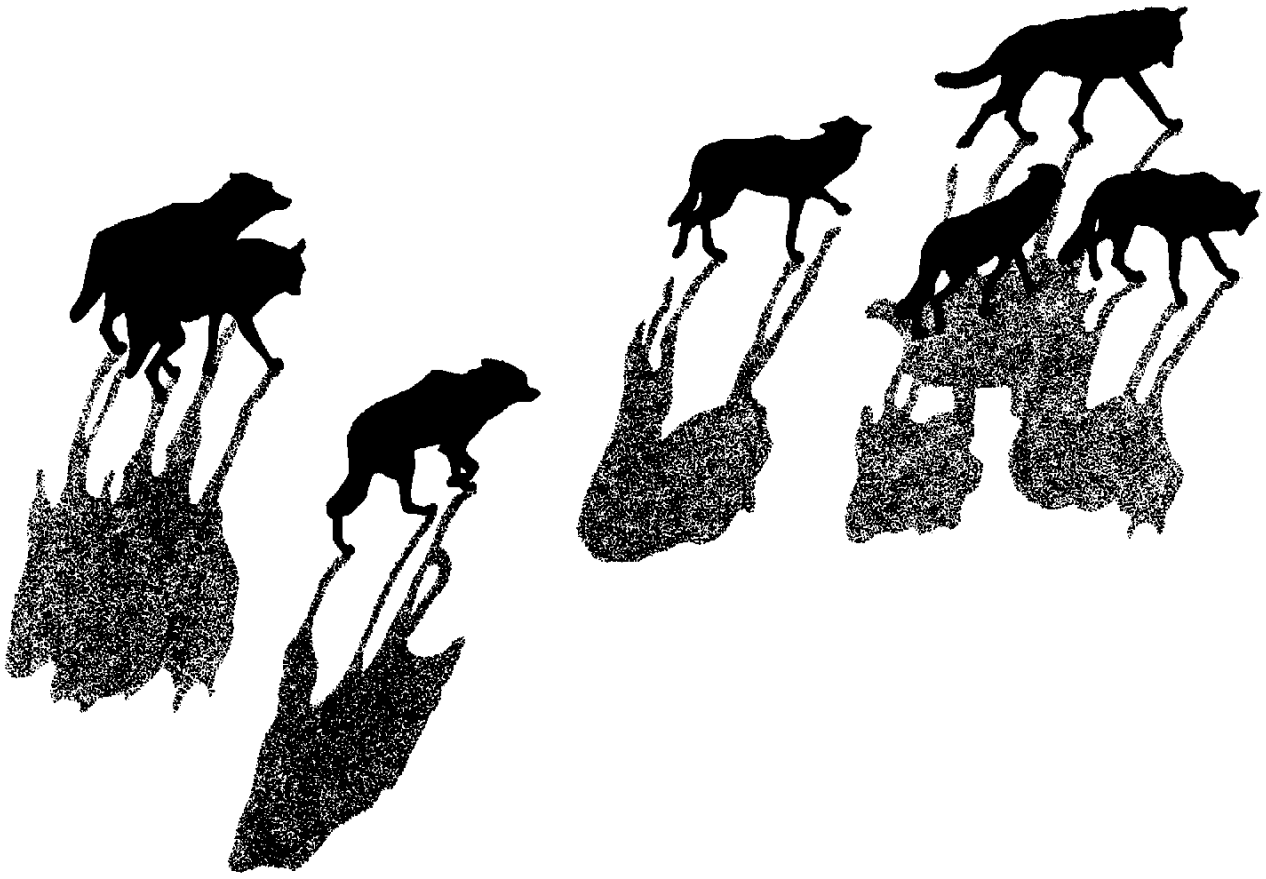
Ecological Studies of Wolves on Isle Royale

Annual Report

1996-97



Ecological Studies of Wolves on Isle Royale

Annual Report—1996-1997*

by
Rolf O. Peterson
School of Forestry and Wood Products
Michigan Technological University
Houghton, Michigan U.S.A. 49931

31 March 1997

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(Results reported here are preliminary, and, in some cases, represent findings of collaborators; please do not cite without consulting the author.)

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Ecological Studies of Wolves on Isle Royale

"Biological systems—especially, self-perpetuating ecosystems—are the most complex entities we know anything about in the universe. The natural life community is an organism that functions as the sum of its parts. Its metabolism is the flow of energy through diverse forms that are held together by their common need and interlocking functions. The community is hedged against extremes and has seemingly endless feedback mechanisms to steer its fluctuations toward a midpoint."

Durward L. Allen

Personnel and Logistics

In summer 1996 Rolf Peterson directed ground-based field work, aided by Cynthia D. Carter, Seth Maefsky, Carolyn C. Peterson, Jeremy D. Peterson, Trevor S. Peterson, Jeffrey Plakke, Eric Trott, John A. Vucetich, Leah M. Vucetich and Joseph R. Zanon. Field work continued from May 11 through August 31.

In 1997 the annual winter study extended from January 21 to March 4. Peterson and pilot Don Glaser participated in the entire study, assisted in the field by volunteers Cynthia D. Carter, Kathy Holt, Seth Maefsky and Graham Neale, and the following personnel from Isle Royale National Park—Elizabeth Amberg, Jack G. Oelfke, David C. Soleim, and Robert K. Whaley.

Summary

The aftershocks of the moose crash during the winter of 1995-1996 continued well into May, 1996, when delayed arrival of spring caused an extended period of starvation for moose. Only 500 moose survived at census time in February 1997, down from 2,400 in 1995. Wolves managed a modest increase in the past year, from 22 to 24 animals (Fig. 1), including seven surviving pups distributed among two territorial packs and a new breeding pair.

Moderate reproduction in the wolf population was almost offset by increased mortality. Even with very abundant food during the first half of 1996, no wolf pack brought through more than 3 pups to winter, 1997, and one territorial pack contained no pups. During 1997 kill rates of moose were near-normal for territorial packs, but it was clear that wolves were having difficulty finding prey. There were no known turnovers among breeding individuals in territorial packs. We still await the appearance of additional young breeding wolves, to evaluate their reproductive performance and genetic fitness.

A record 175 dead moose were examined in 1996, with starvation the most common cause of death. Although calves and old moose predominated among the dead moose, many young adults also succumbed. The 1996 cohort of moose calves was small in stature and abundance, comprising only 3% of the moose population in winter 1997. Wolf:moose ratio has increased seven-fold in the past two years, and wolf predation may now limit moose population increase. A pronounced recovery of moose forage plants is expected.

