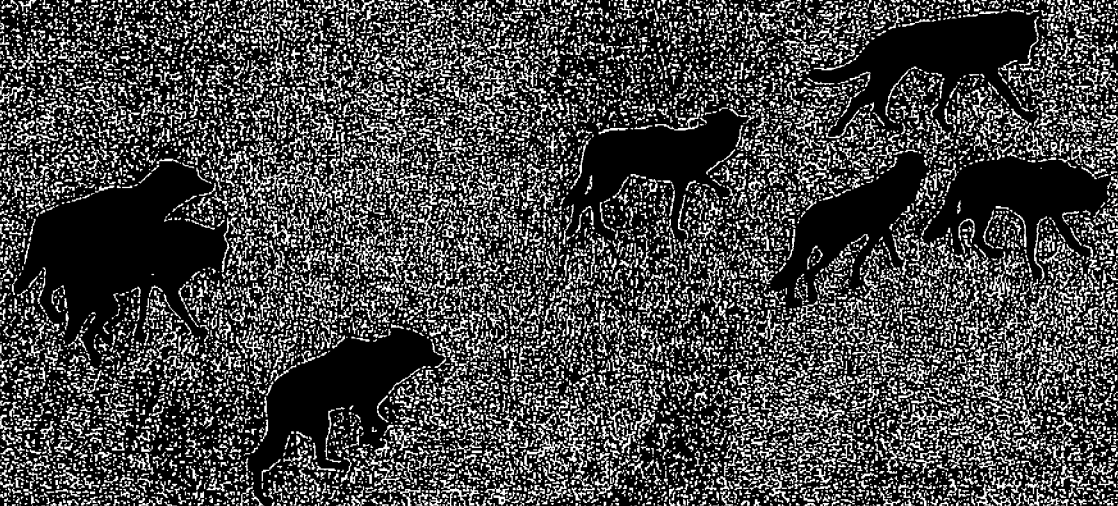
ECOLOGICAL STUDIES OF WOLVES ON ISLE ROYALE

ANNUAL REPORT

1989-90



Ecological Studies of Wolves on Isle Royale*

Annual Report - 1989-1990

(Covering the thirty-second year of research)

by
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(prepared with the assistance of Joanne M. Thurber)

31 March 1990

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TEAM 1: John Bowling, Todd Brabec, Herbert Carson, David Hazen, William Henderson, Dennis Mishler, Ilya Paulucci, John Settlage, John Settlage Jr., Michael G. Thomas.

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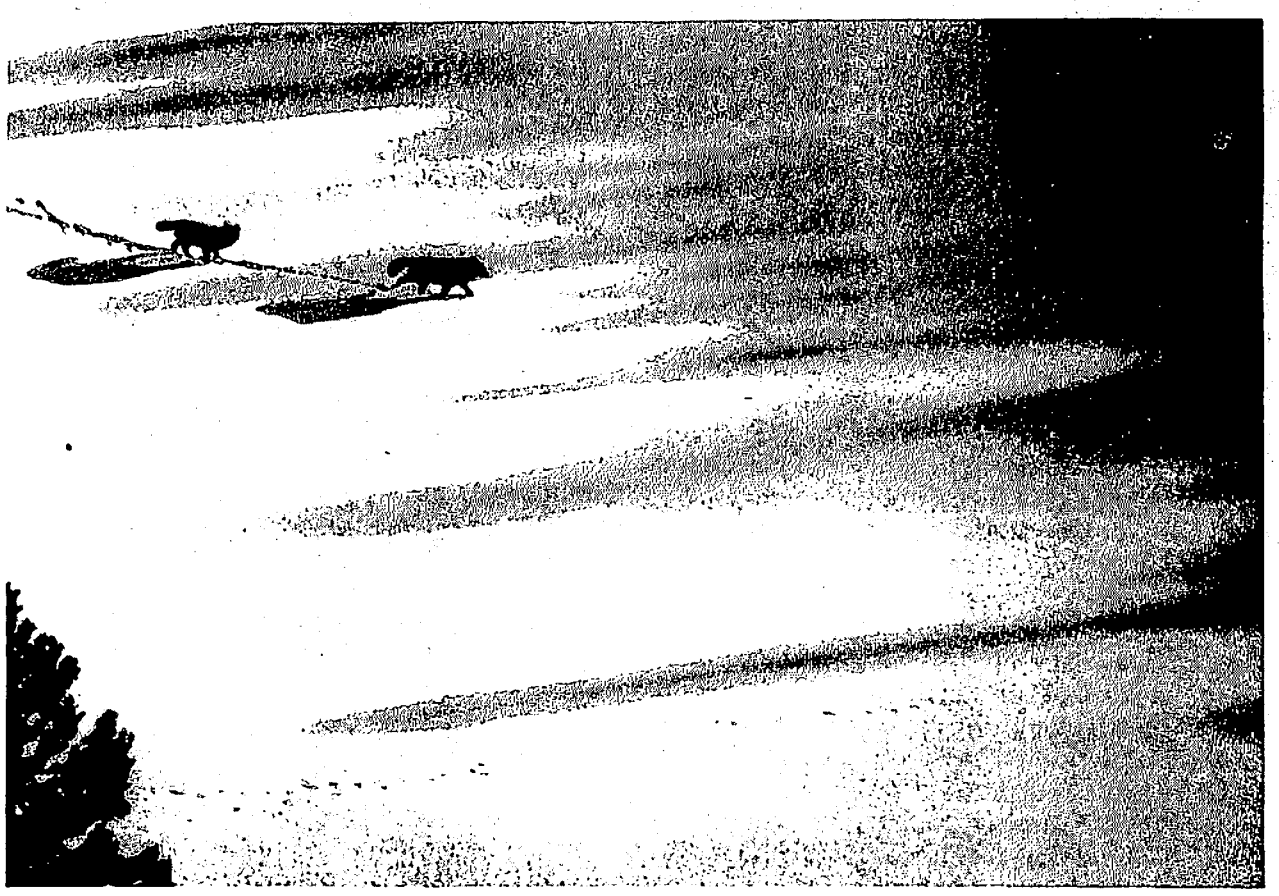
(Results reported here are preliminary, and in some cases represent findings of collaborators; please do not cite in publications without consulting the author.)



