right circumstances, coyotes hunting in

groups are adept at killing deer, including individual deer which are in good physical condition. Predation by coyotes ranks 2nd among mortality factors affecting adult deer annually in Maine; this accounts for nearly 30% of total annual deer losses. Coyote predation is also considered an important component of early losses among newborn fawns in summer.

Coyote predation on deer may be of sufficient magnitude in some parts of the state to contribute to population declines and/or impede deer population recovery. Effects of coyote predation are most damaging in parts of the state in which: 1. wintering habitat quality has been severely reduced; 2. winters tend to be severe; and 3. alternate prey are less available. In northern, western and eastern sections of Maine, inadequate wintering habitat is the primary factor limiting deer populations. There, high predation rates by coyotes are the symptoms, not the cause of deer population problems. In central and southern sections of Maine, habitat quality is better, and we have been able to sustain adequate deer populations despite predation losses to coyotes. In all parts of Maine, allowable harvest to hunters has been reduced (using the Any-Deer permit system), in part, to accommodate losses to coyotes and a host of other mortality factors.

Maine offers the most liberal recreational trapping and hunting opportunities for coyote of any state/province in eastern North America. Coyotes may be hunted year-round; they may be night-hunted from January through April. There is a 7-day early trapping season, followed by a 64-day regular trapping season. Coyotes may be snared in January and February in Maine's

unorganized towns under IF&W direction. Finally, IF&W may direct qualified cooperators to remove coyotes by trapping, snaring or hunting in any town as part of the Animal Damage Control (ADC) program.

Hunting, trapping and ADC activities account for less than 2,000 coyotes annually. Juvenile coyotes comprise the overwhelming majority of coyotes killed. This coyote harvest represents less than 12% of the coyote population annually. Real suppression of coyote populations would require removal of 70% of the coyote population annually. Because of rapid recolonization of vacated territories by dispersing juveniles, coyotes are capable of re-populating large areas in less than two years. For these reasons, large scale control efforts (i.e. from a bounty) would fail, while depleting scarce financial resources.

Specific recommendations are offered relating to: 1. refining the focus of the Animal Damage Control Program; 2. focus on improvement of wintering habitat for deer; and 3. avoidance of bounty programs.

Introduction

This report was compiled as mandated by LD 793, which required the Department of Inland Fisheries and Wildlife (IF&W) to "conduct a study to determine the impact that coyotes have on deer, and to propose recommendations to encourage the harvest of coyotes." Since this study was to be accomplished in less than six months, and since the 117th Maine Legislature did not appropriate funds for this work, we were not able to conduct new research on deer-coyote interactions. Rather, I relied on the body of research which already exists on this subject in Maine, and the northeastern U.S. and Canada to provide the basis for this report. As such, this report is instead, a synthesis of existing information on deer-coyote ecology as it currently relates to management of these species by IF&W. Supporting references appear as superscripted numbers in the text; reference sources appear in the Literature Cited section.

Coyote Origins, Distribution and Population

The eastern coyote (Canis latrans) currently inhabits all towns in Maine, except most offshore islands.¹ Rumors to the contrary, coyotes were not introduced to Maine by humans. They appeared in Maine during the late 1960's and early 1970's as part of a general range expansion across the northern U.S. and southern Canada which probably began in the 1920's.² It is noteworthy that coyotes colonized regions west of Maine prior to the late 1960's; that they expanded their range into eastern New Brunswick in the late 1970's, and then

into Nova Scotia, Cape Breton Island, and even Newfoundland in the mid to late 1980's.³

Eastern coyotes are slightly larger than the western subspecies from which they originated. There is strong evidence that coyotes inter-bred with gray wolves (Canis lupus) in southern Canada as the coyote population gradually expanded eastward.⁴ Hence, the introduction of wolf genes resulted in larger overall size among eastern coyotes. Body weight of eastern coyotes ranges from 30 to 45 lbs among most adults in fall and winter; juveniles commonly range from 20 to 35 lbs at this time.⁵ Eastern coyotes rarely exceed 50 lbs; the record for Maine is about 65 lbs. By contrast, gray wolves range from 70 to 120 lbs as adults.⁶

