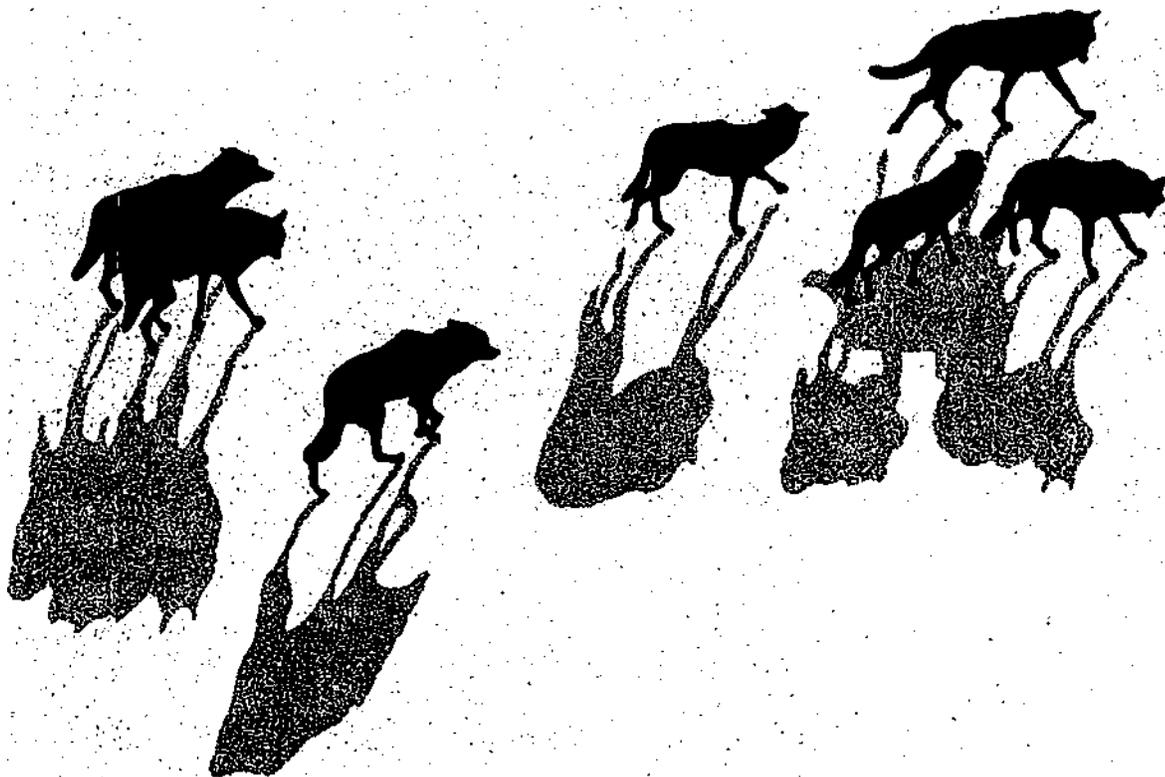


Ecological Studies
of
Wolves on Isle Royale
Annual
Report

1993-94



Ecological Studies of Wolves on Isle Royale

Annual Report—1993-1994*

by

Rolf O. Peterson

School of Forestry and Wood Products

Michigan Technological University

Houghton, Michigan U.S.A. 49931

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(Results reported here are preliminary, and in some cases represent findings of collaborators, please do not cite without consulting the author.)



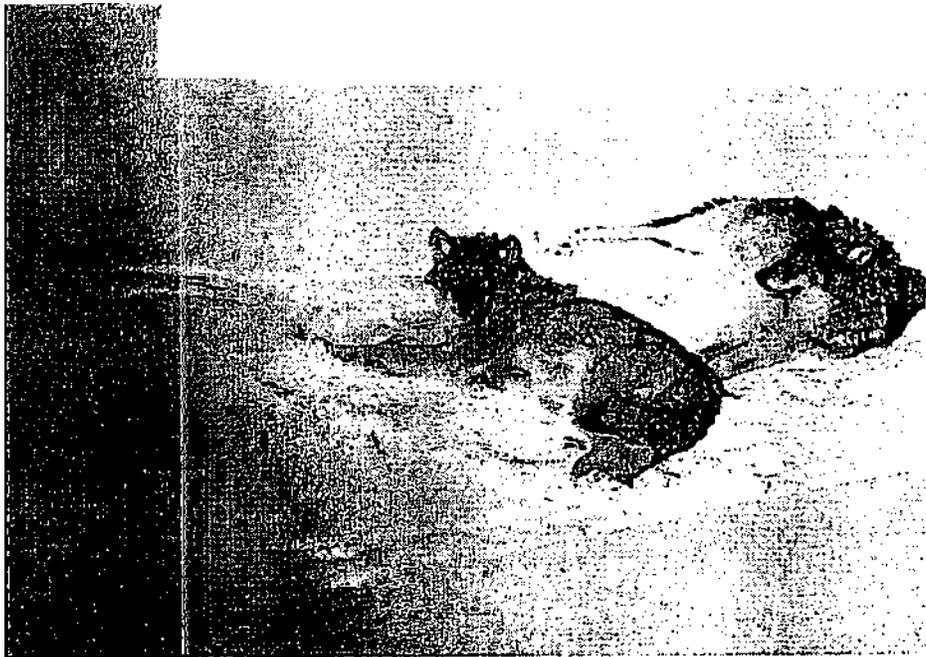
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Ecological Studies of Wolves on Isle Royale



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"When you look into the eyes of a deer, you see a mirror. When you look into the eyes of a wolf, you see intelligence. It has a haunting look . . . one that you will never forget." . . . Ron

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Personnel and Logistics

In summer 1993 Rolf Peterson directed ground-based field work, aided by David P. Bach, Christopher J. Fink, Marco Heurich, Timothy G. Laske, Brian E. McLaren, Carolyn C. Peterson, Jeremy D. Peterson, Douglas W. Smith, John A. Vucetich, and Joseph R. Zanon. Radio-collared wolves were tracked with air support from Isle Royale Seaplane Service and Superior National Forest.

In 1994 the annual winter study extended from January

11 until March 1. Peterson and pilot Don Glaser participated in the entire study, assisted by graduate students Brian E. McLaren and Mary L. Hindelang, and the following personnel from Isle Royale National Park and the National Park Service: Jack G. Oelfke, Ronald Hiebert, Robert K. Whaley, David C. Soleim, Elizabeth J. Amberg, Norman T. Lindsay, Eric Gdula, Larry A. Kangas.

