Ecological Studies of Wolves on Isle Royale

Annual Report

1995-96

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Annual Report—1995-1996*

by

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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 in some cases, represent findings of collaborators: please do not cite without consulting the author.)*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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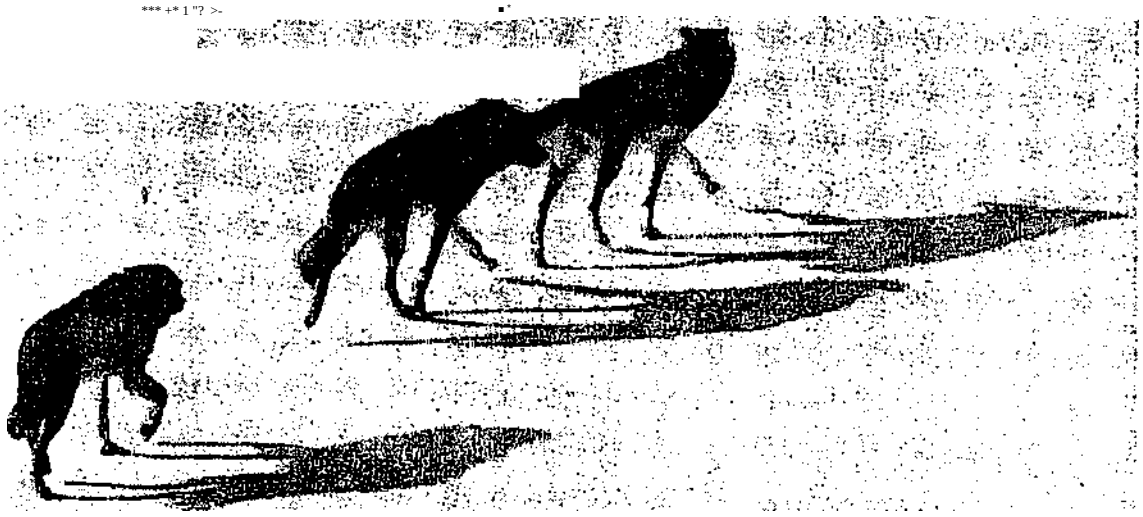


"Probably no society has been so deeply alienated as ours from the community of nature, has viewed the natural world from a greater distance of mind, has lapsed into a murkier comprehension of its connections with the sustaining environment. Because *of this, we have great difficulty understanding our rootedness to earth, our affinities with nonhuman life."*

Richard K. Nelson

Personnel and Logistics

In summer 1995 Rolf Peterson directed ground-based Meld work, aided by David P Bach. Cynthia D Carter. Leah M Cayo. Thomas D. Drummer. Andrew) Henriksen. Menna lones. Carolyn C Peterson. Jeremy D Peterson. Trevor S. Peterson. Matthew Starr. Eric Trott. Thomas A Waite. lohn A Vucetich. loseph R Zanon. Field work continued from May 12 through August 23.

In 1996 the annual winter study extended from lanuary 12 to February 29 Peterson and pilot Don Glaser participated in the entire study, assisted in the field by volunteers Cynthia D. Carter. Ann Mayo, and Darcy R Rutkowski, and the following personnel from Isle Royale National Park—William I Coponen. Larry A Kangas. lack G. Oelfke. David C. Soleim. and Robert K. Whaley—and Brian Kenner from Pictured Rocks National Lakeshore.

Summary

The past year was one of dramatic change at Isle Royale, with wolves increasing to their highest level in over a decade while the moose population crashed from lack of food, a condition exacerbated by winter ticks and severe winter weather. The wolf population rose to 22 individuals (Fig. I), including seven pups distributed in all three territorial packs. Estimated moose numbers, on the other hand, declined to less than 1.200. compared to over 2.400 last year.

Wolves increased as mortality remained low and reproduction was high. Notably, the first litter of pups born to wolves of the next generation was of normal size, with four pups surviving into winter. Three pups survived in the other two territorial packs. Wolf age structure is now dominated by young wolves with high expected survival rates and reproductive potential; all 15 animals alive in March 1995 (one wolf was added to the 1995 count) survived until March 1996. This year marked a significant step toward recovery of the wolf population from a chronic decline that began in 1981, approximately the time of inadvertent human-caused introduction of canine parvovirus. Reproductive performance of the next generation of wolves will provide a test of the consequences of inbreeding in this population, known to have lost genetic variability because of geographic isolation

The moose population seemed to be hit by every possible calamity during the past year. Low calf survival and retarded body growth in calves were evident in summer 1995, and high loads of winter ticks were already causing hair loss in early lanuary. 1996. Deep snow then aggravated a severe shortage of winter forage, and the combined impact of these conditions led to the highest moose mortality rate of the past 38 winters. Significant causes of death in winter were wolf predation. starvation. and falling over cliffs while foraging. Because of poor calf production and survival, plus an increasingly old age structure, the moose population should continue to decline from the historic high level recorded in 1995. These findings indicate that the limits of moose food supply at Isle Royale were reached when moose numbered 2,000-2.500 animals, or four or five per square kilometer