Direct estimates of coyote population size are lacking for Maine or any other location in the northeast. Population estimates used by IF&W for planning purposes were calculated using assumptions for coyote home range size, litter size and dispersal rate derived from prior research, and extrapolated to all areas of the state.¹

As such, we estimate that 10,000 to 16,000 coyotes inhabit Maine, the latter number being the autumn peak. Given that there are 30,000 mi² of coyote habitat in Maine, this would represent a density of 3 to 5 coyotes per 10 sq. mi., or 11 to 18 within a typical Maine township.

IF&W does not utilize indices to detect regional or annual variations in coyote abundance. Nevertheless, opinions regarding the relative abundance of this species are commonly voiced by hunters and other outdoors enthusiasts.

Whether or not these opinions have a basis in fact, we do not know. Monitoring the registered harvest of coyotes is a poor index to coyote abundance, since harvest rate is largely influenced by factors which are unrelated to coyote abundance.

Coyote Social Organization and Reproduction

Coyote social organization centers around family groups consisting of a mated pair of adults, and their offspring which are less than one year of age.⁷ The adult pair maintain and defend a home range which averages 15 to 20 sq. mi. in size. In addition to the family group, these home ranges may also be occupied by one to several juveniles (between one and two years old) which have dispersed earlier from their natal home range elsewhere. Dispersal in eastern coyotes commonly occurs in fall and winter; individual coyotes may disperse up to 400 miles from natal home ranges. A high dispersal rate among juvenile coyotes ensures that breeding territories vacated by the death of former occupants are quickly re-populated.

Coyotes do not form stable packs in the manner of gray wolves.⁷ However, coyotes may form aggregations beyond the adult pair and surviving pups in winter, particularly when they are hunting large prey, such as white-tailed deer (*Odocoileus virginianus*).⁸ This aspect of coyote behavior is poorly understood, and it merits careful research.

Coyotes are capable of breeding prior to one year of age, although few individuals do so.⁹ Established breeders are monogamous; most mating occurs in

February, and pups are born in April after a gestation period of 63 days. Litter size among eastern coyotes is highly variable, ranging from 2 to 10 pups, and averaging 5 or 6. Age at first breeding, litter size and pup survival rate are each dependent on the availability of breeding territories and an adequate forage supply. Increasing the availability of food or reducing competition for breeding home ranges will both tend to increase the reproductive rate of coyotes. The former situation may occur during severe winters, when deer are more vulnerable to predation. The latter may occur when coyote mortality increases sufficiently to depopulate individual breeding territories.

Coyote pups are dependent on the breeding pair for all of their food requirements from birth until abandonment of dens in early summer.¹⁰ This places high demands on the adult pair to provide a large quantity of prey for the developing litter from mid-April until early July. For this reason, breeding pairs of coyotes tend to hunt larger prey items such as deer until pups are able to forage, at least in part, for themselves.¹¹

Coyote Harvest and Natural Mortality

Natural mortality among coyotes typically is high. Early losses among pups are dependent on the amount and quality of food brought in by the adult pair. Once they emerge from dens, pups and dispersing juveniles are vulnerable to a variety of hazards such as accidents, diseases, malnutrition, road-kill, and hunting/trapping. Many of these mortality factors are density dependent. For example, high losses to trapping may increase survival of juvenile coyotes in

winter by reducing competition for relatively scarce prey. Hence, an increase in one form of coyote mortality may cause a compensatory reduction in mortality to other causes.

There is a relatively high turnover rate in Maine coyote populations.¹² First-year mortality among juveniles is roughly 40%, while that for older individuals is probably below 30%. Most coyotes in any given population are less than 3 years of age, although a rare few individuals may attain 10 to 12 years.¹³

In Maine, the eastern coyote is accorded the status of an exploited furbearer; they may be harvested by hunting, trapping and snaring. In regulating the various seasons on coyotes, IF&W seeks to maximize recreational hunting and trapping opportunities, while minimizing the risk of over-harvesting non-target species (e.g. bobcat, fisher, and fox), or protected species which are vulnerable to mortality (e.g. bald eagles).