At last I caught what I was listening for— the long-drawn quavering howl from over the hills, a sound as wild and indigenous to the north as the muskegs or the northern lights. That was wilderness music, something as free and untamed as there is on this earth.

Sigurd Olson, "Singing Wilderness," 1956

Personnel and Logistics

Field work during the past year was conducted from mid-May through early October 1989 plus a seven-week winter study beginning in mid-January 1990. Field assistants during summer were Daniel J. Fehringer, Carolyn C. Peterson, Douglas W. Smith, and Joanne M. Thurber. During wolf capture efforts in July and September we were assisted by Mark Beckel, Diane Boyd, Margaret Callahan, Richard Thiel, James Welch, Matthew Zine and Jeffrey Zuba.

During the 1990 winter study Peterson, Thurber, and pilot Don Glaser participated for the entire seven weeks. National Park Service personnel who assisted during this time were: William J. Coponen, Robert J. Krumenaker, Timothy S. Cochrane, Jerry L. Case, Barbara L. Nelson-Jameson, and Larry A. Kangas. Supply flights to the island were flown by the Ely Aviation Unit of Superior National Forest, while summer telemetry flights were flown by Isle Royale Seaplane Service (Houghton, MI) and Portage Air (Ely, MN).

Summary

The wolf population in Isle Royale National Park increased slightly to 15 animals in 1990, reversing a 5-year decline (Fig. 1). While three pups survived in one pack, the level of reproduction did not change markedly from the low level that has prevailed during the late 1980's. The population increase resulted from an unprecendented lack of mortality—only two wolves have died in the past two years. Most wolves are middle-aged animals that seem secure from mortality for the present.

Intensified studies of wolves continued in 1989 in order to better understand the factors involved in the recent wolf decline. Seven wolves have now been live-captured, blood-sampled for disease and genetics studies, and released wearing radiocollars. This allowed us to readily observe 11 of the 15 wolves on the island during the 1990 winter study and to closely follow predation patterns and social relationships among the wolves. A correction in the 1989 wolf count (from 11 to 12) was made. While four wolf pairs formed during the breeding season in 1990, lack of successful reproduction remains the most unusual characteristic of this population, which is partitioned into the smallest possible packs (optimal for high reproduction).

Of the three possible explanations for the wolf decline (food shortage, disease, and genetic loss), genetic loss has the strongest support. Food shortage is not clearly evident, and disease also does not provide a ready explanation, although Lyme disease effects on wolves remain unknown. Isle Royale wolves appear to have lost about half their genetic variability and the examined wolves are as closely related as family members. This degree of inbreeding would be sufficient to explain the low level of reproduction observed, although the mechanism of reproductive failure is not clear and other factors cannot be ruled out.

The 1990 wolf population consisted of 12 adults, seven females and five males, plus three pups in one pack. Two territorial packs, numbering two and five wolves each, divided the island, while two other pairs formed during the breeding season. Predation rates were near average and utilization of carcasses was very high. Predation on beaver was recorded nine times during periods of warm weather. One lone wolf was killed by a territorial pack during the 1990 winter study, leaving 14 wolves in March, 1990.

The moose population was estimated at 1,216±163, after a 25% decline in the last two years. Heavy mortality in 1989 was attributed to the influence of winter ticks, and recruitment of calves was relatively low. Tick abundance was lower in 1990, but substantial numbers remain and high moose density facilitates tick transmission. Presently, winter ticks, driven by weather, probably rival wolves as a regulating influence for the moose population.