Summary

In 1993-1994 wolf and moose populations at Isle Royale both increased (Fig. 1). Building on improved reproduction in 1993, wolf numbers reached 17 in January 1994, their highest level since 1987. Mortality also increased, with four wolves dying since the 1993 count and two additional deaths during the 1994 study. In the past year three wolves were recovered dead, and all were emaciated with heavily worn teeth. Two of the three territorial packs reproduced, each raising 4 pups. The pups in one pack were orphaned in winter 1994 when both parents died. Most of the surviving wolves (11 of 15) in March 1994 were young—three years old or less. This younger generation contains both males and females, which will help secure the short-term future of the wolf population.

Improved reproduction in the wolf population calls into question the hypothesis that poor reproduction in

this small population was caused by inbreeding. Wolf food supply (old moose) began increasing in the early 1990s, and wolves may now finally be responding to improved food supply, in spite of genetic losses. The outcome of the next few years should help resolve this important question.

The 1993 moose calf crop was larger than average, and the moose population continues to slowly grow. Mortality during the 1994 study included some losses to accidents and malnutrition, but wolves killed 70% of the moose recovered in winter. Winter ticks were not abundant in 1994, and the moose population will probably continue to grow until it is stopped by increased wolf predation, ticks, or winterkill. The previous moose increase (in the early 1970s) was evidently held in check by wolf predation.

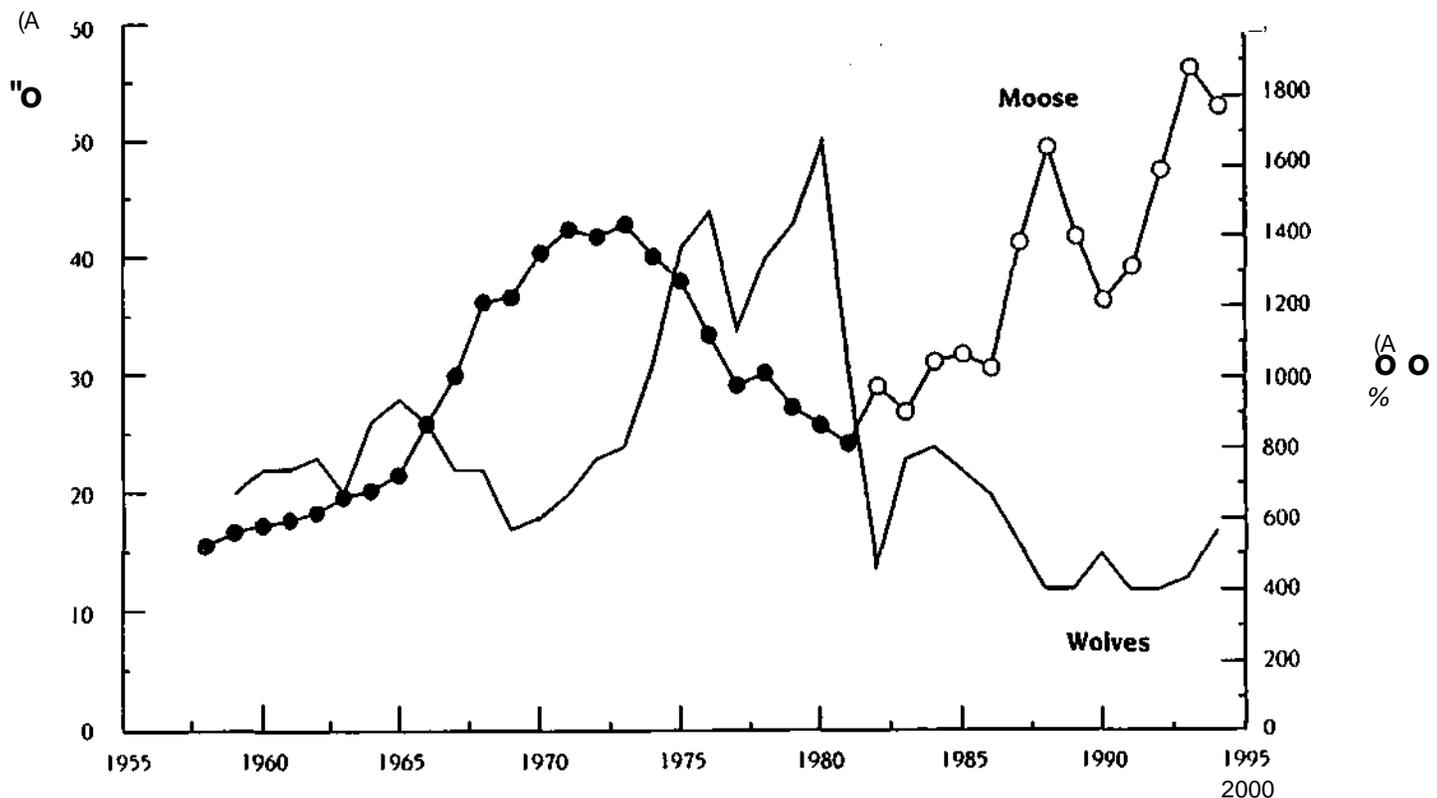


Figure 1. Wolf and moose fluctuations. Isle Royale National Park, 1959-1994. Moose population estimates during 1959-1981 are based on population reconstruction from recoveries of dead moose, whereas estimates from 1982-1994 are based on aerial surveys.