Maine maintains the most liberal hunting and trapping seasons on coyote in the northeast. Coyotes may be hunted with or without dogs year-round, except for Sundays.¹⁴ We provide a 7-day early trapping season for coyote (and fox) in October. In addition, coyotes may be trapped during a 64-day land trapping season during October to December. During January and February, coyotes may be taken with body snares in Maine's unorganized towns by certified trappers who pursue this activity under the direction of IF&W personnel. We also maintain a night-hunting season on coyotes from January 1 to April 30 to facilitate coyote harvest by predator callers. Finally, IF&W maintains a pool of volunteer and paid agents under the auspices of the Animal Damage Control (ADC) program. ADC

agents may be directed to remove specific coyotes from any location in the state, where coyotes are perceived to be causing excessive losses among wintering deer, or livestock (predominantly sheep).¹⁵

Coyotes taken by recreational hunting and trapping must be registered and tagged. Animals taken by ADC agents must be reported to IF&W for accounting purposes. During the past 15 years, the combined take of coyotes from hunting, trapping, and ADC work ranged from 944 to 1,600 coyotes. While it is likely that some coyotes are never tagged or reported, the total of man-induced mortalities of coyotes in Maine probably is less than 2,000 coyotes annually. This represents 12% of the peak autumn population of coyotes in Maine. It is noteworthy that 80% of the coyotes which are trapped in autumn are pups, and that the fall trapping seasons account for the lion's share of the total harvest of coyotes.¹³ Therefore, man-induced coyote losses in Maine selectively target the age class (juveniles) which is most likely to succumb to natural causes anyway. Conversely, that segment of the coyote population which is most responsible for successful reproduction (breeding pairs) appears to be less vulnerable to mortality from trapping in autumn (and possibly to winter snaring as well).¹³

Coyote Food Habits

Coyotes are primarily carnivores, although they readily incorporate soft mast such as blueberries, raspberries, chokecherries and apples into their diet, when available.¹⁶ Coyotes are adaptable and efficient predators; they also readily consume animal carrion and refuse where available. Coyotes consume a wider

variety of foods in fragmented, human-dominated habitats than in heavily forested regions where the variety of potential prey species (and carrion) are greatly reduced.

In Maine, coyotes rely heavily on white-tailed deer and snowshoe hare (Lepus americanus) to satisfy their annual dietary requirements. Reliance on these two species appears to be greatest in parts of Maine dominated by industrial timberland (northern, western and eastern Maine).⁷ Relative vulnerability of deer and hare is related to coyote and deer mobility in snow. When snow is shallow, coyotes readily hunt and consume snowshoe hares. However, when coyote and deer mobility is hampered by deep snow, coyotes reduce hunting effort on hares and concentrate on deer. Based on studies of coyote scats, deer may comprise 50 to 80% of coyote diets in winter.¹⁶

Although coyotes will readily kill deer which are debilitated by old age, malnutrition and disease, coyotes are by no means restricted to killing the "misfits" in a deer population. In a 12-year statewide study of winter losses in Maine,¹⁷ we found that only 15% of the 873 deer killed by coyotes in winter were severely malnourished. The majority of deer killed by coyotes were in good physical condition, based on the status of fat reserves. In addition, all age classes of deer, and both sexes, were nearly equally vulnerable to predation by coyotes.