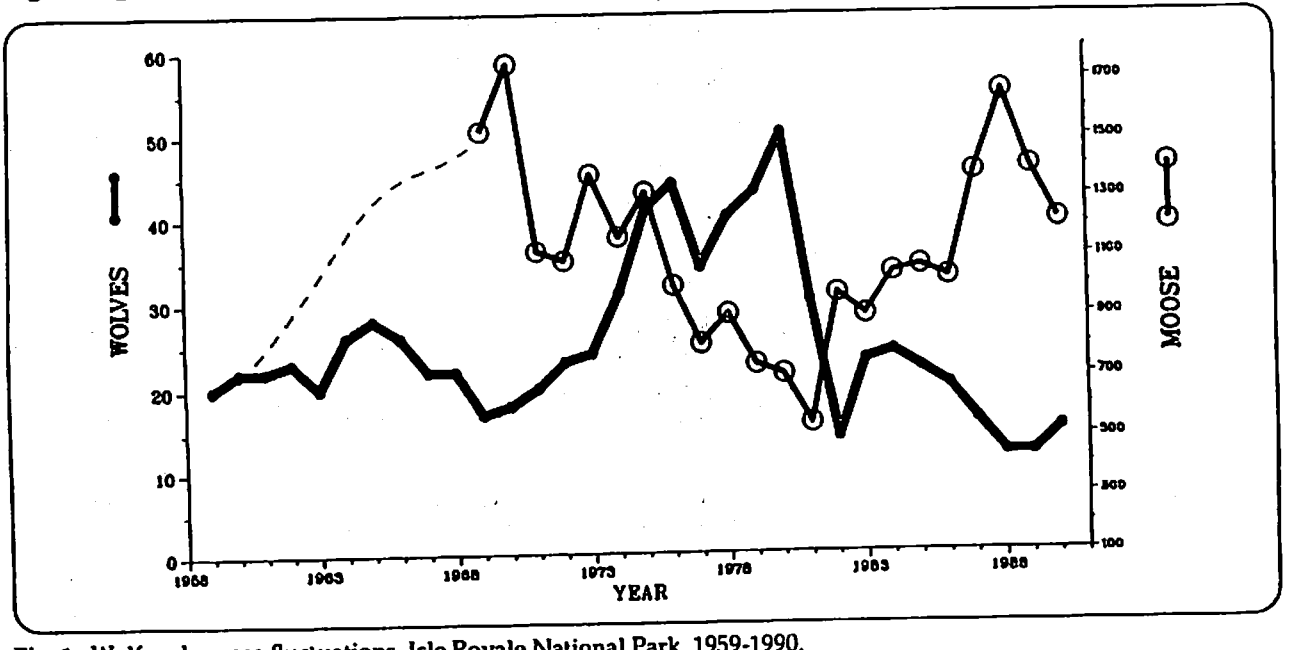


Fig. 1. Wolf and moose fluctuations, Isle Royale National Park, 1959-1990.

The Wolf Population, 1989-1990

In 1990 there were 15 wolves alive on Isle Royale at the beginning of the annual winter study, 12 adults plus three pups in one pack. We revised the 1989 wolf count to 12 animals, rather than the 11 we reported last year. The 1989 count was done under the most difficult of conditions, hampered by very poor tracking snow. Most wolves were not radiocollared and the population was fragmented into very small packs and loners that were difficult to locate and identify.

The end of the wolf decline may only be temporary, as it was brought about by an unprecedented lack of mortality (Fig. 2). Reproduction has remained relatively low throughout the late 1980's. Two years ago, when a study was launched to determine the cause(s) of the wolf decline, three hypotheses were proposed:

1) *Food shortage*, caused by a relative lack of older moose that provide most of the food supply for wolves.
2) *Disease*, with new diseases including canine parvovirus (CPV) and probably Lyme disease.
3) *Loss of genetic variability*, caused by small founding population and genetic drift.

Additional risks faced by the current population include: *stochastic events* that might jeopardize all the wolves, such as a disease outbreak, and *demographic risks* caused by fluctuations in mortality and reproduction or skewed sex ratio.

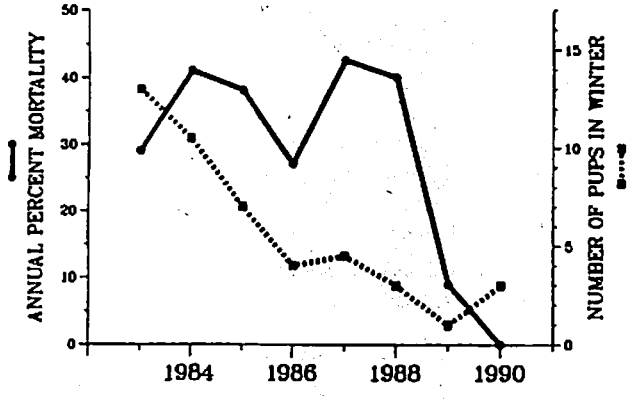


Fig. 2. Wolf annual mortality and reproductive success on Isle Royale, 1983-1990.

Fig. 3. Male 421 (formerly 550), captured in 1988 and 1989. Probably the oldest wolf being monitored, he has remained a loner.

Wolf Demography

With very low mortality and three new pups in the population, wolf numbers increased for the first time since 1984. Only one of the 12 wolves present last year died, this being female 490 who was killed by the two-member West Pack II on February 1. Annual mortality had been very high during the mid-1980's, but mortality all but ceased after 1988, when wolves were radiocollared and we were finally in a position to determine reasons for the high death rate (Fig. 2). Only two wolves (including female 490) from the censused population have died in the past two years, a very low rate that is attributed to most of the wolves being middle-aged and not greatly at risk.