The Wolf Population

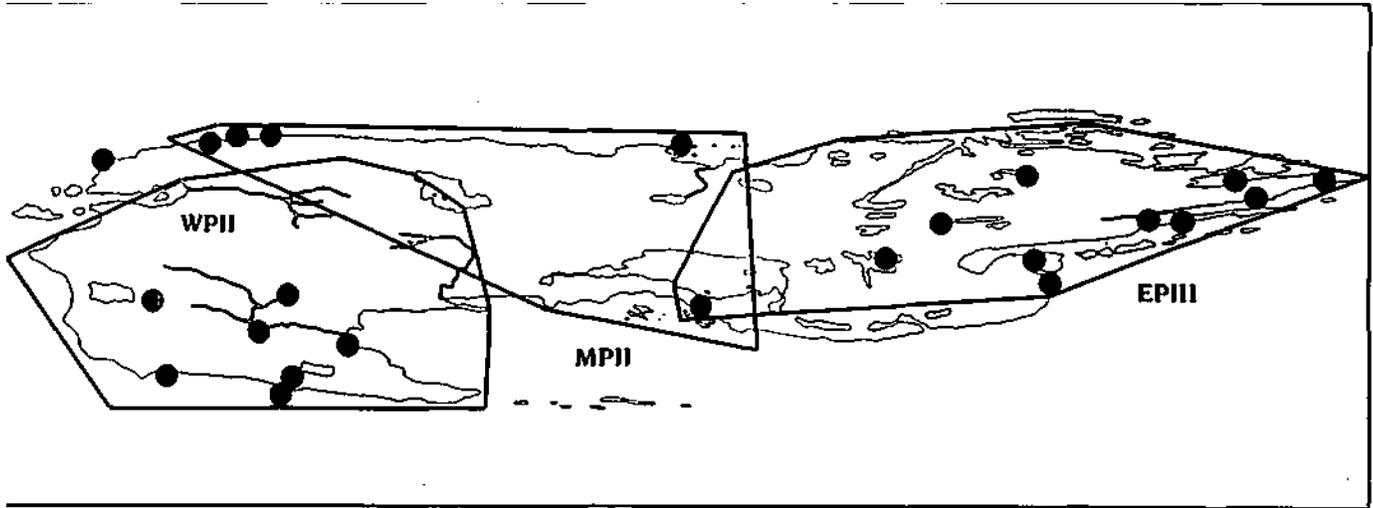


Figure 2. Wolf pack territories and moose carcasses during the 1994 winter study. West Pack II (WP II) was just an alpha pair, but the Middle Pack II (MP II) and East Pack III (EP III) contained six and nine wolves, respectively.

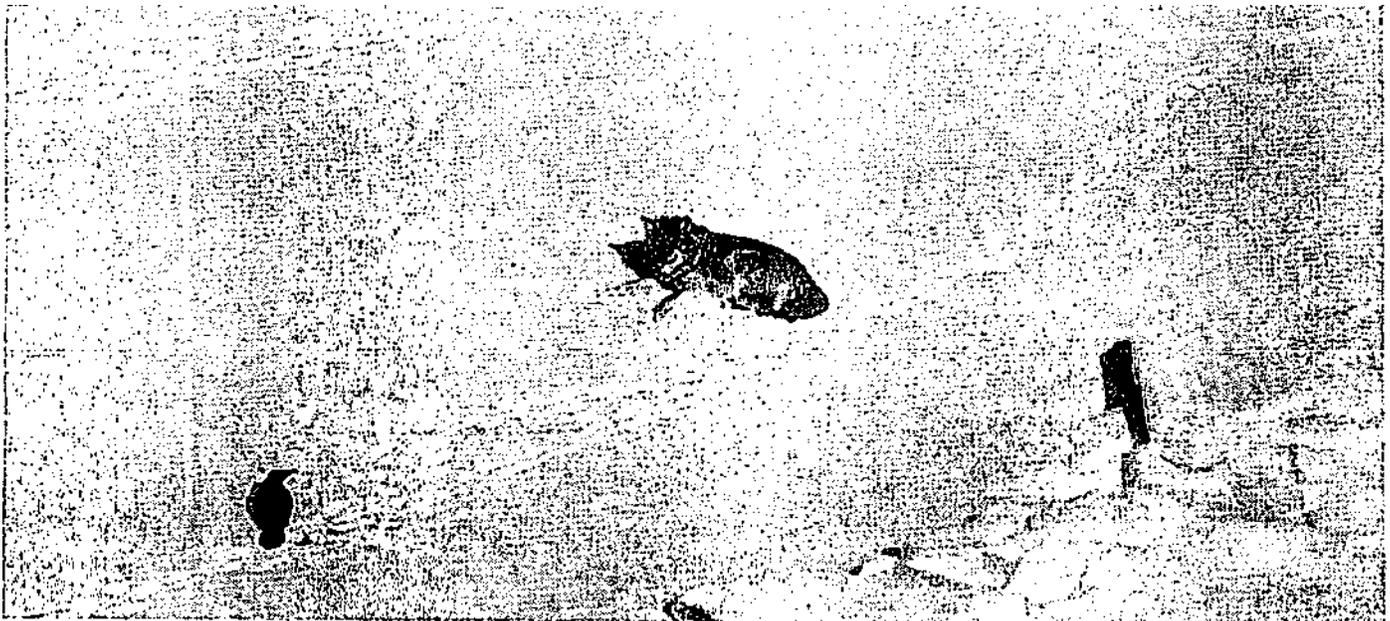
In 1994 the wolf population was organized as follows (Figure 2):

East Pack III.....	9
Middle Pack II.....	6
West Pack II.....	2
1994 total.....	17

Two of the five radiocollared wolves present a year ago (males 420 and 470) died between the 1993 and 1994 studies, and male 550 died in January 1994. Female 450's

transmitter expired but she was alive and identifiable, and her mate (male 410) was collared in spring 1994. Only two wolves (males 410 and 430) wore functioning radiocollars early in 1994.

Eleven wolves were radiocollared on Isle Royale in 1988-1993. Five of these were recovered dead, and causes of mortality were determined. One was killed by wolves, two starved to death with extremely worn teeth, one was injured and died weeks later, perhaps after an injury by moose, and one fell through the ice of Lake Superior. The



A Middle Pack pup with a full belly evaluates a raven that is recycling wolf scats.



Figure 3. Wolf 420, alpha male of the West Pack, was only a skeleton when recovered in August 1993. Overgrown claws indicated a lingering death, perhaps after injury by a moose.

latter wolf (female 670) disappeared suddenly in February 1991 as she traversed the island and explored unfamiliar areas. A hiker found her carcass washed ashore, still hidden, in May 1993, after more than two years of submersion in Lake Superior! No diseases have been implicated in any wolf mortalities, and evidence of canine parvovirus disappeared after 1988.

Only three elderly female wolves were known to exist in 1993, and one of these died in February 1994. Improved reproduction has now reduced the risk of extinction from random loss of one sex, although we know the sex of only four (three males and one female) of the 11 young wolves

now alive.