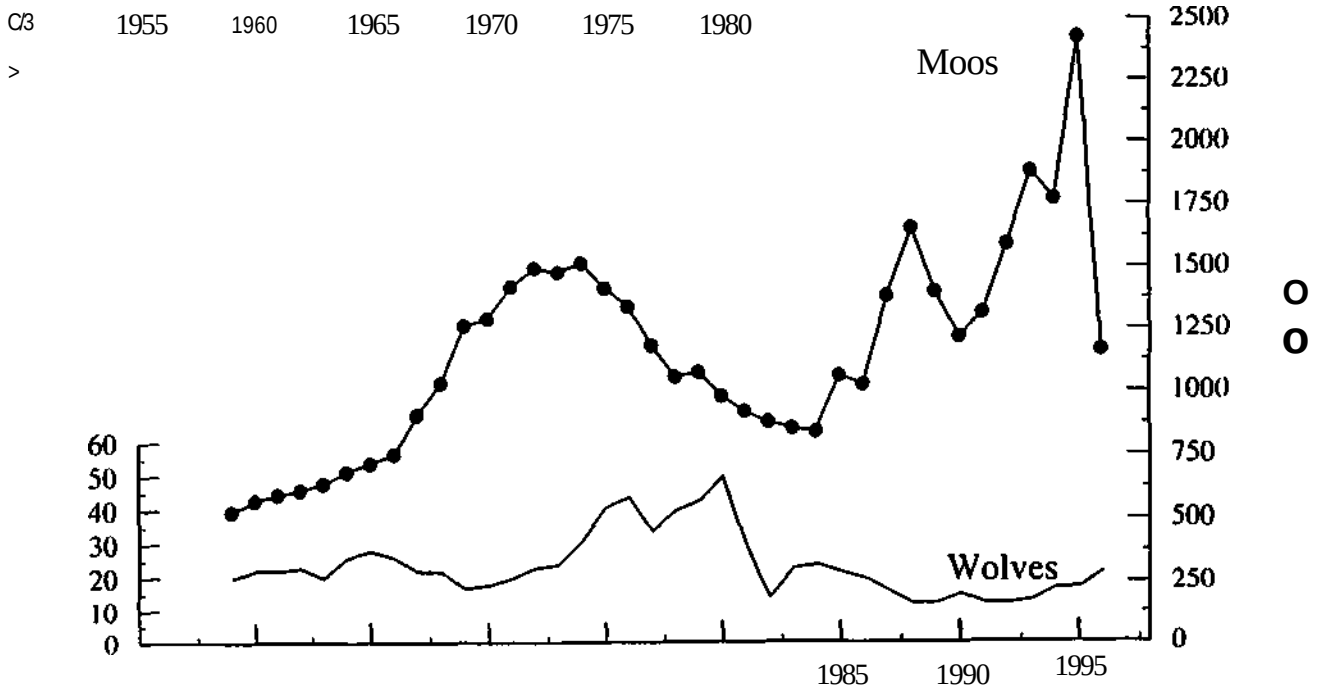


Figure 1. WoKand moose fluctuations. Isle Royale National Park. 1959-1996. Moose population estimates during 1959-1982 were based on population reconstruction from recoveries of dead moose, whereas estimates from 1983-1996 are based on aerial surveys

The Wolf Population

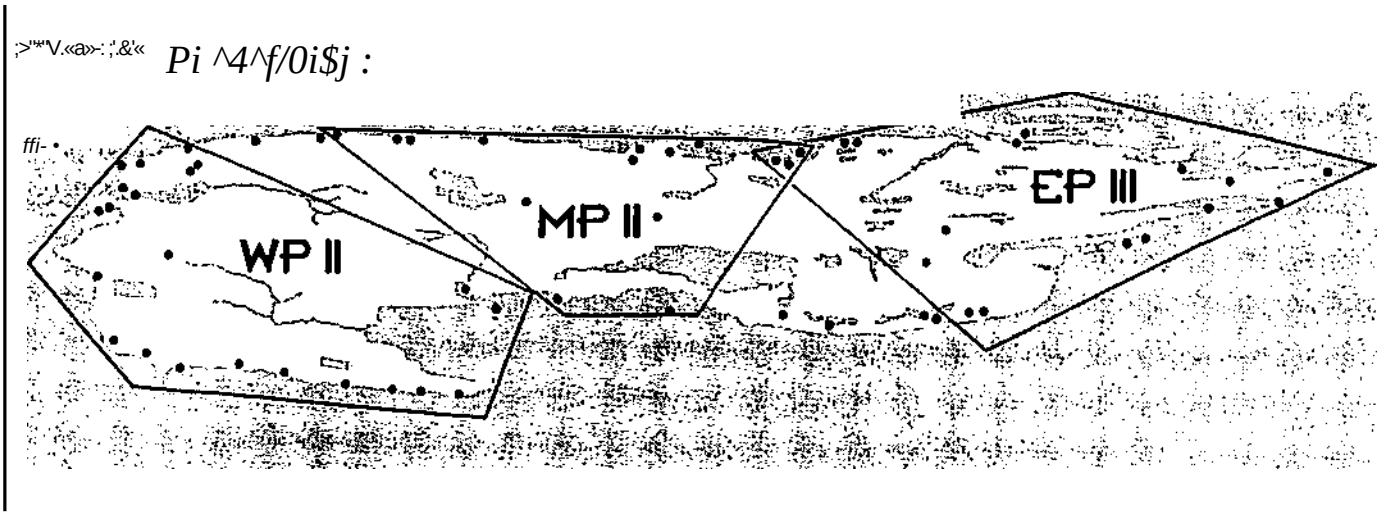
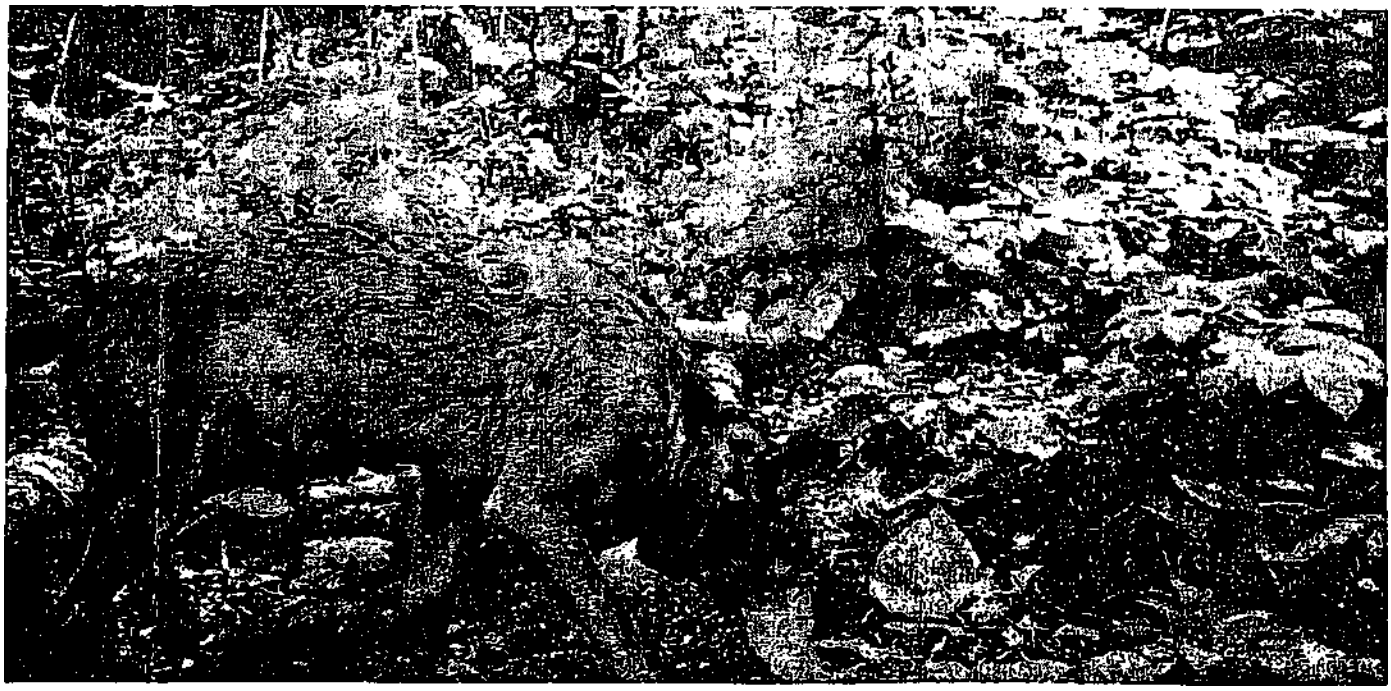