Of the 12 adult wolves present in 1990, seven were females and five were males (Figs. 3-6). Now radiocollared are four of the six females that remained after 490 was killed (450, 590, 600, and 670), and two of the five males (421, formerly 550, and 470). The population included four potential breeding groups, as follows:

West Pack II (WPII) - an uncollared pair that has been together at least since 1988.

450 Pack - female 450, an uncollared mate, and three pups.

Pair - female 670 and male 470, who were together for over five weeks during the breeding season but then separated in early March (Fig. 7).

Pair - female loner and male yearling that paired in early March; the male was a yearling that originated in WPII in 1989.

Lone wolves, largely unassociated with other wolves, included:

Male 421 (formerly 550), captured in April 1988 and recaptured September 1989; he is rarely seen with others.

Female 590, who paired with male 470 in 1989 but was alone throughout the 1990 breeding season.

Female 600, who was nursing at least one pup in August 1989 but was alone and apparently doing poorly in winter 1990; she trailed the 450 Pack and scavenged their kills.

Female 490, alone during the two weeks of close observation before she was killed in February 1990 by the WP II.

Fig. 4. Female 600 (with Rolf Peterson) nursed at least one pup in summer 1989 but was alone throughout the 1990 breeding season.

Fig. 5. Female 490 was a middle-aged lone wolf until killed by the West Pack II in February 1990.

Fig. 6. Female 670, an old female, paired at least temporarily with male 470 during the 1990 breeding season.

The island comprised pack territories that were defended by the WPII and 450 Pack, which both scent-marked their kills prominently and did not overlap spatially (Fig. 8). The 670/470 pair resided within WPII territory but we recorded no direct contact between these groups and 670/470 did not scentmark their kills. The WPII chased female 490 from a kill she made herself and then killed her 2 days later when they confronted her at the same kill. The WPII also chased male 421 from two moose kills that this lone male made by himself, but 421 has frequently traveled across this pack's territory during the past two years. Lone females 590 and 600 once shared a moose carcass briefly, but usually they traveled alone within the territory of the 450 Pack, where they both probably had former social ties.

The WPII alpha pair has recruited only four pups in three years, so they seem unlikely to have high reproductive success in the future. With more than 600 moose in their territory, something other than food shortage must explain the demise of this pack, which dominated the island through most of the 1980's. The 450 Pack might be expected to produce pups in 1990, as this newly-formed pack reproduced for the first time in 1989 (Fig. 9).

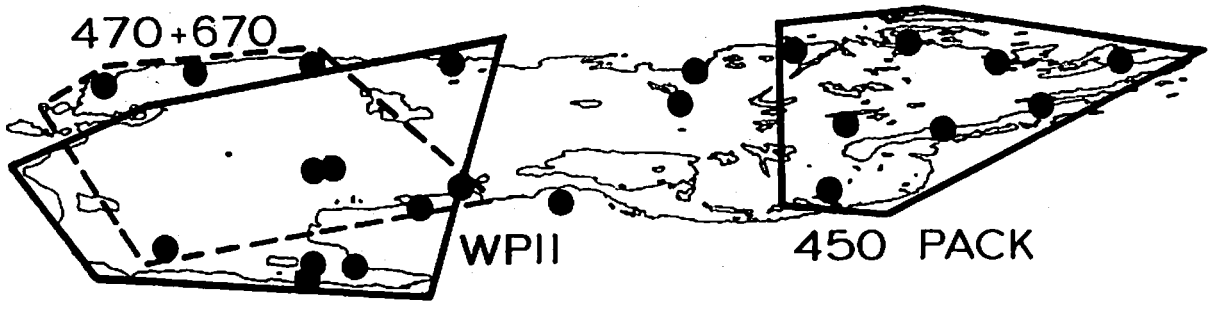


Fig. 8. Wolf pack territories and moose carcasses during the 1990 winter study. WPII = West Pack II (2 wolves), 450 Pack contained 5 wolves, and 670/470 was a non-territorial pair.

Fig. 7. Male 470 and female 670 at the height of the 1990 breeding season. In 1989 male 470 had paired with a different wolf, female 590, but they separated last June.

Wolf food supply

High moose mortality produced an obvious food surplus for wolves last winter (1989) that should have carried well into spring. Winter food abundance has been a good predictor of food supply and reproductive success for wolves at Isle Royale and elsewhere. If food shortage was the sole reason for poor reproduction, then a turnaround was predicted for 1989. While the WPII failed to recruit any pups, the 450 Pack emerged with three pups. For now, this rather mixed response is interpreted as a continuation of the poor reproductive success of the past, providing little support for the food shortage hypothesis.

In 1990 wolf predation rates on moose continued at about the same rate as the average for the late 1980's (Table 1). Except for female 600, estimated food availability has ranged from 6.6-10.4 kg/wolf/day. Female 600's low level of 1.7 kg/day correlated with her low activity levels and she appeared weak when last observed in late February. Twice her signal was in mortality mode (change in pulse rate caused by inactivity), and a special effort will be made to monitor her in spring, 1990.

With several lone wolves radiocollared, we gained some appreciation of their unique ecology. Each individual seemed to have its own means of securing a living: female 600 scavenged moose kills made by the 450 Pack, female 590 specialized in killing beaver (Fig. 10), while male 421 appeared to hunt only moose. Single wolves

Table 1. Travel and kill rates for Isle Royale wolf packs.