Male 430, at four years of age, dispersed from the East Pack in the spring of 1993 and took up residence within West Pack territory. We were surprised to find him in the company of the West Pack alpha male (420), who was quite sedentary in early summer—we supposed they were near young pups, and we were encouraged by the possibility of reproduction in this group. In July, however, the alpha male died, and we then learned that his immobility was caused not by dotting behavior near pups, but by his impending death (Fig. 3). Male 430, who apparently sensed a future opening for himself, remained in West

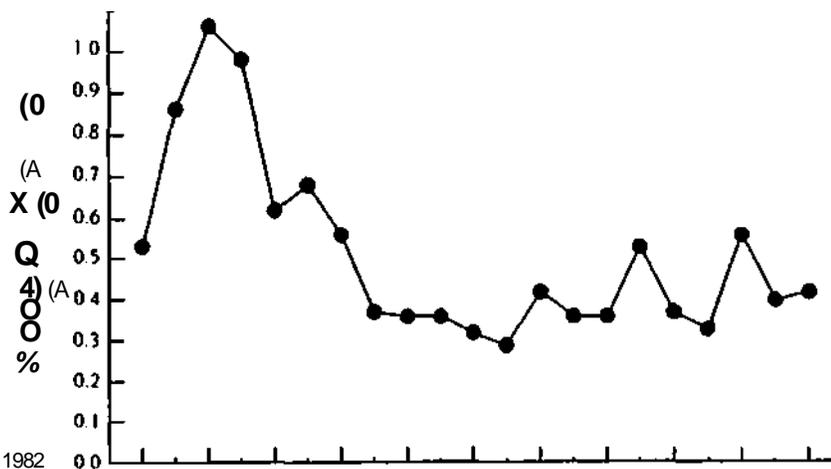


Figure 4. As moose numbers have grown in recent years, moose mortality in winter has been relatively constant



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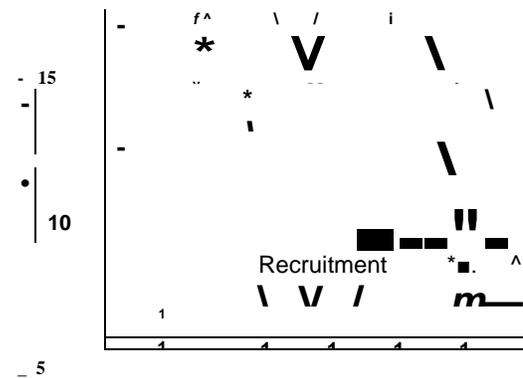
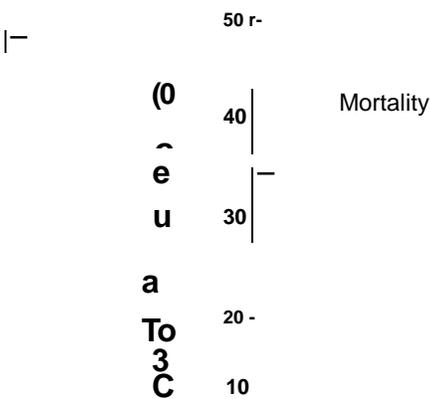
Middle Pack on a moose kill. The alpha male had just died of old age/malnutrition, and the alpha female (left upper) would succumb two weeks later.

Pack territory and became the alpha male in this pack of two in 1994. He courted the alpha female of long-standing, who appeared to accept this newcomer, and they were one of only two possible breeding pairs in 1994.

In 1994 predation rates changed little from previous years (Fig. 4). Because of extreme cold, remains of wolf-killed moose quickly froze, and full utilization of many carcasses was not accomplished until a late February thaw. In fact, for many weeks the West Pack bypassed an intact carcass of a moose that died accidentally, but with the thaw the wolves returned and ate this moose in its entirety.

In reviewing the dynamics of Isle Royale wolves during the past decade, there is strong circumstantial evidence that canine parvovirus, a virulent disease of dogs that first appeared worldwide in 1977, probably arrived on Isle Royale in 1979-1981. The unusually high mortality in 1981 and 1982, together with the loss of all pups in 1981, could be attributed to the arrival of parvovirus on Isle Royale. High mortality from unknown cause(s) continued until 1988, but then ceased at the same time that parvovirus disappeared from the island (Fig. 5).

In the 1980s the wolf population failed to follow trends in its primary prey, the old-age segment of the moose



1983 1984 1985 1986 1987 1988 1990 1991 1992 1993 1994

Figure 5. Wolf annual mortality and reproductive success both increased in 1994.

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East Pack gathers next to the Merrill Lane dock at sunset to begin traveling. Because Isle Royale is closed to visitors in winters, wolves gain access to the entire island.

population (Fig. 6). They were limited by high mortality until 1988, and thereafter by poor reproduction. After parvovirus disappeared there were no known diseases of concern and food seemed ample for the needs of the wolves, so genetic losses in this isolated, inbred population seemed to be the most reasonable cause of reproductive failure. Of course, the turnaround in reproduction in two of the

three packs in 1993 calls into question the genetic hypothesis. Much attention will be focused on this issue in the next few years, when a new generation of wolves will take over pack leadership and reproduction. Improved performance in 1993 increased scientific uncertainty about the cause of recent reproductive failure, but it also helped ensure that there will be another generation of wolves on Isle Royale to help reveal answers.

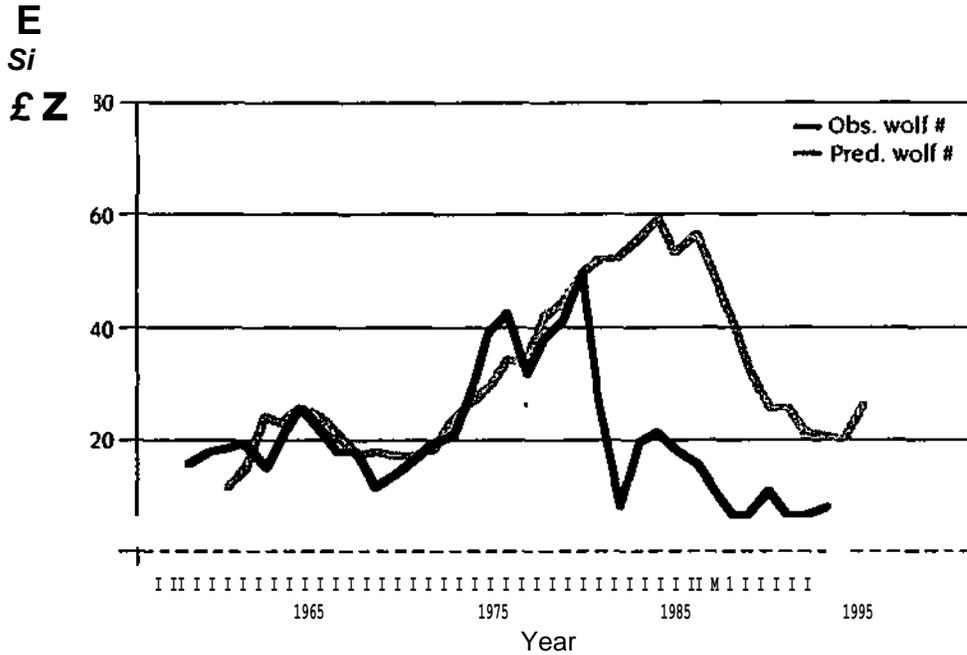


Figure 6. After a decade of unexpectedly low numbers, wolves (lower line) may be starting to catch up with their food supply, moose over 10 years old (upper line).