Coyotes which hunt in groups of 2 or more individuals appear to be more successful at killing deer than coyotes which hunt alone.⁸ Hence, the aggregations of coyotes we sometimes observe in and near deer wintering areas

may be an adaptation to hunting large prey. Whether or not an individual deer is vulnerable to predation by coyotes may depend less on its age, sex, or nutritional status, but rather on its ability to escape a chase involving 2 or more coyotes engaged in a coordinated pursuit.¹⁷ Therefore, factors which impede rapid escape would reduce a deer's odds for survival. Such factors include glare ice, deep snow, crusted snow, impeding vegetation (e.g. dense spruce-fir thickets which are difficult to traverse), and a lack of extensive escape trails in wintering areas. The latter factor may be particularly important. Deer wintering areas which have been extensively logged may pre-dispose deer to higher winter losses. Extensive mortality of spruce and balsam fir during the spruce-budworm epidemic during the 1970's and 1980's may have created similar conditions.¹⁸ Such extensive alterations in deer wintering habitat may: 1. reduce the area occupied by wintering deer; and 2. increase the energetic costs of making and maintaining escape trails (because snow depths are greater where the softwood canopy has been removed). Both of these effects would reduce the ability of deer to thwart pursuit by coyotes by increasing the likelihood of getting "bogged down" in deep snow. Finally, there may be an optimum density below which deer become increasingly vulnerable to predation by coyotes. Creation of extensive trail networks in a deer wintering area requires considerable energy expenditure by deer. Wintering areas populated by only a few deer lack well-maintained, extensive trail systems. Hence, deer in under-populated wintering areas may be more vulnerable to losses to coursing predators such as coyotes.¹⁹

During most snow-free times of the year, coyote dependence on deer decreases, while utilization of smaller prey, and fruits increases. Analysis of coyote scats in late summer and fall in Maine suggested deer comprised 20% to 30% of coyote diets.¹⁶ However, at least in the predominately forested parts of Maine, deer comprised up to 90% of diets consumed by breeding pairs of coyotes and their dependent pups during May and June.¹¹ This diet included newborn fawns and adult deer. Since little deer carrion is typically available in late spring and early summer, these deer largely represent predation losses. Little is known about the dynamics of coyote predation on deer during snow-free times of the year.

Our deer herd, which averaged 250,000 in early autumn, sustained a loss of 75,000 deer to all causes over the past year (1995). Based on an analysis of annual losses in the statewide deer herd during 1990-94,²⁰ predation by coyotes accounts for nearly 30% of annual losses among deer which are ≥ 4 months of age. Of the 75,000 total mortality, about 22,000 deer were estimated to have been killed by coyotes. Among other leading causes of mortality were legal hunting (25,000 deer), unreported illegal hunting (12,500 deer), and road-kills (4,000 deer). Most losses to coyotes (>17,500 deer) likely occurred during winter.²⁰

In addition to predation on deer older than 4 months, coyotes may be an important source of mortality among newborn and very young fawns.¹¹ Each year during 1990-94, Maine's 95,000 white-tailed does produced at least 117,000 fawns. Yet, within 4 months, only 74,000 remained alive. Hence early fawn mortality averaged 37% or 43,000 fawns. The rate of early fawn mortality is higher today than was the case in the 1950's, prior to the establishment of coyotes in Maine.

During 1990-94, about 20% (9,000 fawns) of the early losses of fawns less than 4 months old were attributable to coyote predation.²⁰

The above projections were compiled for the statewide population. The contribution of coyote predation relative to other factors likely varies regionally in Maine. Generally, coyote predation comprises a smaller fraction of total losses in central and southern regions where: 1. alternate prey and carrion is more readily available; 2. wintering habitat for deer is more abundant and of better quality; 3. less severe winters prevail; and 4. deer populations are higher, and hence are better able to absorb predation losses.

Impact of Coyotes on Deer Populations

Deer are subjected to a wide array of mortality factors. The list includes hunting (legal, illegal, and wounding loss), road-kill, other accidents (e.g. falls on ice, drowning, even lightning strikes!), predation (from coyotes, dogs, black bears, bobcats, even by foxes and fishers on newborn fawns), malnutrition, disease, and "old age" maladies.²⁰ No one of these loss factors can be considered apart from the rest when we evaluate the impact of mortality on the deer population.²¹ What matters is whether the sum of these various losses exceeds the number of fawns produced to replace older deer which have died (referred to as "recruitment"). During years when total losses exceeded recruitment, the herd declined. When recruitment exceeded adult losses, the herd grew. On those rare occasions when mortality and recruitment were balanced, the herd stabilized.