Figure 2. Wol(pack territories and moose carcasses (wolf-kills and otherwise) during the 1996 winter study

In 1996 the wolf population was organized as follows (Fig 2):

Cast Pack III	*4*
Middle Pack II	7 (initially 8)
West Pack II	3
extra duos	6
Singles	2
1995 total	22

The Middle Pack provided most of the increase, as four surviving pups brought pack size up from three to eight wolves The eighth wolf, a male that was challenging the alpha male, dispersed in mid-)anuary and probably paired with a female elsewhere, and thereafter the Middle Pack remained at seven (four pups, two adult males, and one adult female) for most of the 1996 winter study The alpha wolves in this pack are only two years old. and the pack has obvious growth potential Although its usual territory has relatively few moose, in 1996 the Middle Pack successfully expanded toward the west, into areas usually occupied by the West Pack



Alpha male 410 in the East Pack broke an infrared beam and tripped an automatic camera while walking on a moose trail in summer 1995

Figure 3. A single pup was present in the West pack in 1996. the first since 1988.

For the first time since 1988. the West Pack brought one pup through to winter (Fig 3). The pup tried valiantly, and with some success, to rally its aging parents in play, the father, a radiocollared male (430), was born in 1989. and the mother is probably over 10 years old

The East Pack, led by an alpha male (410) that is probably at least 10 years old and a two-year-old female, produced two surviving pups in the female's first litter. This pack's territory, stable for many years, contains the highest wintertime concentrations of moose on the island

In 1996 there were three additional pairs of wolves present; all may be male-female pairs Two of these pairs were located within West Pack territory and the third duo occupied East Pack range Prominent scent-marking was observed in two of these pairs in areas where they did not encounter the resident packs Together with two single wolves in 1996. the presence of these pairs ensures that, over the short term, there are ample adult males and females to fill normal territorial vacancies

Wolves encountered a surplus of food during the 1996 winter study Hunting packs consistently killed a moose within 12 hours, usually during their first night of effort. and there were many other moose dying of starvation or accidents. Moose calves were highly vulnerable to all sources of mortality, and they were readily targeted because of weakened condition plus deep snow or surface crusts During lanuary wolf food supply was derived mostly from kills, but in February wolves consumed more carcasses of moose dying from other causes (Fig 4)

Wolves were responsible for about half of the moose mortality recorded in winter. Kill rate by wolves, about 0.6 moose/day. was the highest observed since 1979.

Figure 4. Pilot Don Claser collects bones from carcass of moose that fell off the steep north shore of Isle Royale Most such carcasses were partially consumed by wolves

Figure 5. Middle Pack found travel easy on shoreline ice early in winter, when deep, soft snow reduced wolf travel in the interior

During lanuary and February deep, soft snow made movement through the island interior very difficult for wolves. and they restricted their movements to shorelines where there was ample ice (Fig 5). All three packs began to move through interior areas after snow density increased in mid-February A strong surlace snow crust that formed alter rain on 23 February supported walking wolves under most conditions (Fig. 6). but running wolves often broke through Hardness of this crust measured 2,300 g/cm^{1} (SE<130g/cm^{J})

Wolves were unable to chase moose for long distances when the snow was deep and soft, early in the study period Nevertheless, they were readily able to hunt moose along the island's shoreline We observed wolves approach or test moose nine times in 1996, two of these resulted in kills.

Almost 60% of the dead moose examined in winter were calves, and wolves usually fed only once on these small-bodied prey before moving on. Kills were typically underutilized by wolves but heavily used by scavenging loxes. ravens, and bald eagles During warm temperatures in late February wolves frequently dug out carcasses of moose that had died earlier of starvation.