The Moose Population

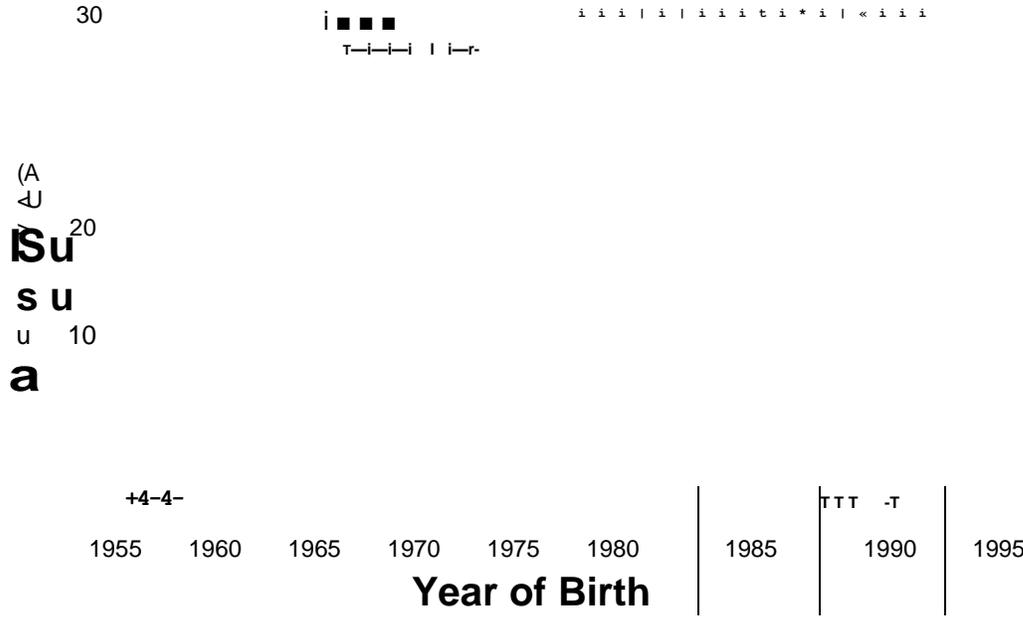


Figure 7. Moose calf abundance (at approximately six months of age) on Isle Royale, as a proportion of the total population. These are single best estimates, the mean of all available counts for each cohort [summer ground observations and aerial counts in autumn and winter).

In spite of high density and scarce winter forage, moose calf abundance was slightly above average in 1993. Based on summer ground counts and the winter census, calves comprised 14% of the moose population, slightly above average (Fig. 7). This should more than offset current mortality, allowing the moose population to continue to expand.

An aerial census of the moose population was conducted in February, 1994, by means of intensive counts of small plots totaling 15% of the island area (Fig. 8). On these plots 252 moose were counted, and we estimated 75% of the moose on the plots were seen. The resulting population estimate was 1,770 moose, with a 95% confidence interval of +/- 370. Although this is slightly lower

than last year's estimate of 1,880 moose, the drop in estimates is probably due to random error.

Isle Royale moose have been increasing steadily since the early 1980s, except for a brief decline associated with winter ticks in 1989. This upward trend will probably continue until mortality increases from wolf predation, another outbreak of ticks, or a late winter dieoff from malnutrition. Weather patterns might well dictate the short-term outcome.

Even with the reduced wolf population, predation is still the only important cause of death for Isle Royale moose. Of 24 dead moose examined in winter 1994, 17 were killed by wolves, two died of malnutrition, and one died after lodging its foot between two birch trees. In a

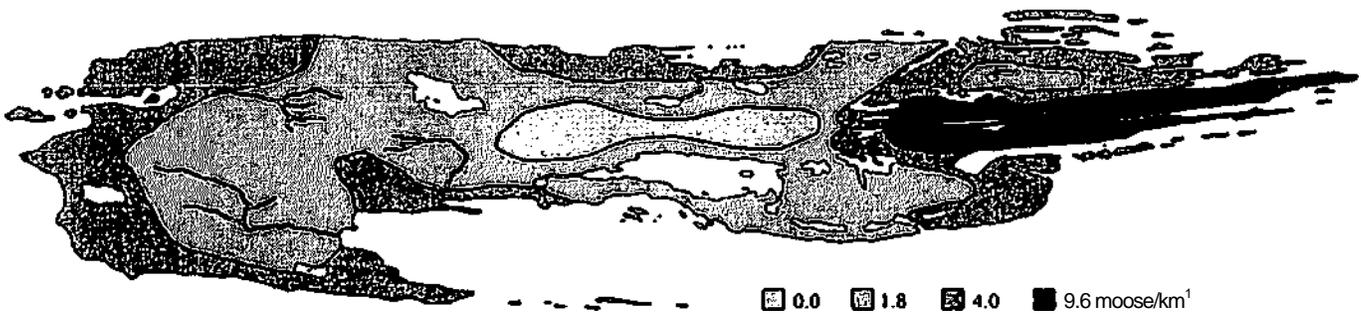


Figure 8. Moose distribution on Isle Royale during the aerial census in February 1994.



Eighteen hundred moose in Isle Royale exert tremendous pressure on the island's vegetation, especially through winter browsing

Figure 9. This moose calf fell 20 meters to its death off an icy north shore cliff at Isle Royale. The fourth to do so in a 10-day period in February 1994





Figure 10. A moose calf survived a fall onto an ice ledge (left), and was marooned for a day (right) before successfully completing its descent to the ice below

single 10-day period, four moose died after they fell off the steep north shore of the island onto the ice of Lake Superior (Fig. 9). We observed two other moose that survived similar accidents (Fig. 10).

Fat content in bone marrow of moose recovered in winter has declined in recent years (Fig. 11), coincident with the rise in the moose population. Likewise, there has been a slow decline in the urea content of moose urine in winter, a reflection of reduced protein intake.

Highest concentrations of moose in winter were found in regenerating fir stands at the eastern end of Isle Royale. in century-old, post-fire forests. Moose habitats at the western end of the island tend to be much older.

but concentrations of moose also occurred in the youngest forests there. For example, Beaver Island, near our Windigo base camp at the west end, was cleared a century ago to allow residents to view approaching ships. It now supports thick stands of regenerating fir, and attracted 20-25 moose, or about 40 moose/km², throughout the winter study in 1994 (Fig. 12). We collected a cow and calf from the island in February, and their body weights were the lightest recorded at Isle Royale—293 kg for the cow and 136 kg for her calf. Bone marrow fat content was <30% for both moose, indicating that their fat reserves were almost completely depleted.