When deer populations are held well below what the habitat will support, most causes of mortality in the herd are additive.²² In other words, an increase in one cause does not cause a decrease in another. When losses are additive, an increase in one cause results in an increase in total losses.

In contrast, when deer populations are at or near a maximum for that habitat, many forms of mortality are compensatory.²² That is, an increase in one mortality factor is matched by a decrease in another form of mortality. Deer maintained at the maximum limit of their summer food supply compete for scarce food resources. Such deer are thin, and a significant proportion of the herd is susceptible to malnutrition losses in winter. Under this scenario, an increase in deer mortality to hunting, for example, would cause a corresponding reduction in the number of deer which later die from malnutrition.

During the past 25 years, Maine's deer herd has remained well below the carrying capacity of its summer habitat.²³ It follows that most losses, including deer losses to coyotes, were additive in nature. Since few adult deer in summer are demonstrably debilitated either from poor nutrition or from injury or disease, most such losses to coyotes during the snow-free time of the year are additive. In addition, the finding that total losses of young fawns in summer was higher after coyote establishment in Maine than previously, suggests that coyote predation on newborn fawns is an added drain on the herd's ability to replace losses to adult deer.

Unfortunately, interpretation of winter deer losses to coyotes is not so clear-cut. On the surface of it, the finding that: 1. coyote predation was the

leading cause of winter deer mortality during 1978-89; and 2. that most deer selected by coyotes were still in "good" physical condition suggests an additive loss to the herd.²⁴ In practice, however, this may only be partially true. Since 1970, the amount and quality of wintering habitat has declined markedly, particularly in northern, eastern and western Maine townships.¹⁹ While that habitat base was eroding (through logging and spruce-budworm mortality), predation by coyotes was the predominant mortality factor.²⁴ Regardless of the existence of coyotes in Maine, there is no question that the winter carrying capacity for deer in at least half of the state of Maine is much lower today than was the case 25 years ago. If there were no coyotes, winter losses to malnutrition would have gradually increased wherever yarding habitat was degraded. Under this scenario, however, the herd may have taken many more years to adjust to its new (lower) carrying capacity.

There is little doubt that the establishment of coyotes has complicated deer management in Maine and the northeastern U.S. Depending on the magnitude of other herd losses, coyote predation can contribute to total losses which exceed the herd's ability to maintain stable populations. Then too, the additional mortality to the annual crop of newborn fawns caused by coyote predation today reduces the ability of the herd to rebound whenever high losses to adult deer occur.

It is likely that coyotes played a role in the deer population declines which occurred first in the 1970's in Quebec and Maine, and in the 1980's in New Brunswick and Nova Scotia. Also inherent in these herd declines were a

reduction in winter habitat quality and an initial failure to reduce total losses of deer (primarily by regulating doe harvests) to levels which the herd could sustain. In Maine, the implementation of the Any-Deer permit system was designed to bring adult doe losses down to levels which each regional population could sustain.^{21,25} In the absence of coyotes, annual hunter harvests would certainly be higher, but deer populations in eastern, western and northern Maine would still have declined from levels we enjoyed 25 to 35 years ago. It is also important to note that, in any part of the state, severe winters will periodically inflict heavy winter losses on the herd. However, sustained predation by coyotes during subsequent winters may retard herd recovery back to the long-term carrying capacity of the wintering habitat.

Most locations in central and southern parts of Maine support sizeable deer populations while sustaining respectable deer harvests,²⁶ and while absorbing ongoing predation by coyotes. This is possible because: 1. deer populations remain high enough to readily absorb coyote losses; 2. doe harvests are tailored to balance out total losses vs. fawn production; 3. wintering habitat is relatively abundant and of good quality; and 4. severe winters are infrequent. If each of these conditions remain unchanged, IF&W can manage for an abundant, harvestable deer resource indefinitely. However, in the remainder of the state, major improvements in sustainable deer populations will only occur when, and if, the quantity and quality of wintering habitat increases.