Courtship behavior was most obvious in the Middle Pack, where the alpha female led the pack on long travels during several days of estrous On February 25 the alpha

Figure 6. East Pack wolves walked easily on a surface snow crust that formed alter rain in late February.

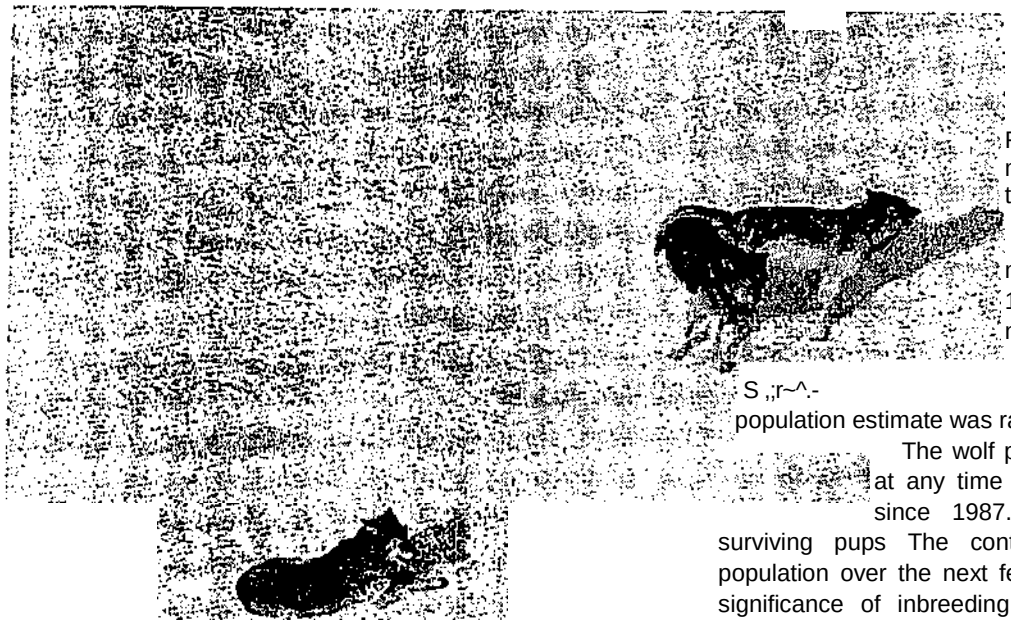


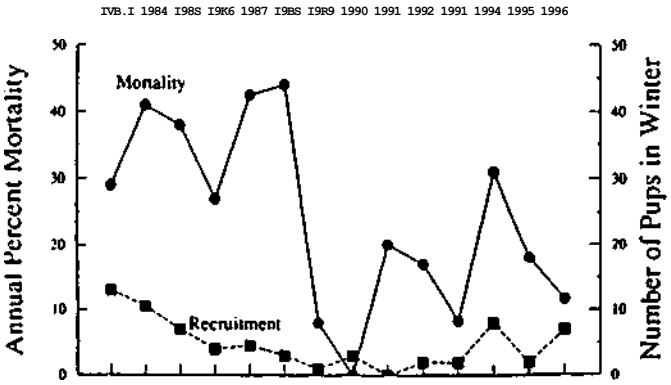
Figure 7 The alpha pair in the Middle Pack mated on February 25. 1996. scrutinized by the beta male

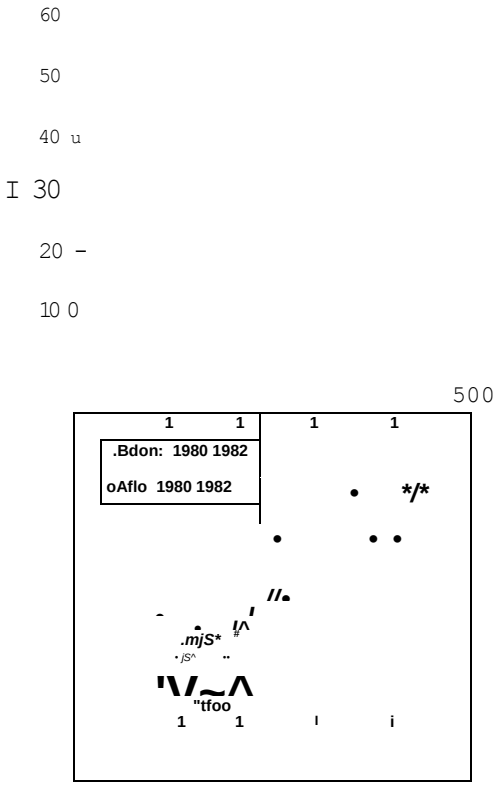
pair was observed mating (Fig. 7)

The Middle Pack was led by an alpha male and female that were both two years old. The alpha male was born in the Middle Pack and succeeded his father, who died of old age/malnutrition in lanuary 1994 The alpha female very likely came from the adjacent East Pack. The West Pack and East Pack each retained one elderly alpha wolf that survived disease and malnutrition in the 1980s. Fully 19 of the 22 wolves alive in 1996 were born after 1991. especially 1993 and 1995. so the wolf population is young.

Seven pups were included in the 1996 total ol 22 wolves Mortality rate over the 12 months since January 1995 was only 12% (Fig. 8) One wolf was evidently missed in the 1995 count, based on 1996 data on pup and total numbers, so last year's wolf population estimate was raised from 16 to 17.

The wolf population in 1996 was higher than at any time since 1985 and, for the first time since 1987. all territorial packs produced surviving pups The continued performance of the wolf population over the next few years should shed light on the significance of inbreeding in this isolated population (see sidebar on page 8) Wolf lood supply |moose over 10 years old (Fig 9)|. reached a low point in 1991 and should increase through the current decade.