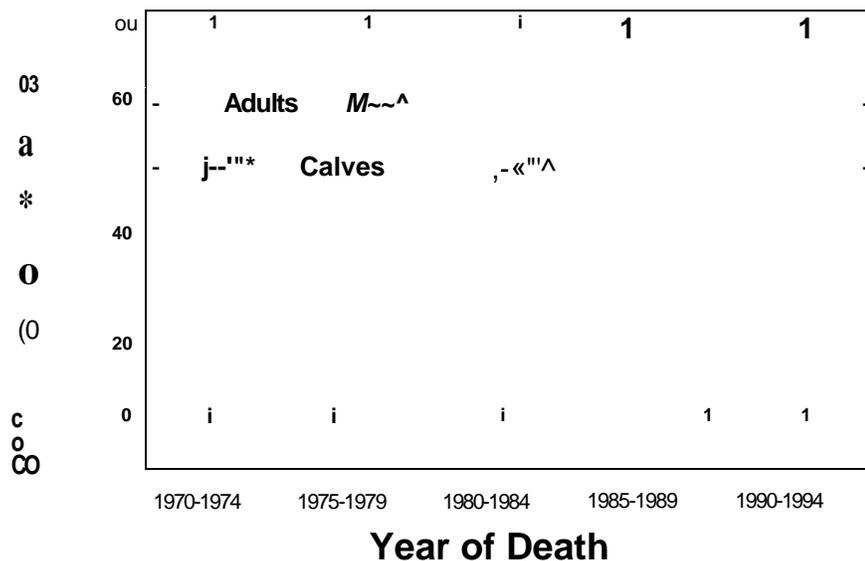


Figure 11. Long-term trends in moose bone marrow fat. Data for calves (which best reflect current conditions) represent mean levels, whereas adult data is the proportion with >70% marrow fat.



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Figure 12. A group of moose invades a stand of regenerating balsam fir on Beaver Island, where moose density was 40 per square kilometer in February 1994.

Earntuwlcfi volunleers *tieeraj Tayal and Michael Thomas* examine two bulls that died together in the 1992 rutting season.



A Tale of Two Alphas

they became known to us, casually, as the "Old Map"; and the "Old Udy" the alpha male of the Middle Pack. She was old gray around her muzzle and sides; and she, may have had a rival earlier in her life. When these two wolves paired off and claimed a territory in the middle of Isle Royale in 1990, they were the best hope for renewed reproduction. Their territory, dominated by mature birch, had very few moose, and wolf packs had not dwelled there since the 1970s, in August 1991 we radiocollared the male (550), but we found no evidence of reproduction that year. In 1992 we diligently monitored his radio signals in summer, and again failed to locate any pups. By 1993 there was little hope that the Middle Pack would amount to much, and monitoring efforts were shifted to the other two packs. So it was a genuine surprise to find six wolves in the Middle Pack in January 1994, including four new pups. The alpha male's collar was in mortality mode, however, and we soon recovered his emaciated carcass. With severely worn teeth, he had simply run out of energy when the temperature bottomed out at -36°C.

The male had wandered away from his pack before he died and, after waiting nearby on a kill for 10 days, the female led her four offspring on an extensive route through their territory, perhaps looking for her mate. Eighty kilometers later, the troupe ended up back on their kill, without ever finding the male (by then in our freezer). We wondered about the new burden on the female, having to kill moose without much assistance. As luck would have it, she led the pack outside their territory and found a moose that had fallen to its death off a north shore cliff, and it was here that we last observed the female alive, on February 7, 1994. We searched her territory in vain for a week without

finding a trace of her; . . .

For three weeks the four pups relaxed together on the north shore, eating the moose that fell from the shore cliffs. They found one quick foray back into Middle Pack range and then returned to finish off the carcasses along the shore.

On our last flight in the winter study, we found a fresh fox track along the shore almost 20 km from the pups. We landed and followed the fox tracks. One was dead, and we were stunned to find the old female dead, sprawled on her chest beneath a spruce tree. She had continued to travel as long as she could and, like her mate, was emaciated with heavily-worn teeth. On their home trip, the pups had come within a few meters of their dead mother, and they probably knew she was gone.

This is not the way wolf societies usually work, as alpha wolves tend to feed themselves first and should outlast other pack members, even their own offspring. This alpha pair had been chronically undernourished for months, judging from their weight loss and coincidentally each neared its end-point after they successfully raised their first litter of pups. The male, with an enlarged heart and a bruised liver, may have been pushed beyond the point of survival by record-low temperatures. And the female, gone a month later—what finally triggered her death? Coincidence, perhaps—but could it have been the death of her spouse? Ernest T. Seton, in 1894, caught a male wolf in New Mexico that had returned to where his mate had been killed a few days earlier. Seton chained the male overnight, but the wolf, with no apparent injury, was dead the following morning. Seton thought distress over the death of his mate triggered the male's own death. Such effects are well-documented in our own species.



Four pups feasting on the carcass of a moose that had fallen to its death from a north shore cliff.

Other midlife

Red fox and snowshoe hare abundance (Figs. 13 and 14) were both low in 1994. after an eruption of hares in the late 1980s. Without many hares to support them, foxes have had to rely on scavenging the rather small number of wolf-killed moose available.

River otters have staged a remarkable recovery at Isle Royale in the last decade (Fig. 15). Populations of lake herring recovered dramatically in the early 1990s, and

this fish may be an important food source for otters.

Bald eagles and ospreys are slowly increasing at Isle Royale after disappearing completely in the 1960s. In 1993 the National Park Service recorded 5 active eagle nests, probably fledging 8 young, along with 2 successful osprey nests. With little open water in winter 1994, eagles were seen only twice during the winter study.