	West Pack II 1990	450 Pack 1990	470,670 1990	All packs, 1971-90 average (sample size)
Pack size	2.0	5.0	2.0	8.0 (51 packs)
Travel rate (km/day)	-	6.4	3.3	9.1 (1419 pack days)
Kill interval (days/kill)	9.7	7.4	9.2	7.6 (373 kills)
Travel between kills (km/kill)	-	34.8	16.6	48.9 (292 kills)

Fig. 9. 450 Pack bedded near a kill, including (left to right) 3 pups, alpha female 450, and the uncollared alpha male.

killed four moose by themselves during the 1990 winter study.

By the early 1990's wolf food supply will increase as abundant moose cohorts from the early 1980's begin reaching middle age (8-10 yrs old), providing the best test of the food hypothesis. We expect the age structure of dead moose to slowly shift away from extremely old animals as this occurs. A very slight increase in the number of young and middle-aged moose dying in the last two years may signal the start of this trend (Fig. 11).

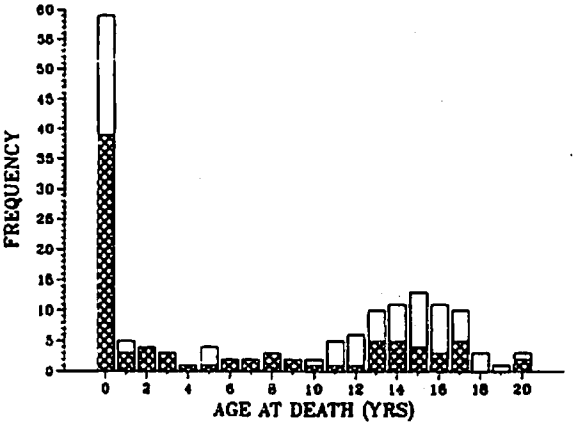


Fig. 11. Age structure of moose dying on Isle Royale in 1986-1989 (last two years highlighted).

Disease status

While canine parvovirus (CPV) was the disease which raised initial concern when wolf capture efforts were initiated in 1988, we have found no evidence that CPV is currently a problem. An extensive survey of diseases and parasites by Nancy Thomas, of the U.S. Fish and Wildlife Service National Wildlife Health Research Center in Madison, Wisconsin, will continue for any additional wolves handled at Isle Royale.

Surprisingly, three of the first four wolves captured had positive titers for Lyme disease, which had not yet been recorded from Isle Royale. Lyme disease appears to cause reproductive problems in some mammals. In 1989, with the help of Elizabeth Burgess from the University of Wisconsin, we sampled ticks and blood from

Fig. 10. (Left) Beaver are usually safe below ice in winter, but they are very vulnerable while foraging above ice during warm weather. (Right) Female 590 and freshly-killed beaver, one of nine killed during the 1990 study.

other mammal species in order to confirm the actual presence of the bacterium *Borrelia burgdorferii*, which causes Lyme disease. Additional foxes were blood-sampled as well as snowshoe hares, red squirrels, and deer mice, and ticks were cultured for *Borrelia*. To date Burgess has confirmed three additional species of ticks not previously known for the island, and a *Borrelia* species has been cultured from three different tick species. Some snowshoe hares and foxes also exhibited positive titers to a *Borrelia sp.* The deer tick, a common vector of Lyme disease, has not been found at Isle Royale and all four tick species known from Isle Royale are very specific for mammals other than humans. This is indeed fortunate, as William Samuel, University of Alberta, recorded over 25,000 winter ticks on each of two Isle Royale moose that died in 1989.

Wolf genetics

Genetic characteristics of seven of the 12 wolves alive in 1989 have now been studied by Robert Wayne, Univesity of California at Los Angeles. All Isle Royale wolves have the same type of mitochondrial DNA, one of ten that he has identified in wolves from across North America. After sampling almost 150 wolves from other parts of North America, we have found the "Isle Royale type" in only one other wolf, from Nipigon, Ontario. All of the Isle Royale wolves sampled thus far are as closely related as siblings or parent-offspring. This is strong evidence that the entire population consists of descendants of a single female, and that there have been no new arrivals that supplemented the original gene pool.

Finally, Wayne's studies indicate that Isle Royale wolves have lost about half of the genetic variability of mainland wolves, in line with predicted loss for such a small, isolated population with a common ancestor. Genetic losses of this magnitude could explain the current low reproductive success of Isle Royale wolves. As yet we know nothing about the actual mechanism of reproductive failure, nor can we exclude other contributing factors.

Future for the wolves

Given the genetic makeup of the current Isle Royale wolf population, we do not think that the mini-recovery in 1990 should dispel concern over their survival. Assuming that reproduction continues at current levels, and that annual mortality will return to 20% or more, typical for a protected population, wolves could stabilize for a time at 10-15 animals. It is clear that the pace of decline has greatly slowed in the last two years, providing a bit of short-term security for the wolf population. For now, intensive study of this test-case in small population viability will continue, and no manipulation or intervention is presently being recommended.

