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Rabies in Wolves of the Great Lakes Region

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ABSTRACT: We report six cases of rabies (three confirmed, three suspected) in gray wolves (*Canis lupus*) representing 21% of the total wolf mortality in a 5 yr study (1987 to 1992) of radio-collared wolves in Algonquin Provincial Park, Ontario, Canada. Reports of rabies in wolves of the Great Lakes region of North America are rare, even though wolf populations have been studied extensively for almost 40 years. No cases have been documented in wild wolves on the U.S. side of the Great Lakes, whereas, in Ontario, 15 cases have been documented since 1960.

Key words: Rabies, epidemiology, gray wolf, *Canis lupus*, Algonquin Provincial Park, mortality, case report.

Reported cases of rabies in gray wolves (*Canis lupus*) in the Great Lakes region of North America are rare. Rabies generally is not considered to be a factor of the population ecology of wolves in Minnesota, Michigan, Wisconsin (USA), or Ontario, Canada (Johnson, 1992). We describe six cases of rabies in our current study of wolves in Algonquin Park, Ontario (45° to 46°N, 78° to 79°W).

From 1987 to 1991, 57 wolves (33 male; 24 female) from 22 packs were radio-collared in Algonquin Park, Ontario as part of an ongoing study of the interaction of wolf-ungulate populations. The park covers an area of 7,571 km^2 and has an estimated 28 to 32 wolf packs, at a density of 2.7 wolves/100 km^2 (Forbes and Theberge, 1993). Collared wolves were monitored by ground and aerial telemetry at weekly, monthly or consecutive (block period) intervals. Each wolf collar (Lotek Engineering, 34 Berczy St., Aurora, Ontario, Canada L4G 4J9) contained a mortality-mode motion sensor, which identified when a wolf had died.

When suitable for examination, wolf carcasses were frozen and later necropsied at the Ontario Veterinary College, Guelph, Ontario, to determine cause of death. In cases of suspected rabies, the brain was sent to the Rabies Diagnostic Laboratory, Agriculture Canada, Nepean, Ontario. Samples of brain were tested for rabies virus using a fluorescent antibody test (FAT) using fluorescein-conjugated goat anti-rabies antibody (Webster and Casey, 1988).

During the course of the study, three known and three presumptive cases of death from rabies were recorded among radio-collared wolves from three wolf packs. In the first incident, four wolves from two packs in the northwest section of the Park (46°2′ to 45°50′N, 78°56′ to 79°1′W) were found dead in a 38 day period from 14 July to 22 August 1990. One wolf tested positive for rabies. The other three wolves had died approximately 1 wk before discovery and were in too advanced a state of decomposition for rabies examination. Based on available data, we believe that rabies was the cause of death in these wolves. The cases were consistent by having broken vegetation around the carcass but no apparent injury, and a broken stick approximately 5 cm long wedged in the upper palate of several wolves; these also all were cases of atypical mortality in mid-summer. As well, one of the dead wolves, a member of the same pack with the confirmed rabid wolf, had travelled 12 km out of its resident territory to be found within 1 km of a carcass of a member of the neighboring pack.

In the second incident, two collared wolves from a pack of five individuals died of rabies in the following winter. This epizootic occurred 90 km southeast (45°39′N,

77°35'W and 45°49'N, 77°45'W) of the earlier cases. In one case on 17 March 1991, the wolf had dragged its hind legs for several hundred meters before dying on a patch of bare ground. Based on telemetry data, a second wolf had been travelling with the pack, but separated from them after 20 March. It was found dead on 31 March 1991, within the park, 12 km from its pack mates. The carcass was located halfway inside the active den of a black bear (*Ursus americanus*), though the wolf carcass was not disturbed by the bear. Rabies was confirmed in both wolves by FAT.

Clinical evidence of rabies in wolves are limited. In the six wolves with known or presumed rabies in the study, five cases were associated with damage to nearby vegetation. In three of six cases, broken sticks were wedged in the palate. The broken stick in the mouth may be a clinical sign but not exclusive to rabies since five of eight wolf carcasses killed by trapping also possessed sticks lodged in the palate, apparently during its struggles in the trap.

No collared wolves remained in the northwest section of the park after August 1990, and we lost regular contact with packs in these areas. However, based on aerial track surveys on the territory of each of the affected packs in the winter of 1990 to 1991, wolves still were present. Further, based on howling surveys, we located a pack on the territory of one of the two packs in May 1991. Howling surveys also were used to locate resident packs persisting in the second area of rabies cases. Potentially, an entire pack can be decimated by rabies (Chapman, 1978). While invasion by neighboring wolves could have occurred, it is unlikely that whole packs would have established themselves there so quickly (Mech, 1970).