100 400

200 300 Old

Figure 8. In 1995-1996. wolf population size grew as annual mortality was low and reproductive success was relatively high.

Moose

Figure 9. Both before and after the wolf population crash in 1980-1982. wolf population size was closely related to the number of old moose present.

With their numbers edging into the 20s for the first time in ten years, can wolves on Isle Royale be considered out of trouble?* And can'we now be certain of the cause of their doldrums—disease, food shortage, or inbreeding? '. >-. ■

Some answers are clear The vital statistics of the decline are well-documented, exceptionally high mortality in 1980-1987 brought the wolf population to its^ lowest level since wolves came to Isle-Royale in the late 1940s. Declining reproduction'from 1985 to the early 1990s prevented recbveryof thepopulation.'

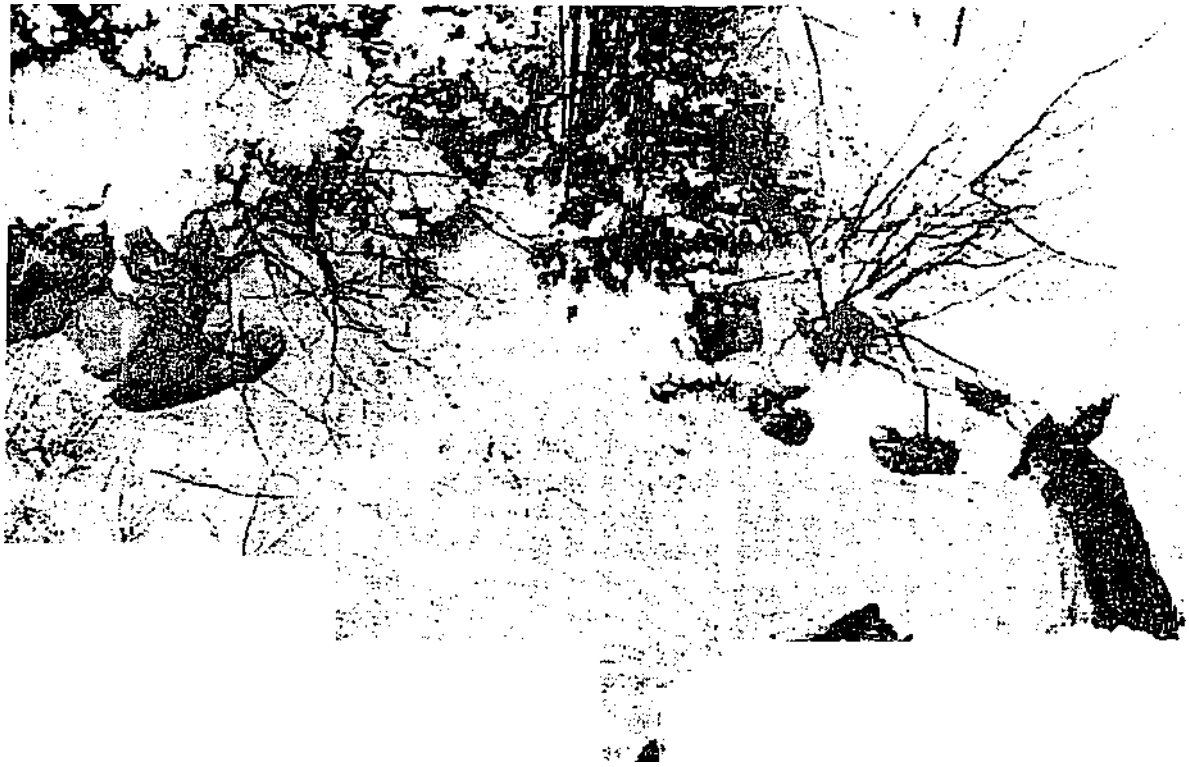
One reason for the decline is easily explained. Exotic (humapTihtrdduced) disease, canine parvovirus, was present in th'elsle.Royale wolves" in the 1980s and probably led to.theirpopulation crash in 1980-1982. After 1988. evidence of parvovirus disappeared, and wolf mortality returned to normal levels.

Food supply was another problem for wolves in the 1980s and early 1990s. .Although there were many moose on the island (2/km' in 1980 and 4/km in 1994). Isle Royale wolves thrive on old moose. >9 yrs of age. Wolf population size has been correlated with the number of old moose, even after other factors depressed wolf numbers after 1982. The supply of old moose bottomed out in the early 1990s, just when the wolf, population reached its lowest point. But the same number of old moose had supported twice as many wolves in the 1970s Was something else amiss?

Because of Isle Royale's isolation, the genetic makeup of. its wolf population is unusual. Studies by Robert Wayne (Univ. California, Los Angeles) revealed that the island's wolves are inbred and have lost genetic variability. "Poor reproduction in the last decade might be blamed on genetic decay, if all other factors can be ruled out. Thatwill take more time

We have learned that nature often plays havoc with scientists' predictions and timetables. On Isle Royale, a relatively simple ecosystem, there is still much complexity. and natural patterns are slow to emerge.