Wolves Outfoxed?

A pair of wolves walked slowly on the ice, along the shoreline of Isle Royale's Todd Harbor. Suddenly, the pair broke into a vigorous run toward a small island a few hundred meters away. A red fox was the cause of excitement, and the wolves quickly caught it, biting and tearing at both ends of the hapless fox. After only a few seconds, however, the wolves abruptly ceased their attack and walked directly off the island toward a nearby moose kill. It was late in the breeding season, and the wolves had a full agenda. The fox's carcass remained stretched out on the snow, just as the wolves had left it. After watching the wolves for several minutes, we took one more close look at the fox, and were astonished to see the fox sitting up. Its fur was a bit matted, but the fox was clearly alive and functioning. The fox slowly stood up and ambled off onto the frozen lake surface, where it sat down with front legs spread wide, as if for added support. One rarely sees a fox sit still for long, but this fox evidently had much to occupy its thoughts as it stared across the ice at the setting sun. When we returned for another look 15 minutes later, the fox had vanished.

The Moose Population, 1989-1990

Growth of the moose population ceased two years ago, and since then the population has declined by about 25%. The moose reduction is attributed to the influence of winter ticks (*Dermacentor albipictus*), which increased greatly following the warm springs of 1987 and 1988 (Fig. 12). Of course, transmission of ticks to their moose host is enhanced by the exceptionally high moose density at Isle Royale, some three to five times higher than most mainland areas in North America. Further, the impact of ticks may be heightened by the relatively poor condition of Isle Royale moose in winter.

Moose census, 1990

The aerial moose census in 1990 commenced on February 6, after moose distribution had stabilized and most animals inhabited mixed or conifer-dominated habitats (Fig. 13). Sightability tests over radiocollared moose in previous years indicated that about 75% of the moose on a plot can be detected under these conditions, providing snowcover is complete and plots are flown under good conditions. The 1990 estimate was 1,216 moose, a decline from over 1,600 moose in 1988. The 95% confidence interval for the 1990 estimate was ± 163 (13%).

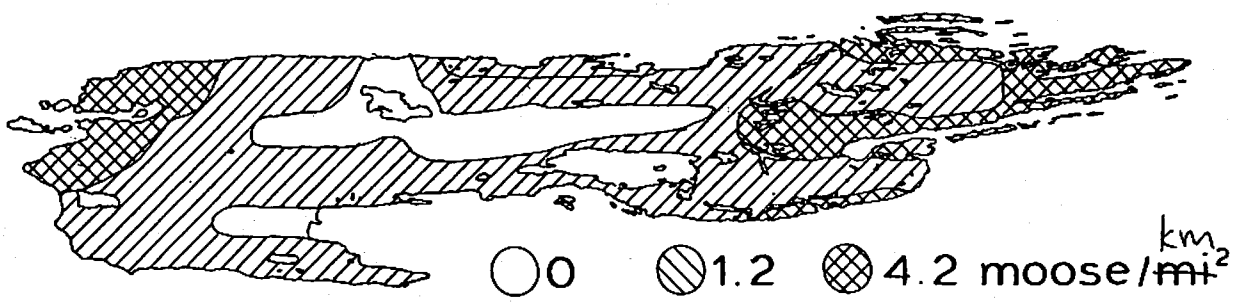


Fig. 13. Relative moose density during census in February, 1990.

Fig. 12. Hairless moose near a mineral spring in May 1989. Moose rub much of their winter hair off in response to irritation caused by winter ticks. A new coat of hair is grown each summer.

Moose reproduction and mortality

Of 223 moose counted on census plots covering 18% of the island area, 29 (13%) were calves (Fig. 14). Given the obvious forage limitations, we have expected calf recruitment to decline as moose density increased rapidly during the 1980's.

A substantial die-off of moose occurred in late winter and spring, 1989, and the frequency of tick-loaded carcasses was unlike anything witnessed at Isle Royale in the past 30 years. Animals most at risk were very old moose and calves, those age classes with lowest energy reserves. Of eight radio-collared moose alive in March, only four remained alive two months later in May (most of these moose were old animals, collared in 1984). All of the dead radiocollared moose perished from malnutrition and were heavily loaded with ticks— none had been consumed by wolves!

Winter ticks and sparse forage have led to chronic undernutrition for many moose, and there is a downward trend in bone marrow fat reserves of moose dying in winter (Fig. 15). We believe the short-term future for moose will depend on conditions for tick reproduction, which may be weather-driven and difficult to predict.

Carcasses of 23 moose were located during the 1990 winter study, including 17 that died during 47 days of coverage (Figs. 16-17). Down from the high death rate of 1989, moose mortality was similar to other recent years (Fig. 18).

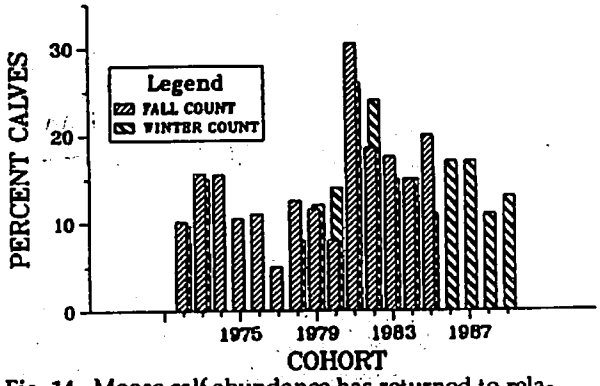


Fig. 14. Moose calf abundance has returned to relatively low levels after moose density increased during the 1980's.