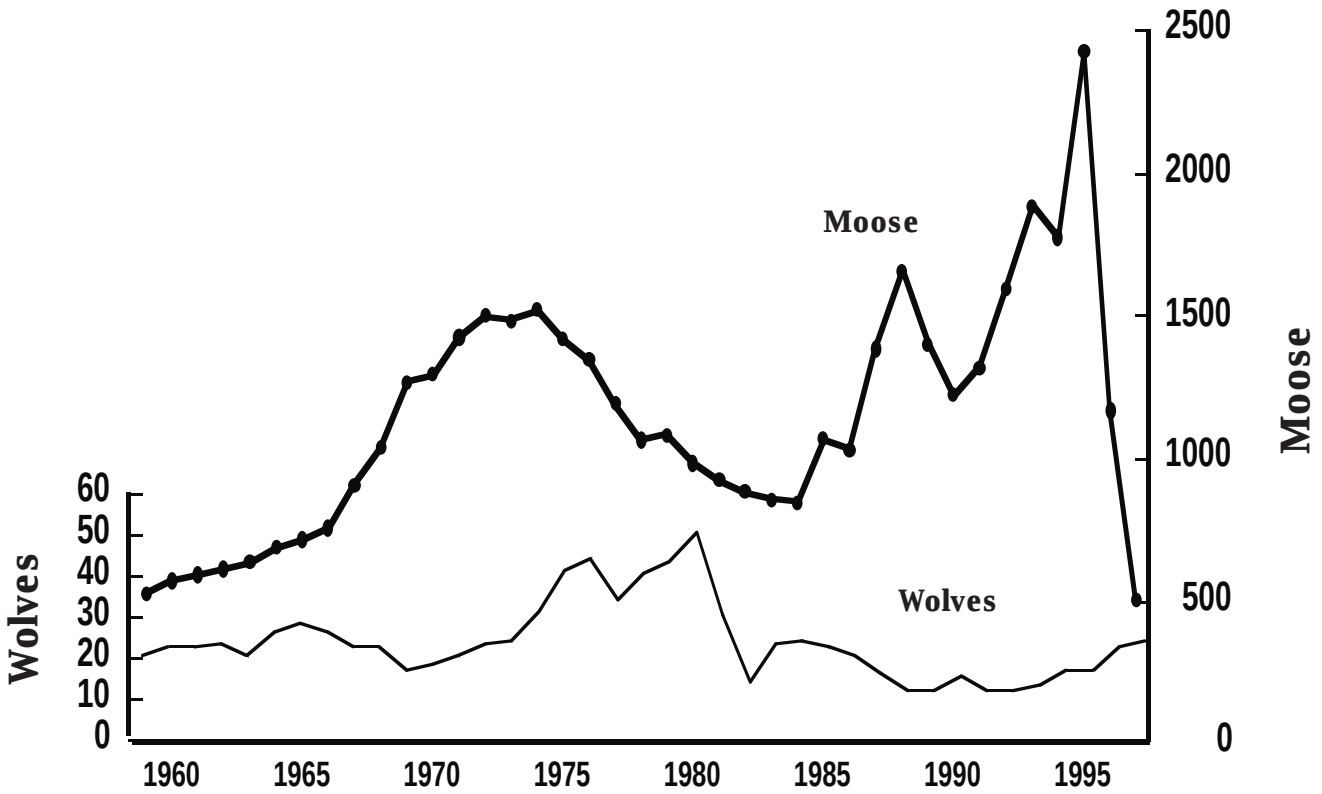


Figure 1. Wolf and moose fluctuations, Isle Royale National Park, 1959-1997. Moose population estimates during 1959-1982 were based on population reconstruction from recoveries of dead moose, whereas estimates from 1983-1997 are based on aerial surveys.

The Wolf Population

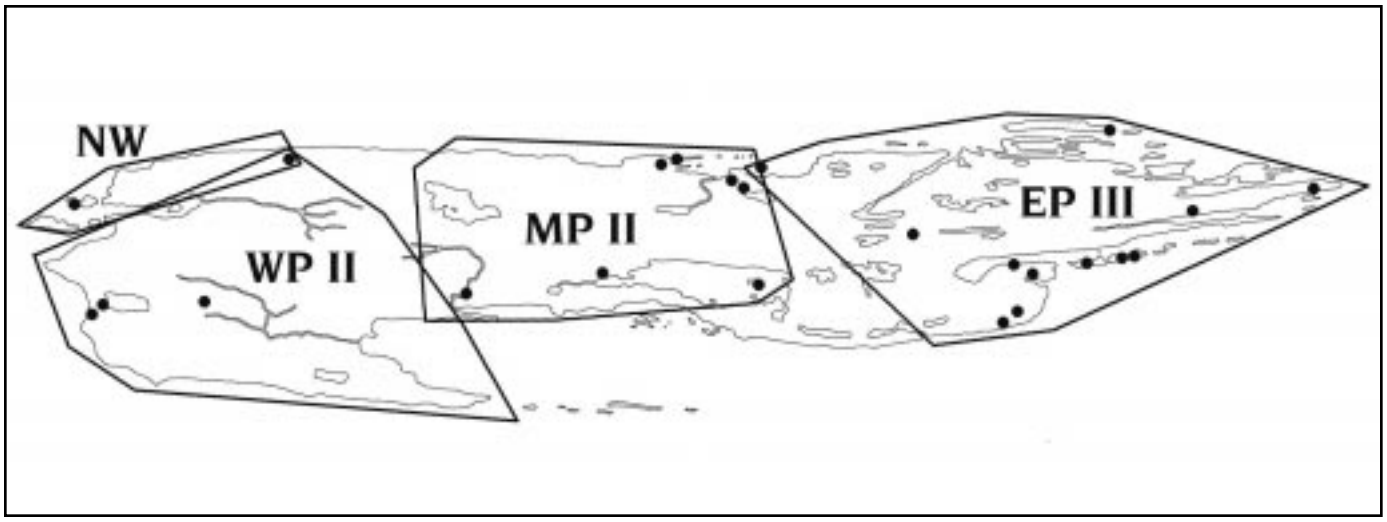


Figure 2. Wolf pack movements and moose carcasses (wolf-kills and otherwise) during the 1997 winter study. All packs except NW actively marked their territory.