Feasibility of Coyote Control

Since coyotes do impact deer populations to varying degrees in Maine, the idea of reducing coyote populations to increase deer is popular among deer hunters. Aside from ethical considerations surrounding the killing of one species to favor another, long-term suppression of coyote populations over large areas is not biologically achievable using traditional hunting and trapping techniques. The coyote evolved with a high and changeable reproductive rate as well as the ability to quickly fill vacant territories by dispersal of juveniles. Both are superb strategies which evolved among coyotes to counter the effects of high mortality rates.

Suppression of coyote populations in Maine would require an annual removal in excess of 70% of the peak autumn population.²⁷ In the first year, that would require a human-induced mortality of more than 7,000 to 11,000 coyotes.¹ This level of coyote removal has never been achieved in the open rangelands of the Western U.S., even when poisons were legal for coyote control. In heavily forested Maine, our annual harvests of < 2,000 coyotes are a far cry from the harvest level which is required to cause coyote numbers to decline.

Major alterations in harvest strategies for coyote which increase IF&W's financial and manpower commitments, or which divert these resources from other necessary functions while also failing to provide long-term suppression of coyote populations, cannot reasonably be justified. Therefore, coyote bounty systems, however popular among some members of the public, cannot be recommended as a

viable option to increase either the deer population or hunter harvests of deer in Maine.

It may, however, be feasible to intensively remove enough coyotes from small areas to temporarily reduce their impact on deer. In fact, some of our ADC cooperators who snare coyotes in winter may temporarily reduce coyote predation in some individual deer wintering areas. However, these small locations appear to be quickly repopulated with coyotes, since there are usually as many coyotes available for capture during the next yarding season. Therefore, any positive effects of coyote removal remains localized within a small area and are temporary at best.

Recommendations

The following recommendations are offered for consideration by the Maine Legislature.

1. Inland Fisheries and Wildlife's Animal Damage Control (ADC) Program should be examined relative to removal of coyotes in winter. Currently, IFW expends approximately 10-15% of its ADC annual budget directly on coyote control efforts. This includes contracts with trained ADC trappers that snare during winter months in deer yards, and hourly wages and mileage reimbursements for ADC trappers responding to local or temporary deer yard impacts by coyotes. These coyote control efforts now total approximately \$5,000 to \$15,000 annually, depending on the severity of the winter, the identification of areas with higher coyote impacts, and the availability of ADC trappers trained in the use of snares.

It may be desirable to focus ADC efforts away from areas where the deer population is already thriving or away from areas where depleted wintering habitat cannot support higher deer numbers. Coyote control efforts should also be avoided in areas where deer cannot be hunted. Therefore, effort could be directed at areas most likely to see a benefit. Inland Fisheries and Wildlife is currently working towards redirecting the funded portion of our snaring program (as opposed to the opportunities for recreational snaring) towards areas where deer may benefit most from local, temporary reductions in coyote numbers.

2. Recognize that the real obstacle to attaining a higher deer population in more than half of the state is the declining quality and quantity of wintering habitat for deer. A real opportunity exists to improve long-term carrying capacity for deer if we can find an efficient way to protect and enhance a minimum of 1.5 million acres of deer wintering habitat, statewide.²⁸ Committing state funds and effort toward habitat conservation would, in the long-run, be far more cost-effective than engaging in widespread coyote killing campaigns.

Currently, the Wildlife Division is working with several large industrial landowners to plan, on a landscape or watershed basis, for maintaining and enhancing deer wintering cover. This approach allows a cooperative management philosophy that will provide for deer and other wildlife in areas many times larger than traditionally zoned deer yards. IF&W will continue to expand its efforts for cooperative management arrangements on a landscape basis with all willing landowners.

3. Coyote bounties are not a viable option for achieving higher deer populations. Unless a bounty system can remove more than 70% of the coyote population annually, and prevent rapid re-colonization from surrounding states and provinces, real suppression of coyote populations can never be achieved. Also, bounties are not directed and do not remove the animals that may be causing the greatest impact. Animal damage control efforts are always most effective when the specific problem animals are targeted.

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