Wolves are not awaiting our answers. In 1996 a new generation was off to an excellent start, with the young alpha pair in the Middle Pack bringing through four pups in their first litter Eventually, additional young wolves will replace the old East Pack alpha male and West Pack alpha female If these young wolves, disease-free and well-fed throughout their lives, do not produce larger litters of pups than their parents did, then genetic problems will remain the cause

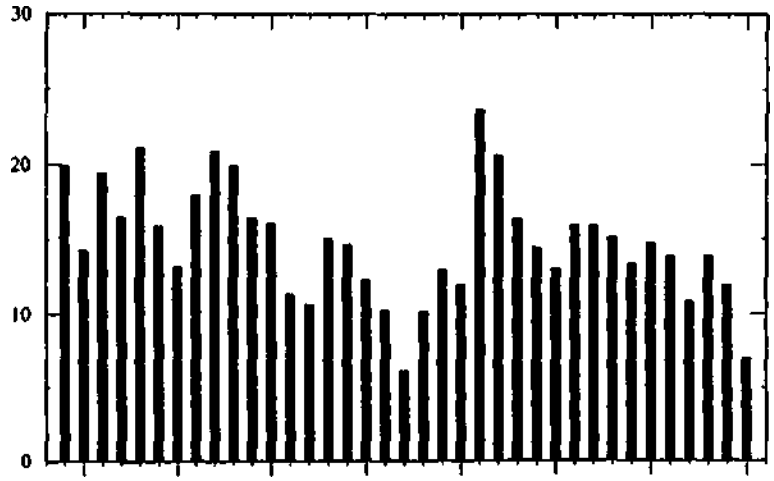


The Moose Population

Figure 10. The size of moose calves born in 1995 was small because of nutritional limitations in winter brought on by high population density. This mother and calf were photographed by an automatic camera on July 21.

The moose population has been growing continuously since the wolves crashed in the early 1980s, except for a brief downturn following the 1988 outbreak of winter ticks Malnutrition and growth retardation became increasingly evident in the 1990s, but calf survival remained relatively high through winter 1995. In 1995 the moose population was estimated at over 2.400. the highest census-based estimate ever (in 1930 Adolph Murie estimated that "at least 1.000. perhaps as many as 3.000" moose were present).

The anticipated dieoff of moose finally arrived in 1996. New mortality intervened strongly in 1996. following very poor calf production and survival in 1995 (Fig. 10). Summer ground counts and winter aerial census indicated that the 1995 cohort of new calves was very small (8% calves in summer 1995 and 5% calves in winter 1996) Calf proportion was lower than in all previous years but one (Fig. 11). Only one set of moose twins was observed



1960 1965 1970 1975 1980 1985 1990 1995

Year of Birth

Figure 11. Moose call abundance lat 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 rn'Mer}.*

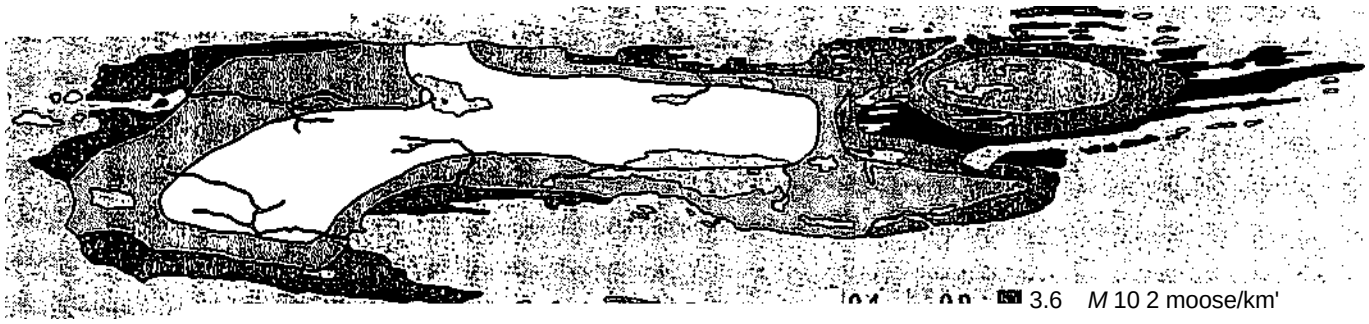


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Figure 12. Moose distribution on Isle Royale during the aerial census in February, 1996.

in winter, the lowest total since the early 1980s. Analysis of long-term data for Isle Royale moose has revealed that population growth or decline is best predicted by abundance of surviving calves, potentially the most abundant age group. Provided that wolves continue to increase, it is expected that the moose population will decline further in the near future.

Population size for moose was estimated by aerial census in February, 1996, using intensive counts of small plots (one km') totaling 14% of the island area (Fig 12) Areas of traditional high moose density along Lake Superior shorelines remained high, but moose were much reduced throughout the island's interior Moose favored shoreline areas where they could avoid deep snow and also move about on lake ice (Fig. 13). On 74 plots a total of 216 moose were counted, compared to 451 moose on 92 plots in 1995 The resulting population estimate in 1996 was 1,163 moose, with a 95% confidence interval of +/- 248 (21%). a major reduction from the 1995 estimate of 2.422 moose. Reduced sightability in 1996 might explain some of the decline, but all indications still point to a dieoff ol historic proportions in 1996. Ground surveys for carcasses in spring 1996 will provide the best relative indication of the scale o(mortality.

Moose were beset by many problems during the winter study in 1996 In lanuary hair loss from winter ticks was common Snow had been present lor two months and built up quickly in lanuary There were record cold temperatures in midwinter and deep snow persisted through much of March Throughout the 1996 winter study period wolf kill rates were high, moose were dying of starvation. and with surprising frequency foraging moose fell to their

Figure 13. In winter. 1996. snow depth approaching one meter forced moose to shoreline areas where they could move on lake ice.

Figure 14. Field assistant Darcy Rutkowski begins extricating bone specimens Irom a moose that died several days after falling off a steep shoreline onto an ice shelf.

deaths off cliffs (Fig. 14) and steep shorelines (13 cases). Most of the moose that died from falls were malnourished. judging from fat content of their bone marrow (Fig. 15).

It was quite evident that a desperate shortage of winter forage existed in 1996 Dead moose recovered in 1996. including wolf-kills, were in uniformly poor condition. Moose movements were restricted to shoreline areas. where available browse had been removed in early winter (Fig. 16) Foraging moose were commonly observed stripping arboreal lichens from trees and feeding on recent windfalls. Two moose that died held in their mouths sprigs of white spruce, considered inedible.