In 1997 the wolf population was organized as follows (Fig. 2):

East Pack III	6
Middle Pack II	9
West Pack II	3
Northwest Pack (new)	3
singles	3
1997 total	24

Even with a surplus of food available, there was not a pronounced rebounding of wolf numbers. Territorial packs changed little in size, and the appearance of a new breeding pair at the northwest corner of the island was the most significant change from 1996. The Middle Pack, including three pups, continued as the largest on the island. East Pack had two pups, and West Pack had none. Within traditional West Pack territory a new breeding pack emerged, but by February 1997 only two pups and one adult persisted; we observed no interactions or spatial overlap between these wolves and the West Pack.

The alpha male (right) and a single pup present in 1996 both survived to 1997 in the West Pack. Together with the alpha female, this three-member pack claims half of Isle Royale yet it has produced only one surviving pup since 1988.

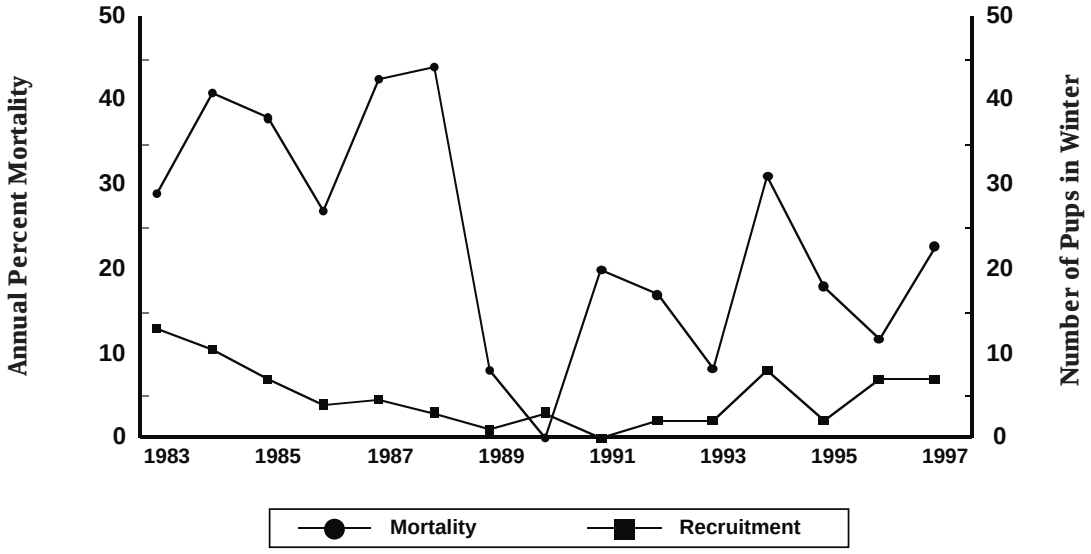


Figure 3. In 1996-1997, wolf population size grew slightly as moderate mortality was matched by reproductive success.

Pack territories and pack sizes changed relatively little from 1996. The Middle Pack grew to nine individuals, the largest pack witnessed at Isle Royale in the past decade. As three-year-olds, the breeding pair in the Middle Pack had three surviving pups, after four pups in 1996. The East Pack, with two pups present, increased from four to six wolves while the West Pack remained the same with three wolves. The West Pack again had no surviving pups, just as in seven of the past eight years.

In 1996 there were three pairs of wolves present outside of established packs. In winter 1997 a new pack (NW) contained just one adult and two pups. This is probably a marginal group of wolves, as the pups appeared to be small and we saw no scent-marking in this pack, suggesting that they did not claim a territory.

There were no mortalities among breeding individuals during 1996-1997. The breeding female and male in the West Pack and East Pack, respectively, are both believed to be over 10 years old. Only the Middle Pack has a young breeding pair, now 3 years old. The reproductive performance of these young wolves, with no history of disease or early malnutrition but more inbred than their parents, may help indicate whether genetic losses are contributing to poor reproduction. In 1995 and 1996 the Middle Pack produced four pups and then three, while usual litter size for wolves is four or more.

Five of the 22 wolves alive in March 1996 died before the 1997 winter study, for a annual mortality rate of 23% (Fig. 3). All we know about this mortality is that it claimed either pups or socially-subordinate wolves.

Ample shoreline ice provided wolves (here, Middle Pack on the north shore) with relief from deep, soft snow in the island's interior in midwinter.

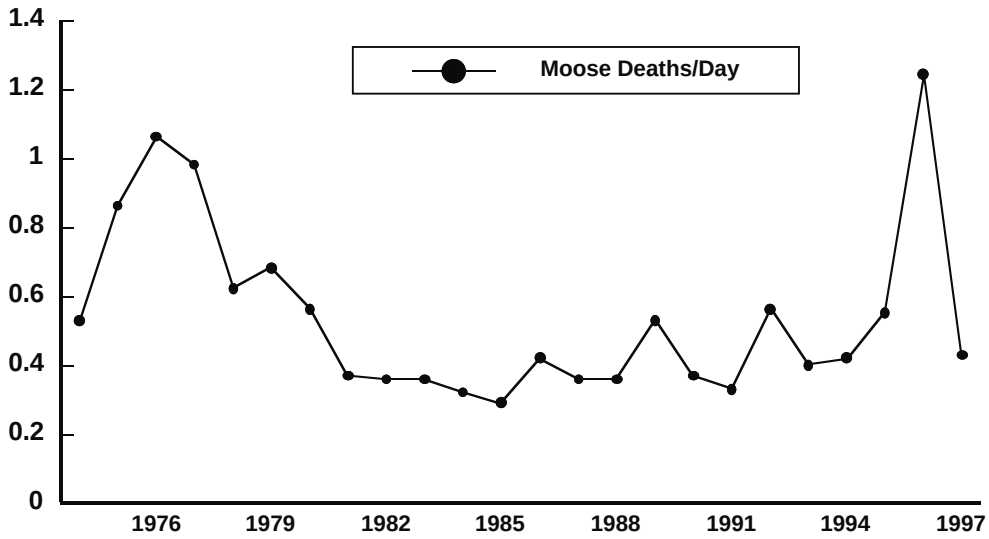


Figure 4. Moose mortality rate in midwinter was at an all-time high in 1996, then fell back to a level typical for the past decade.