Including known and presumptive cases of rabies, rabies was second only to human-related trauma as a source of wolf mortality observed in the study (Forbes and Theberge, 1993). Of the 29 radio-collared wolves that died during the 6 yr of this study, six (21%) individuals from three packs are thought to have died of rabies. The number of wolves radio-collared annually approached or exceeded 10% of the estimated total wolf population in the park; thus our results may reflect general mortality in the entire population. Nevertheless, it is difficult to assess the importance of rabies in the Algonquin wolf population. All of the rabies cases occurred within 9 mo of each other, and, in each case, the pack apparently survived the epizootic. Thus, it is not known if mortality from rabies is a rare event of little consequence to the population or periodically exerts significant impacts.

The only previous record of rabies in wolves in the park was in January 1970, when a rabid wolf, found at a deer kill site, apparently had been injured or killed by the deer, and eaten by other wolves (Frijlink, 1977). Based on records of rabies cases, there was no evidence for an increase in rabies cases in wildlife or domestic animals in the vicinity of the park in the winter of 1969 to 1970 (Ontario Ministry of Natural Resources, Maple, Ontario).

Rabies in North American wolves typically has been considered a phenomenon limited to arctic environments, since most reports have originated from areas north of 60° latitude (Krebs et al., 1992). In 1977, all members of an Alaskan wolf pack apparently died of rabies (Chapman, 1978). In another study, the death of nine radio-collared wolves in Arctic National Wildlife Refuge was linked to rabies (Ritter, 1991). In Alaska (USA) rabies epizootics in wolves occur every 2 to 3 yr during coincident epizootics of rabies in Arctic fox (*Alopex lagopus*), a species in which rabies is believed to be enzootic (Johnson, 1992).

The cases reported here are the first radio-collared wolves affected by rabies documented in the Great Lakes region. Rabies has not been considered as a mortality factor in this region's wolf populations. In Ontario, only 15 wolves have been confirmed or strongly suspected of rabies since 1960 (Ontario Ministry of Natural Re-

sources, Maple, Ontario; this study). Less than 15 rabid coyotes (*Canis latrans*) are reported annually in Ontario (MacInnes, 1987).

Rabies appears to be more prevalent in large canids in Ontario than in the Great Lake states containing wolves, Minnesota, Michigan, or Wisconsin (USA). Except for four cases of rabies in a captive wolf in Minnesota, and three captive wolves in North Dakota, no submitted wolves tested positive for rabies in the lower 48 United States from 1981 to 1991 (Johnson, 1992). From 1986 to 1990, no rabid coyotes were reported in Minnesota, Michigan or Wisconsin (Johnson, 1992).

The higher number of cases of rabies in wolves in Ontario compared to the U.S. Great Lakes area may be related to the rabies strain and associated principal vector species present in the two areas. Five distinct antigenic strains of terrestrial (i.e., non-bat) rabies have been identified in North America (Smith and Baer, 1988). In Ontario, virtually all cases of terrestrial rabies are attributed to an Arctic fox strain that originated in the Arctic and was spread by red foxes into Ontario after 1954 (Johnston and Beauregard, 1969). The three wolves in this report that were tested at the Rabies Diagnostic Laboratory had the Arctic fox strain. The principal vector of rabies in Ontario is the red fox with secondary cases in striped skunk (*Mephitis mephitis*) (MacInnes, 1987). By contrast, most rabies cases in other areas of the Great Lakes where wolves occur are due to a skunk strain (Johnson, 1992).

The probability and outcome of interactions between wolves, and potentially rabid foxes and skunks is unknown. Both foxes and skunks are scavengers and oral transmission from carcasses to scavenger is feasible among carnivores (Carey and McLean, 1978). However, while foxes commonly frequent prey carcasses killed by wolves, skunks do not and the likelihood of contact between wolf and skunk may be low. Similarly, skunks have not been reported as wolf prey, but wolves have been observed to chase, kill, and eat foxes (Mech, 1970). In addition, foxes may act as better agents for rabies transmission than skunks because foxes are active throughout winter and are highly mobile, especially during dispersal (Voigt and Macdonald, 1984). Other factors possibly influencing the probability of rabies transmission to wolves include differences between fox and skunk densities in Ontario and Minnesota, and the extent of habitat overlap and interaction of wolves with each of these other species. Though fox rabies is uncommon in areas of the Great Lakes region inhabited by wolves, occasional eruptions occur (MacInnes and Nunan, 1991) which may provide opportunities for transmission to wolves.

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