Marten were reportedly extirpated from Isle Royale

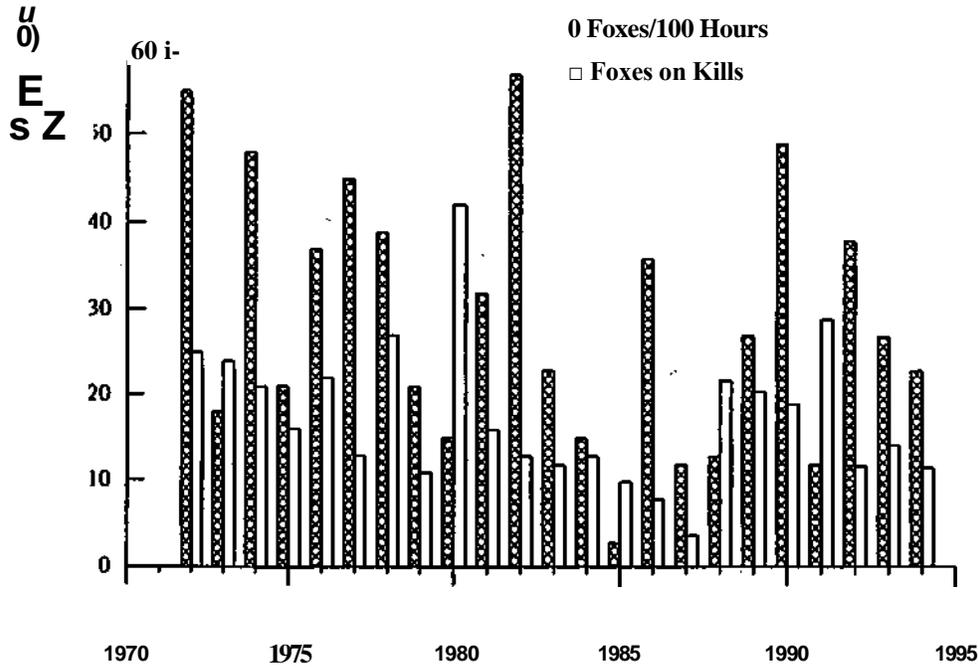


Figure 13. Relative abundance of red foxes from aircraft observations. 1972-1994. Hatched bar is the number of foxes seen away from moose carcasses/100 hours, while the open bar is the maximum number of foxes seen on carcasses.

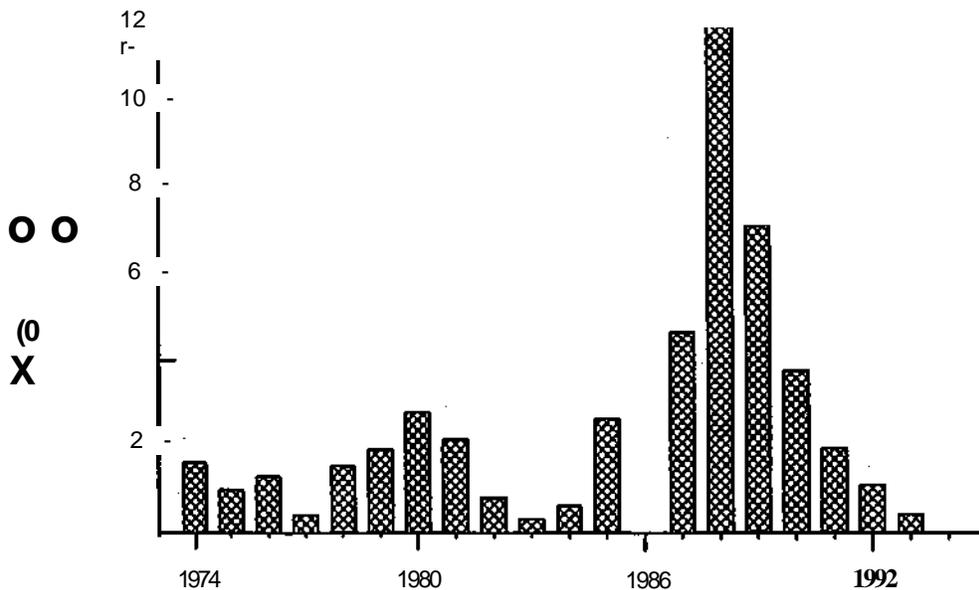


Figure 14. Snowshoe hares on Isle Royale have declined to very low levels after a population eruption in the late 1980s. Index is the number seen per 100 km hiked in summer.

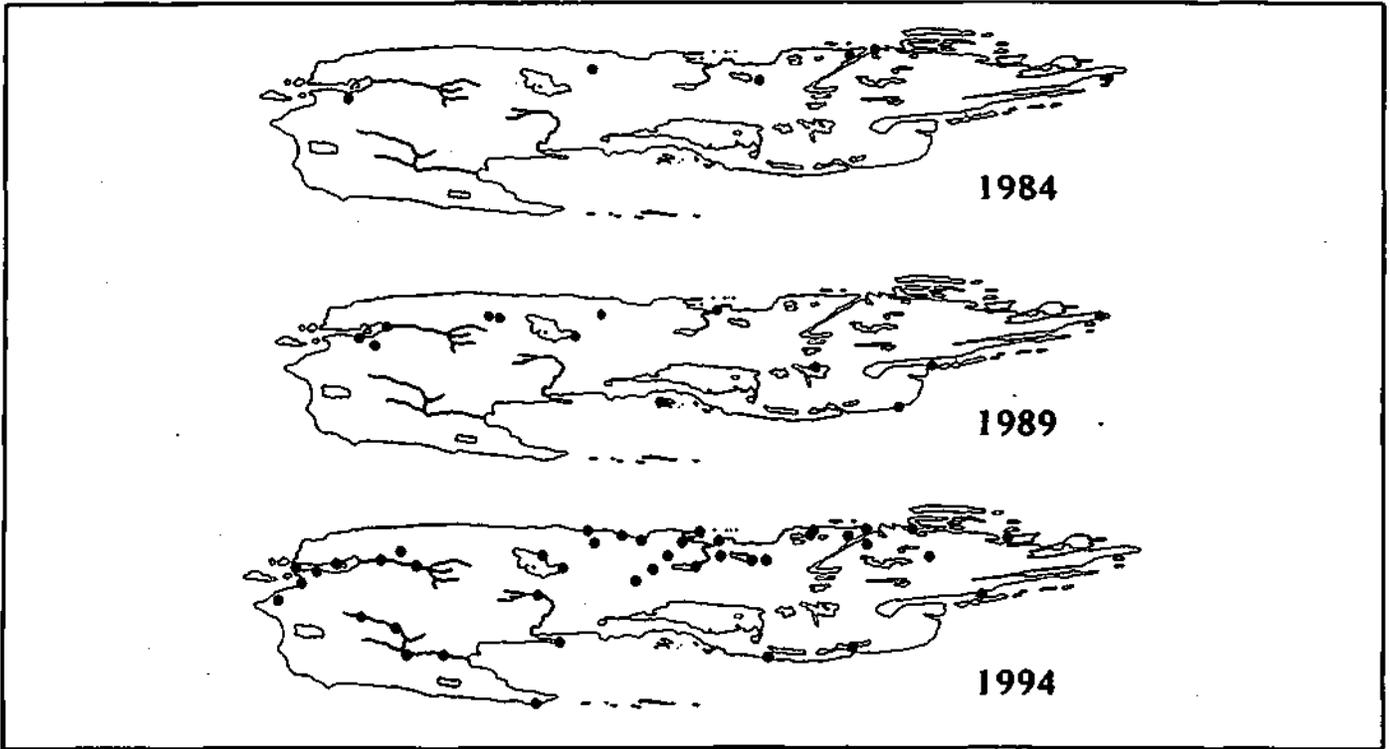


Figure 15. Otter sign (tracks and slides) in winter has increased dramatically in the past decade.