Wolves appeared to have genuine difficulty in locating vulnerable prey animals in winter. All three territorial packs were observed returning to moose that had been wounded up to a month previous. Particularly important to the wolves was the lack of moose calves, the age class most commonly killed. In spite of the drastic reduction in prey abundance, the territorial packs managed to kill moose at near-average rates (Fig. 4). As usual, wolves were generally unable to kill moose in prime age classes of 2-6 years of age.

Supplementing the meager supply of moose in 1997 were alternate prey species beaver and snowshoe hare. The Middle and West packs killed at least one beaver per pack during the winter study, and the West Pack killed at least two snowshoe hares. An injured leg prevented one wolf in the Middle Pack from accompanying its packmates on their usual winter travels. This wolf confined its activities to a few miles of shoreline, remaining near old moose kills or a beaver colony where it was often joined by the entire pack (Fig. 5).

Obvious courtship behavior was observed in the dominant pair in two of the three territorial packs, the Middle and East packs, where both breeding females exhibited vaginal bleeding by late February. The

Figure 5. An injured Middle Pack wolf (upper center) that was unable to travel camped out at a beaver colony, ever hopeful for an easy meal. Beavers were using an access hole in the center foreground, then traveling to the tree where the wolf lay waiting. The Middle Pack killed at least one beaver here in 1997.

Well-used remains of a bull moose killed and consumed by the East Pack in 1997 illustrated that vulnerable prey were not readily located by wolves.

prospect of reproduction seems low for the West Pack, with the same aging alpha pair that has raised only one pup since 1988. A small pack sequestered within West Pack territory at the northwest corner of the island may be able to flourish, after raising two pups in 1996. For this to occur, however, the single adult remaining in this pack must secure another mate and they must take over territory from the three-member West Pack, which still holds one-half the land area of Isle Royale.

Prior to the collapse of the moose population it was anticipated that food supply for wolves would steadily increase during the 1990s as old moose accumulated in the population. By the mid-1990s already about half of the moose population was estimated to be over 10 years old. Thus, with the disappearance of disease and an evident surplus of food, lack of reproductive response in the next generation of wolves could likely be blamed on genetic losses in this isolated population. Sudden high mortality among old moose in the 1996 crash will force us to evaluate carefully the confounding effect of food limitation on wolf reproduction.

Middle Pack alpha pair in courtship after suppressing subordinates lying on their backs in the snow.

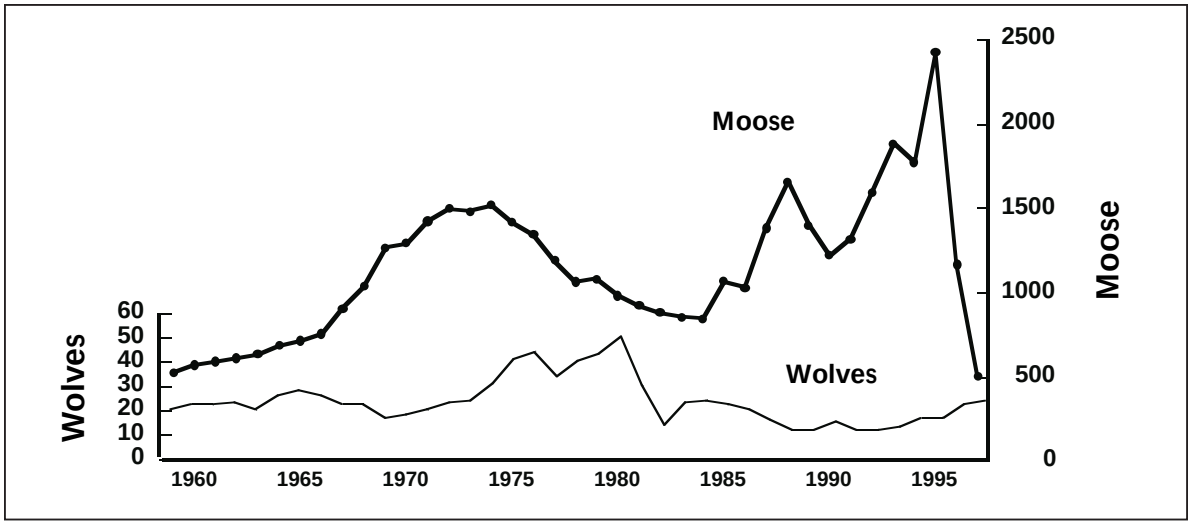
Déjà vu or Chaos?

> *"The further one goes in studying the habits of animals and plants the more perplexing the details and variations become. Nothing seems to hold still long enough to be understood . . . How long do you have to stay at this to see the same conditions come back again? Likely enough, they never do come back."*
>
> —Durward L. Allen, The Wolves of Minong, 1979

Many years from now we will know whether the crash in the moose population in 1996 was an extreme version of a periodic moose decline, or a unique coincidence of conditions in a chaotic system. The predator-prey cycle for which Isle Royale is famous has adequately described the fluctuations in wolves and moose since the late 1950s. Wolves prey primarily on calves and old moose, with old moose providing far more food than do calves. But the limiting effects of wolf predation are levied primarily on the calves, whose death or survival dictate future trends in moose population size. When wolf numbers are low and calf survival high, years of positive growth in the moose population usually follow. As moose in this "baby boom" mature and finally reach an age and condition where they fall victim to wolf predation, their abundance leads to a rising wolf population, which will in turn reduce calf survival for many years. The decade-long lag between successive increases in moose and wolf populations can produce long-term cycles in abundance . . . at least in theory.

Reality may be much less clear than text-book theory, and other patterns may intervene, from annual fluctuations in winter severity to centuries-long patterns of forest successional change. And random disturbance from fire and wind may obscure some patterns and accentuate others. Even single perturbations, such as the arrival of canine parvovirus, may reverberate for decades.

In the past four decades, moose on Isle Royale have declined dramatically twice, once from wolf predation and once from starvation. The recent period of exceptional growth and crash seems clearly linked to the wolf crash in 1980-1982. Now, with moose cut back to a level where wolf predation may once again limit population growth, a measure of stability may be introduced.