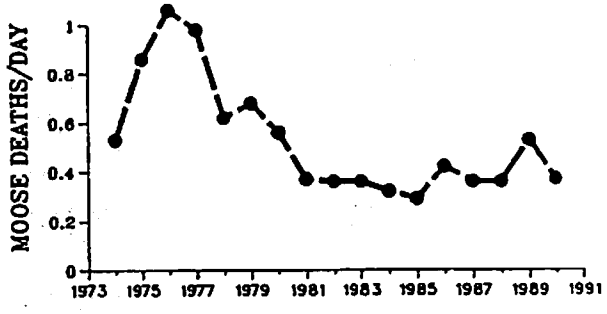


Fig. 18. Moose mortality in 1990 was comparable to the average level during the 1980's. The actual percentage dying each winter has thus declined as the population increased.

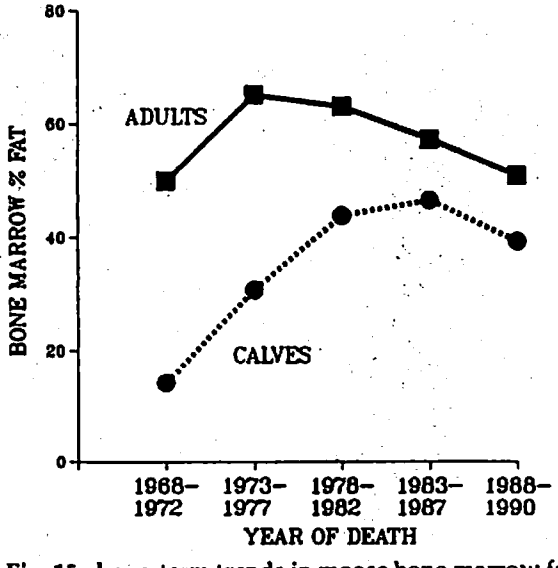


Fig. 15. Long-term trends in moose bone marrow fat suggest increased malnutrition in the late 1980's.

Fig. 16. Calf moose with broken leg is guarded by its mother after an attack by wolf 421. This growth-retarded and malnourished calf died several days later.

Fig. 17. Pilot Don Glaser inspects partially consumed kill of the 450 Pack. Weighing the carcasss, we found 90 kg of edible muscle, bone, and hide left remaining. Later the pack returned to feed on the remainder.

Weather, Snow and Ice Conditions

Fortunately, the Lake Superior area experienced a record-cold December in 1989, otherwise the equally unusual warm weather in January could have prevented ice formation and the initiation of the annual winter study at Isle Royale. Cold weather finally returned late in January and overall snow and weather conditions in 1990 were near long-term norms (Fig. 19). Heavy winds in late February greatly hampered flying and also prevented formation of any ice bridge to mainland Ontario.

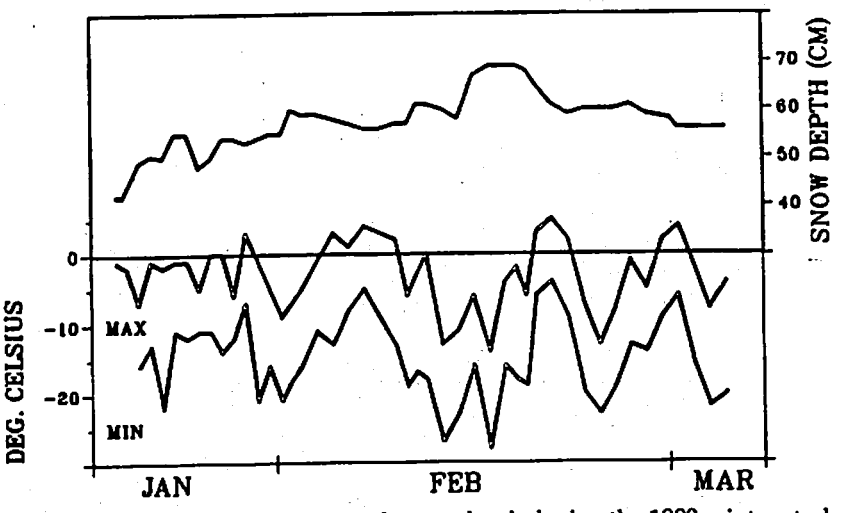


Fig. 19. Temperature extremes and snow depth during the 1990 winter study at Isle Royale.

Other Wildlife Species

In 1989 snowshoe hares seemed to decline somewhat from a recent historic peak (Fig. 20), but they remained locally very abundant. Red foxes, which depend heavily on hares for prey, have been relatively numerous during the past three winters (Fig. 21). Currently fox numbers may be following trends in the hare population.