early in the 20th century, as in most of the Midwest U.S. Marten-like tracks were observed near Windigo in winter, 1991 and 1992, and a photo of a suspected marten was taken by a visitor in 1993 (Fig. 16).



Figure 16. Park visitor Thomas E. Rogers (Sheboygan, WI) snapped this photo of a suspected marten near Little Todd Harbor in summer 1994. If they persist, another mammal species will be added to the Isle Royale fauna (and thanks to Stanley Johns, President of the Upper Peninsula Trappers Association, Baraga, MI, for an expert opinion on this animal).

Weather, Snow and Ice Conditions

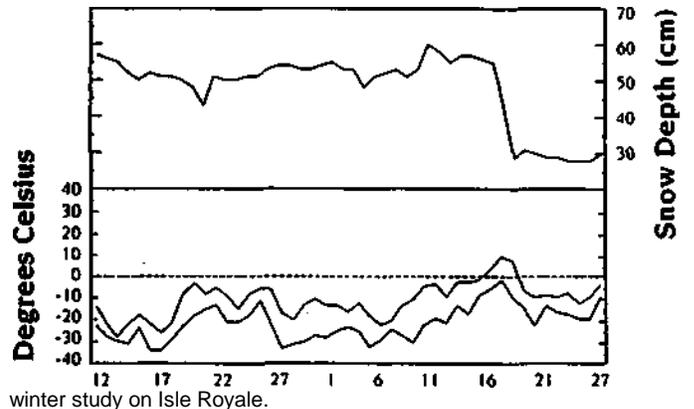
Record-low temperatures dominated the winter study period, with daily minima < -20°C for all but 6 days during the first month of the winter study (Fig. 17). By the

end of January a firm ice bridge extended from Isle Royale to mainland Ontario, and all of Lake Superior was frozen for a brief period, on February 9-10. The ice bridge to the mainland lasted throughout February, and was probably intact for about a week after our departure on March 1. No wolf movements over the ice were detected.

The weather was very dry during the 1994 winter study, and average snow depths were maintained only because of unusually cold weather (Fig. 18). A major thaw occurred in late February, exposing much bare ground. Lack of snow will probably alleviate the scarcity of browse for moose in late winter.

January February

Figure 17. Snow depth (top) and temperature extremes during the 1994



winter study on Isle Royale.

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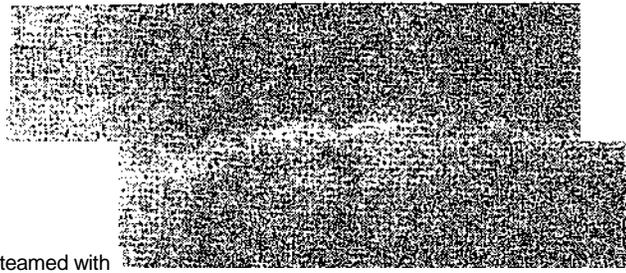


Figure 18. With the temperature at -30°C at mid-day. Lake Superior steamed with "lake effect" cloud

For the first time in 35 years, skis were removed and the research plane was mounted on wheels after a sudden thaw in late February 1994.



Scattered through the history of Isle Royale wolv.es are a few individuals of extraordinary importance. Their individual lives include complex relationships with other wolves; inside and outside their packs. Recently, because some of the wolves have been trapped and genetically fingerprinted, we have learned that family relationships were not always what they seemed.

When female-450 was radiocollared in 1988 and she never reproduced, "even though she was middle-aged! and she was loosely associated with two other wolves. This group made a living, but they had no exclusive territory and they gave little hint of future success; In 1989 female 450 left this little group forever; and moved into the East Pack, which comprised an alpha male and female and their offspring. Female 450, soon stole the pups, became alpha female, and mated with the alpha male the next year; The real mother was no longer tolerated near the pack, but she often followed the group, watching them from a safe distance. Although the unchallenged leader of the East Pack, female 450 did not have pups of her own until 1991; and her eight pups in 1991-1993 helped stave off the threat of wolf extinction.

As all alpha wolves of long tenure must be, female 450 is an exceptional hunter. In January, 1994, with the temperature hovering at -32°C, we watched the pack surprise a bedded bull moose in early evening. The bull was suddenly beset by wolves on his rump, his back, and even his nose. In a frenzy the bull shook off all the wolves and bolted. Undaunted, female 450 gave chase and regained her hold on a rear leg. Singlehandedly she stopped the moose's flight while the alpha male with seeming indifference stood and watched his mate's heroic struggle. Meanwhile, the pups were engaged in a game of tag just out of harm's way. Within the research plane seemed to be the only ones interested, in this impressive contest between the tough and the determined

old wolf. - Forty minutes later darkness forced us to leave the scene", but the next day we found the wolves a mile away. On another kill, while the wounded moose was still standing. Female 450's efforts were, finally rewarded three days later, when the wolves returned to claim their victim.

On average, female 450 brought down a moose once every four days in 1994, usually with some help from the alpha male. In one unusual case the male held on to a cow moose while the female caught her calf. The male was quickly shaken off and the cow abandoned her calf to save herself.

One afternoon we found female 450 bedded on a ridge, her head and chest drenched in bright red blood, and we thought she had finally met her match. An antlered bull moose stood nearby, wounded yet still aggressive. Unable to tell whether the blood on 450 was the moose's or her own, we watched as pack members crowded around her, licking her thoroughly. Minutes later she sought solitude to curl up and sleep. She moved slowly and deliberately, as if measuring the cost of each step. Perhaps a dozen years old, she had probably killed hundreds of moose, and she knew when to persist and when to rest. The next day we found the moose, half-eaten, and the engorged wolves, including 450, sleeping soundly.



The East Pack female works alone to bring down a moose calf