The Moose Population

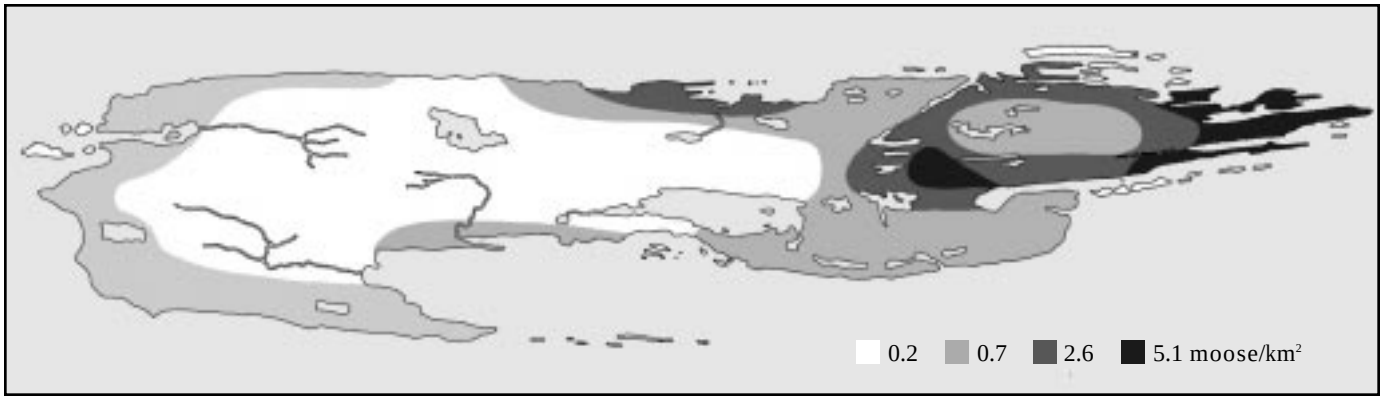


Figure 6. Moose distribution on Isle Royale during the aerial census in February, 1997.

Moose increased in number almost every year from 1981 through 1995, a period with wolf abundance was chronically low. Wolf predation did not halt growth of the moose population. Population size was estimated at 2,400 in 1995 and only half that, about 1,200, in 1996, although reduced sightability during the 1996 count might have contributed to a lower count. In any case, very heavy mortality ensued in the late spring of 1996, so the 1997 winter census was the first opportunity to measure the full extent of the moose dieoff in 1996.

The census results in 1997 were startling, pointing to an 80% reduction in moose from the 1995 peak. Moose were found on only 42% of 91 census plots in 1997, which comprised 20% of the area of the main island (Fig. 6). Where 451 moose were counted in

Earthwatch volunteers found themselves on solid ice on May 11, 1996, the day of the first scheduled ferry from Minnesota, after a long day which included chartered boat, canoe, toboggan, and snowshoes. The ice finally broke up in Washington Harbor during the third week of May.

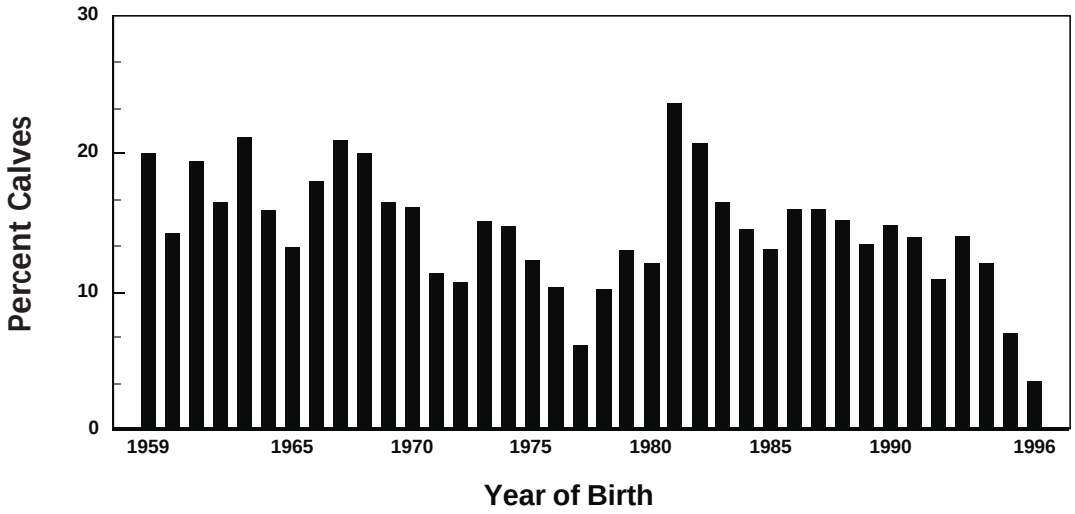


Figure 7. Moose calf abundance (at approximately six months of age) on Isle Royale, as a proportion of the total population. These are single best estimates, the mean of all available counts for each cohort (summer ground observations and aerial counts in autumn and winter).

1995, only 100 moose were found in 1997. The final estimate was 502 moose, with a 95% confidence interval of +/- 121 (24%).

Calf cohorts born in 1995 and 1996 were very small, contributing to the population decline and reducing the potential for future increase. The 1996 cohort, born after a winter of almost unprecedented hardship, was the smallest ever measured at Isle Royale (Fig. 7). In 1997, for the first year since 1981, there were no sets of surviving twins observed in winter. It will be interesting to see whether the surviving cows will be able to rebound in 1997, or whether there is a significant lag before their health is restored to the point where normal ovulation and pregnancy can occur.

Winter conditions for the surviving moose in 1997 were much improved over 1996. Hair loss to ticks was not high, and browse shortage was greatly alleviated. Nevertheless, snow was again almost a meter deep in midwinter, and two-thirds of the moose killed by wolves showed partial or complete depletion of fat reserves in bone marrow (Fig. 8).

There were only three areas remaining with significant moose concentrations in winter (Blake and Scoville peninsulas at the east end, Moskey Basin to Chickenbone Lake at the east end, and Todd Harbor in the island's midsection). All of these areas have dense understories of balsam fir, which emerged during the late 1970s when wolf predation pressure on moose