Regenerating areas of balsam fir. primarily on the east end of Isle Royale, were heavily browsed by moose. Three moose, two yearlings and a middle-aged cow. were collected in February by rifle from one such area (Beaver Island at the island's southwest end), where regenerating fir provides a rare successional-stage habitat in otherwise old forests. All three moose had internal fat reserves in bone marrow and elsewhere, and the older cow. weighing

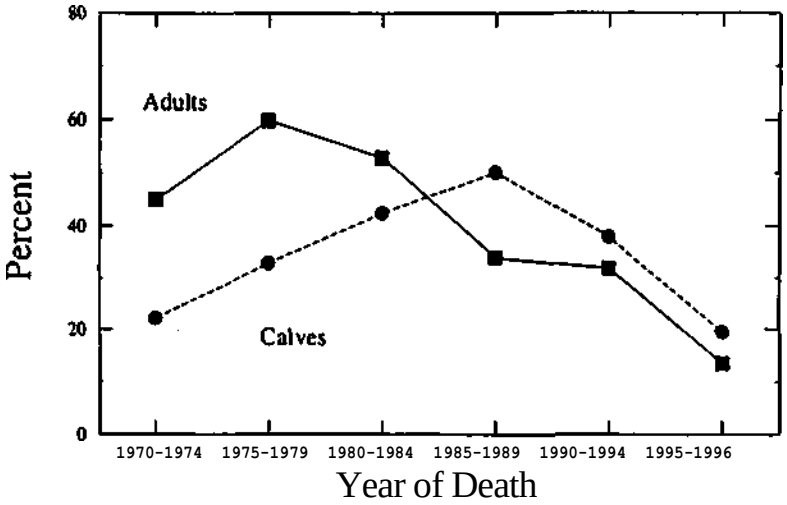

Figure 15. Long-term trends in moose bone marrow fat. Data for calves (which best reflect current conditions) represent mean levels, whereas data for adults is the proportion with>70% marrow fat

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Figure 16. Typical moose browsing pressure on windfallen balsam (ir tree in winter. 1996.

325 kg. was pregnant with one fetus.

Ticks were commonly observed on all moose recovered after death, but extensive hair loss was rarely seen in 1996 (Fig. 17) Most moose harbored ticks, but hair loss was usually restricted to just a few patches The winter study ended before the late winter period when ticks withdraw their final blood meal and hair loss accelerates Continued high mortality of moose, with ticks as a contributing factor, is expected until snowmelt in spring

PhD student Brian McLaren completed his studies ol balsam fir, an important winter forage for Isle Royale moose. His findings indicate that fir can escape moose herbivory and regenerate in the forest only in succes-sional stage forests where the density of germinating seeds is high and they are exposed to high light levels in forest gaps (as on the east end of Isle Royale). Limitation ol the moose population by wolf predation also appears to be a prerequis-te for fir to grow normally At the west end of Isle Royale. where lir is inore sparse in old forests, the tree is unable to escape through growth because of intensive moose browsing. About one-fourth of these mature seed-bearing fir trees in the forest canopy at the west end have died in the past 8 years, based on monitoring of almost 500 lagged trees (Pig 18)

Figure 17. A so-called "ghost moose," denuded by winter tick infestation, was occasionally seen in winter The incidence of hair loss in 1996 on Isle Royale was relatively high.

Figure 18. Balsam fir trees, with the characteristic spire-like top, are disappearing without replacement from the west end of Isle Royale because of moose herbivory, but on the eastern end. where growing conditions are more favorable, fir trees escaped" from moose during the high wolf years of the 1970s.

These trees were established before moose became numerous on Isle Royale.

Erosive lesions discovered in the skulls of old moose on Isle Royale prompted studies of bone dynamics that were recently completed by Ph D student Mary Hinde-lang. She discovered that old moose, especially antler-growing bulls, undergo pervasive loss of bone as they age. There is extensive remodeling of long bones, however. and moose at Isle Royale are able to avoid increased risk of bone fractures, even with extreme loss of bone density. Some old moose that died of malnutrition had lost up to 80% of the bone mass in their long leg bones

We have collected many different bones of moose as indicators of long-term nutritional status Metatarsus length of calves has been a useful parameter, while brain volume has proven to be highly variable. MS student Kathy Holt is currently measuring about 1,500 moose mandibles from Isle Royale to compare to other bones that we have used for estimating herd condition

Afl ***the recovered skulk of wolves from*** **Isle** ***Royale cover a large table while being measured by*** **Dr. Btoi>e** ***Van Valkenburgh*** **(Univ. CA. Los Angelas).** ***who is studying patterns o\ tooth breakage in large carnivores.***

Other Wildlife

In winter 1996. red foxes were infrequently observed except near moose carcasses, probably because deep, soft snow made travel difficult until surface crusts were established. The primary year-round prey of foxes, snowshoe hares, continued to slowly increase from a population low reached in 1993 (Fig. 19). After a lag. the fox population is expected to follow suit and increase (Fig. 20).