Another resident species at Isle Royale that seems to have recently increased is the gray jay. This species nests in March, and feeds extensively on dead moose that are most abundant in late winter. After reaching high numbers during the years of moose decline in the early 1970's, when carcasses abounded, this bird became uncommon in the early 1980's. We are still in the process of assembling records, but our impression is that gray jay density has recovered substantially in the last few years. Others have noted that gray jays feed heavily on blood-engorged winter ticks that drop off moose onto the snow, so 1989 should have been an excellent year for gray jays.

Eagles and ospreys continue a slow recovery at Isle Royale, with young fledged in two nests of each species in 1989. Ten peregrine falcons were released at Isle Royale last summer, the third annual release. In 1989 a female peregrine hacked at Isle Royale in 1988 found a mate from Chicago and nested successfully on a building in downtown Milwaukee, Wisconsin.

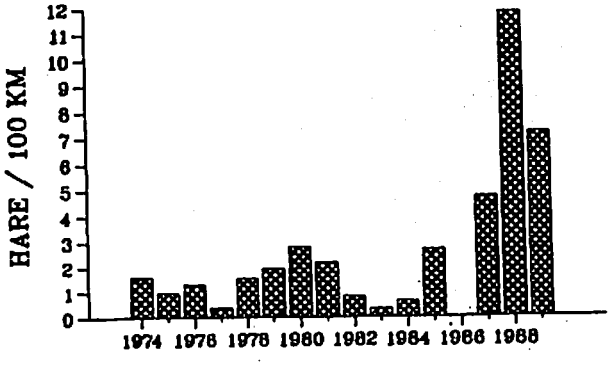


Fig. 20. The snowshoe hare population at Isle Royale has recently reached a historic high level (no data for 1986).

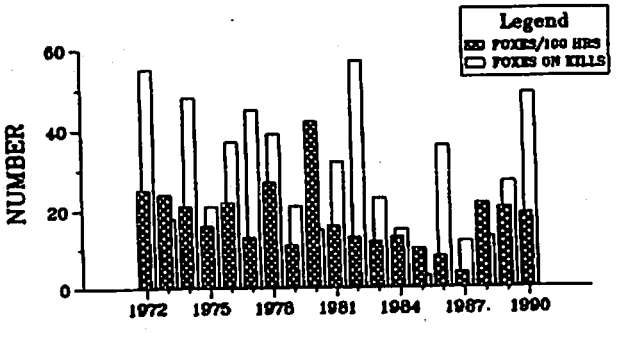


Fig. 21. Relative abundance of red foxes from aircraft observations, 1972-1990. Hatched bar is the number of foxes seen away from moose carcasses/100 hours, while the open bar is the number of foxes seen on carcasses.

Fig. 22. The influence of moose browsing on the forest is clearly revealed by a fenced exclosure (right) erected at the southwest end of Isle Royale ten years ago.

Fig. 23. A cow moose and her twin yearling offspring trot across a frozen lake on Isle Royale.

The High Cost of Living

While scientists have carefully studied the predator-prey interaction between wolves and moose, reducing it to analytical tables and graphs, the actual kill is rarely witnessed, as most kills occur at night. Early in February, however, the 450 Pack, consisting of alpha female 450, the alpha male, and three pups, entered a thicket of trees near Lake Mason. A moose soon ran out of the thicket followed by the alpha male, lunging through the snow, just inches from the moose. With one ambitious and seemingly reckless leap the male grabbed and locked his jaws on the back leg of the running moose. Hanging on was no small feat, because of the piston-like movements of the moose's leg, and the alpha male was jolted, up and down through the air, flopping like a rag doll.

As the moose slowed to weave its way through another clump of trees the alpha female was able to assist her mate. Now the moose was slowed down by two wolves, attached leech-like to each hind leg. The moose continued lunging ahead for another four minutes, mainly on the strength of its front legs. The three pups caught up as the moose came to a halt, but they carefully distanced themselves from the pounding hooves of the moose. The moose quickly collapsed onto its sternum, but kept its head up and often watched the wolves while kicking out with its rear legs, desperately trying to regain its footing. The two adult wolves worked quickly now, tearing at the moose's rump. Blood appeared in the snow beneath the moose. The pups, still fearful of the thrashing moose, continued to watch from a safe distance.

With a sudden lunge the moose regained its feet, the alpha male still clinging tightly to one leg. The moose pummelled the wolf with rapid-fire kicks of its other rear leg. Little wonder that old wolves at Isle Royale have suffered fractured scapulae, cracked skulls, and broken ribs! The moose lashed out at the alpha female, who danced just out of reach, in front of the moose. Action now reached a frenzied peak, the blood-soaked male refusing to yield its hold while the moose whirled back and forth quickly in a vain effort to trample the alpha female. The pups, clearly frightened, clung to safety behind a circle of trees. Unable to gain a hold elsewhere, the alpha female finally rejoined the male and, side-by-side, each held tightly to the rear of the moose. The wolves were repeatedly dragged over logs and thrown against trees as the moose whirled around, but they maintained their hold. Only when the moose actually sat on the wolves did they let go, to quickly shift their hold. Over the next few minutes the moose slowed and finally went down again onto its sternum. With head up, panting heavily, the moose frequently glanced back at the wolves, but gradually its lunges became feeble; finally the rear legs could kick no more.