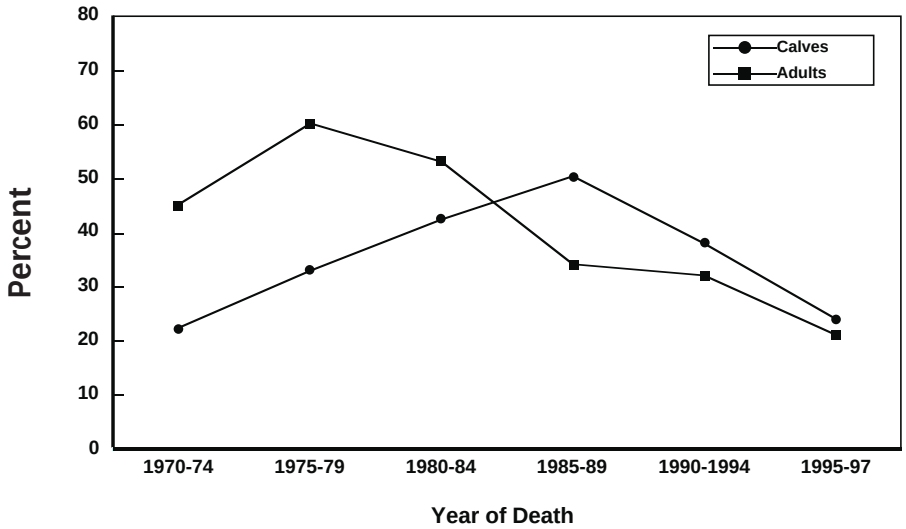


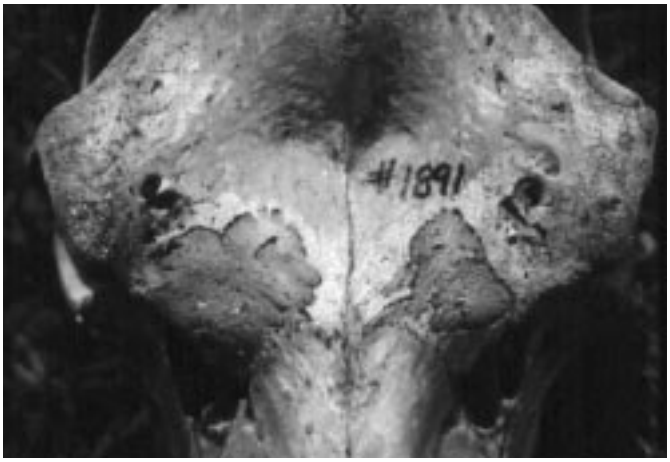
Figure 8. Long-term trends in moose bone marrow fat. Data for calves (which best reflect current conditions) represent mean levels, whereas data for adults is the proportion with >70% marrow fat.

Beaver Island, a small island at the west end of Isle Royale, has for many years supported 20-40 moose per square kilometer in winter. Stands of balsam fir were killed by moose browsing in spring 1996, and carcasses of seven starved moose were found on the island.

reached a peak and moose declined. On the western half of the island fir regeneration remains scarce and absolute forage abundance is much less; here moose suddenly became scarce. Ironically, although fir is considered to be poor quality forage, it supported survival of moose during the extraordinarily difficult conditions of 1996. The distribution of fir regeneration currently has implications for wolves, as they had highest kill rates in pockets where moose were abundant (see maps, Figs. 2 & 6). Of the 18 wolves in territorial packs, 15 of them were found on the eastern half of Isle Royale.

Graduate student Katherine Holt is completing a study of moose mandible size and growth patterns, in a search for effects of density dependence in a prey population heavily limited by wolf predation. She is comparing mandible measurements for moose born during lows in moose numbers to those born during

In 1996 carcasses of 175 dead moose were examined, and skulls and other specimens accumulated at the summer research cabin on Rock Harbor.



Osteoporotic lesions were not uncommon on the skull surfaces of old moose that died of malnutrition. In such moose there is pervasive bone loss throughout their skeleton.

times of high moose density. Her data point to retardation of growth rates when moose exist at 2-3 animals/km^2 compared to 1-2 moose/km^2, but at both "high" and "low" densities moose ultimately achieved the same body size. Moose born during conditions of high population density exhibited an extended growth period, and eventually achieved the same body size as moose born at low density (improved nutrition).

New technologies are now being used to measure genetic characteristics of Isle Royale moose. Paul Wilson, from McMaster University in Ontario, is in the final stages of a study of moose genetics across much of the North American range of the species. His study, using analysis of microsatellite DNA, mitochondrial DNA and genetic fingerprinting, suggests that Isle Royale moose are genetically distinct from moose in mainland Ontario. Preliminary results point to more genetic variability than expected in portions of the Isle Royale moose genome, at least compared to Wilson's results for moose in Newfoundland, where moose have been also been isolated for almost a century.

There was extensive ice coverage on the western half of Lake Superior early in 1997, but no movements of wolves to or from the island were recorded.

Other Wildlife

Summer ground travel provides an index of snowshoe hare density on Isle Royale (Fig. 9). For over 20 years hares remained relatively stable at low levels, except in the late 1980s, in contrast to the famous 10-year snowshoe hare cycle described for mainland regions of the North American boreal forest.

In winter 1997 foxes were highly visible on Lake Superior shorelines at Isle Royale (Fig. 10), where they fed heavily on fruit from mountain ash (*Sorbus decora*). Trees were heavily laden during much of the winter with fruit, brought to the ground irregularly by ice-storms or high winds. Foxes had few opportunities to scavenge from wolf-killed moose because wolf utilization of their kills was very high. Additionally, snowshoe hares did not provide an abundant prey source in 1997. Overall, red foxes on Isle Royale remain relatively abundant.

Douglas W. Smith conducted a biennial aerial survey

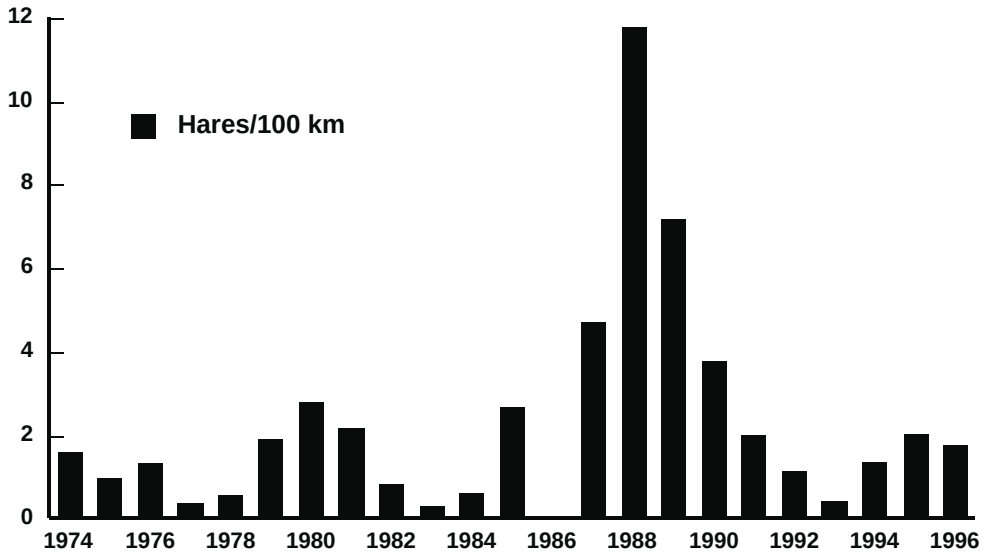


Figure 9. Snowshoe hares on Isle Royale seem to be slowly increasing again after reaching a population low in the early 1990s. Index is the number seen per 100 km hiked in summer.

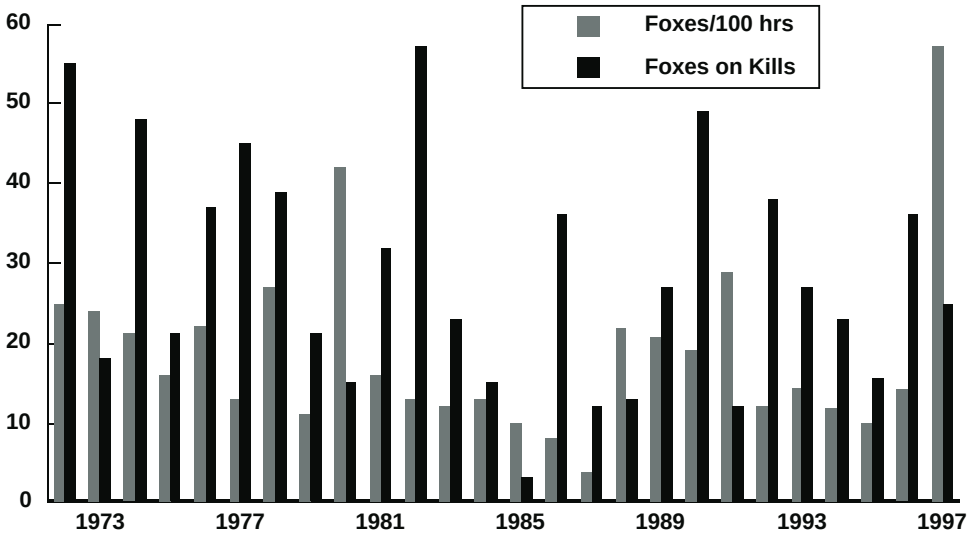


Figure 10. Relative abundance of red foxes from aircraft observations in winter, 1972-1997. Hatched bar is the number of foxes seen away from moose carcasses/100 hours, while the open bar is the number of foxes seen on carcasses.

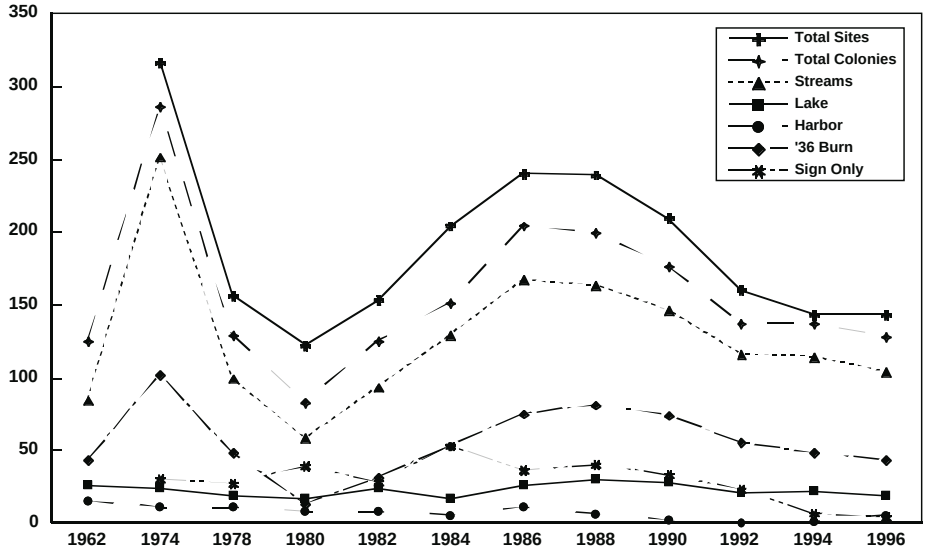


Figure 11. Trends in beaver population size by habitat type, from aerial counts in October.

of beaver colonies in October 1996. This survey was initiated in 1964 by Philip C. Shelton and has been continued on a regular basis by Smith. Results (Fig. 11) indicated that the beaver population is relatively stable at a low level. Aspen stands accessible to beaver have largely been removed in recent decades, and successional stands of this important forage tree are slowly being replaced by balsam fir and white spruce. In spite of slow decline in habitat conditions for beaver, this large rodent, an important secondary prey of wolves, has shown resilience in adapting to declining conditions. The most noteworthy change in beaver numbers occurred in the late 1970s, when wolf predation on beavers was evidently sufficient to reduce beavers numbers. Beavers continue to provide Isle Royale wolves with an alternate source of food.

The Lake Superior portion of Isle Royale National Park continues to support increasing populations of double-crested cormorants, river otters, bald eagles, and ospreys. Flocks of hundreds of cormorants, absent before the 1980s, are now a common occurrence; the nesting population numbers several thousand birds. In the last decade river otters have become widely distributed and relatively common throughout the island, particularly along the Lake Superior shore (Fig. 12).

The National Park Service conducts aerial surveys each year of bald eagle and osprey nesting success.

Figure 12. A river otter forages for snails amidst the rocky bottom of a Lake Superior harbor. Otters have become commonplace in the past 10 years, after decades of virtual absence.

Bald eagles began renesting at Isle Royale in 1985, after an absence of over 15 years attributed to effects of the persistent insecticide DDT. In 1996 eagle production was low throughout the Lake Superior area, probably because of the severe winter conditions that persisted into late April and May. Six nests produced six fledged eaglets in 1996, compared to 11 fledged in 1995. Six nests of ospreys produced four fledglings in 1996.

In winter 1997 tracks of one marten were identified at the west end of Isle Royale (Grace Creek) by field assistant Graham Neale. The species has been recorded rarely but consistently almost every year during the 1990s.

The Moose Catastrophes of 1934 and 1996

On March 7, 1934, overwintering fisherman Holger Johnson sent a shortwave message to the mainland, claiming that "hundreds" of moose were dying. Johnson had found five dead moose near his house on Chippewa Harbor and he reasoned that moose were probably dying throughout the island. (Based on comparative observations since that time, it can be surmised that moose numbered 3,000 or more in the early 1930s). Adolph Murie, who had conducted field studies of moose on Isle Royale in 1929 and 1930, had warned that the moose population, unchecked by any predator, was heading for disaster.

Hickie, a game biologist, and Coburn, a pathologist, reached the island by boat on April 21 and conducted ground surveys and necropies on dead moose during the next month. Even in mid-April snow was one to three feet deep, and the preceding winter had brought prolonged periods of "extremely low temperatures." Thorough examinations were made of five dead moose and three more that were shot by Hickie and Coburn in late April and May. Winter ticks were found in great numbers on just one moose examined. Moose had been greatly restricted in their foraging movements by deep snow, and they fed heavily on windfallen balsam fir and arboreal lichens. Bark stripping and breaking of fir tops over one inch in diameter was noted. An estimated 90% of the fir foliage within reach of moose had been consumed. Wrote Hickie and Coburn, "The heavy losses sustained during the past winter are apparently the result of a number of factors, chief of which is a shortage of food associated with weather of great severity." Hickie made another 2-week visit to the island in September 1934, when he gathered additional reports of dead moose from island vacationers. During six weeks of effort by a single team of investigators, he accounted for 42 dead moose including reports from many seasonal residents primarily active along the island's shorelines. It was widely reported that the moose population was reduced to just "a few hundred" animals. Construction of corral traps was initiated, to capture surviving moose for transport by boat to mainland Michigan in 1935. At the time, this was the only relief considered feasible.

In 1996 frozen harbors prevented boat passage to Isle Royale until the middle of May. During spring and summer two field crews were available for six weeks and a single crew for another six weeks, so sampling effort was about three times greater than in 1934 (plus coverage of the interior by visitors was much greater in 1996). Carcasses of about 115 moose that starved to death were discovered during summer field work. Another 60 moose carcasses were spotted from aircraft in winter were also inspected, about half of these dead from starvation. Given the differences in field effort, it appears that the magnitude of the dieoffs in 1934 and 1996 were similar. There has always been skepticism about the severity of the population reduction in 1934—after all, how could so many moose die in a single winter, immediately after years of increase? The record from 1996, when four out of every five moose perished, helped corroborate the historical record and provided a classical story of ungulate overpopulation. Lacking in both cases was effective limitation of a population of large herbivores by top carnivores; wolves were absent in 1936 and reduced by disease prior to 1996.

(Some of the preceding material was drawn from a 1935 Game Division Report, Michigan Department of Conservation, by Paul Hickie and Don Coburn).

Weather, Snow and Ice Conditions

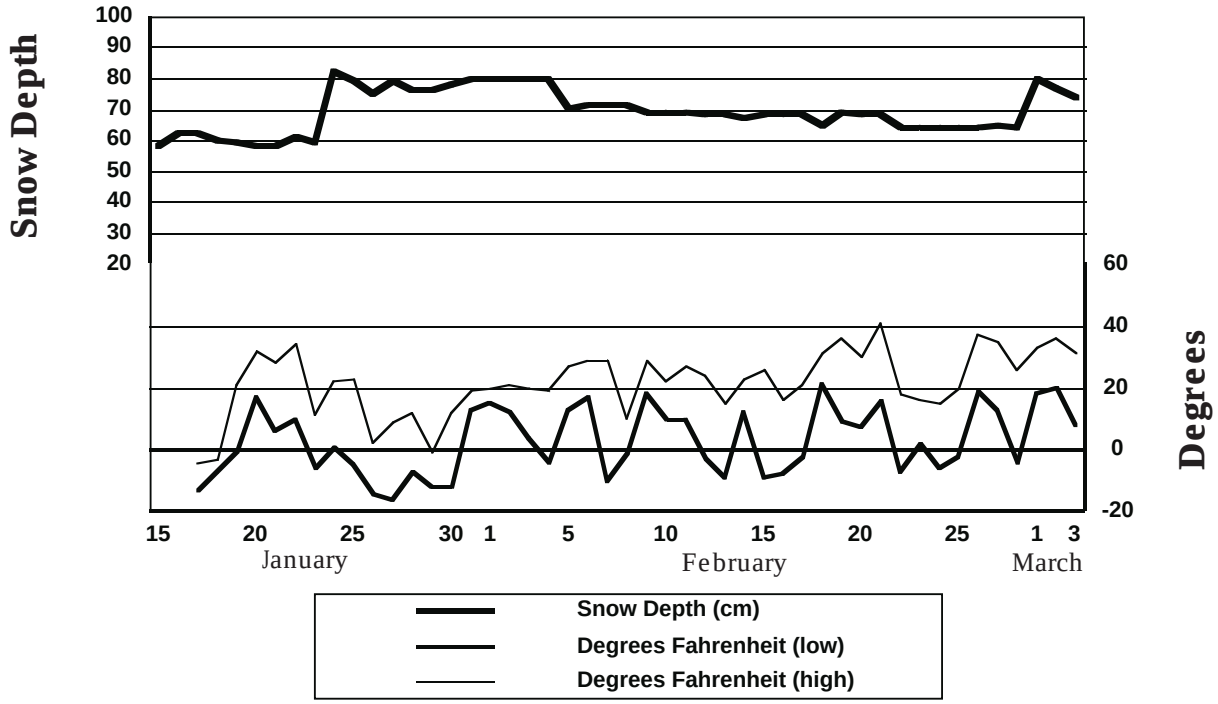


Figure 13. Snow depth (top) and temperature extremes during the 1996 winter study on Isle Royale.

Snow depth was slightly above average during the 1997 winter study and temperatures were near normal for January and February (Fig. 13). Cold temperatures kept snow at low density until mid-February and reduced wolf mobility, but wolves found ample shoreline ice on which to travel throughout the winter period. There was considerable ice cover on Lake Superior during February and an ice bridge existed between Isle Royale and the mainland for most of the month. We were not aware of any wolf movements across the ice bridge to the mainland. By late February, prior to our departure, large leads of open water once again isolated Isle Royale from passage by any terrestrial wildlife.

Wolf tracks were an ephemeral ice sculpture as the bottom of the snowpack melted into a cedar swamp in May 1996.

Isle Royale Natural History Association
87 North Ripley Street
Houghton, Michigan 49931