The river otter population continues to grow each year, probably because of the recovery of lake herring in Lake Superior (Fig. 21). In winter 1996, otters were seen from survey aircraft four times, whereas in previous years Peterson had never observed otters in winter. In one case the three-member West Pack watched a single otter cross open ice and disappear down a hole In another case two otters easily chased off a scavenging red fox. Bald eagles and osprey continue to increase at Isle

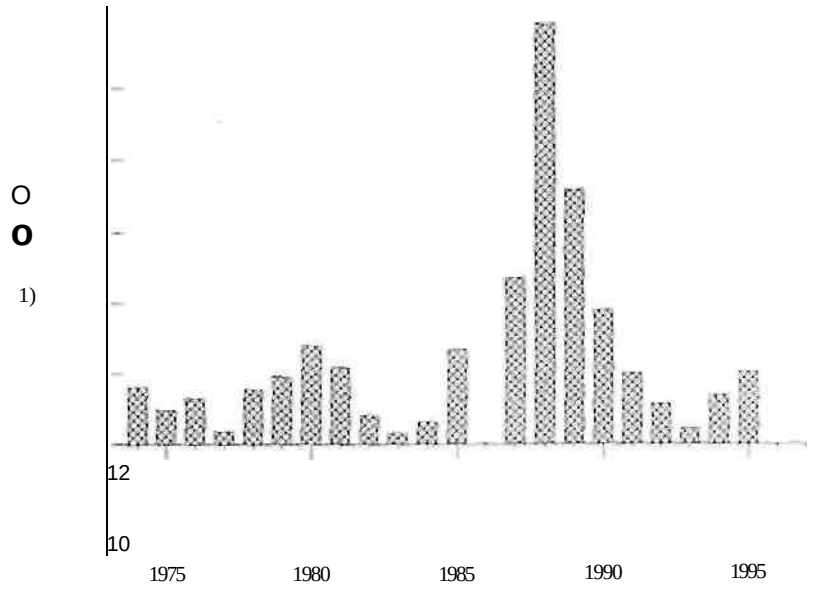

Figure 19. Snowshoe hares on Isle Royale seem to bo slowly increasing again alter reaching a population low in the early 1990s. Index is the number seen per 100 km hiked in summer.

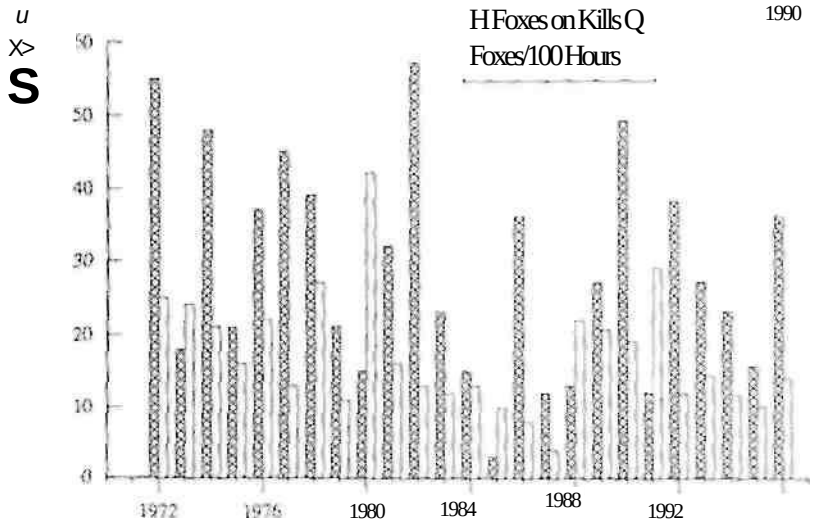

Figure 20. Relative abundance of red Ioxes from aircraft observations in winter, 1972-1996. Hatched bar is the number of foxes saar away from moose caicasses/100 hours, while the open bar is the number of foxes seen on carcasses.

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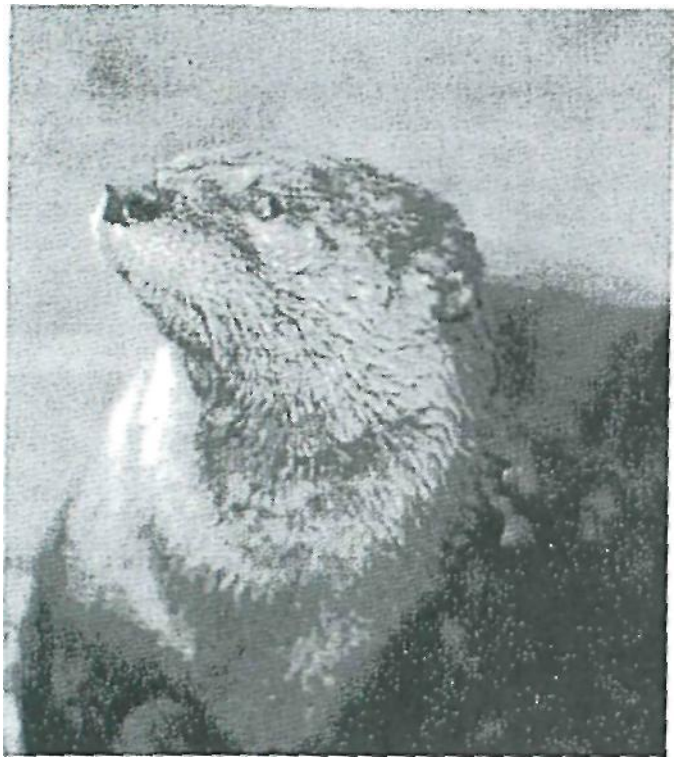

Figure 21. River otters have become common at Isle Royale in the past decade.

Royale from virtual absence in the 1970s attributed to DDT contamination In 1995 the National Park Service recorded 7 active eagle nests at Isle Royale. fledging at least 11 young, plus 3 active osprey nests fledging *A* young

Several bald eagles overwintered at Isle Royale in 1996. in spite of little open water. Eagles were observed in perches directly over areas of otter activity, and otters may provide eagles with foraging opportunities that were formerly absent Eagles also fed on carcasses of moose that accumulated along the shorelines of Isle Royale.

In 1995 Ph.D. student Leah Cayo initiated studies of the woodland deermouse at Isle Royale. which exists in isolation from all other small mammals and most predators. Mouse density on Isle Royale in spring was similar to the level found on the adjacent Ontario mainland, but over the course of the summer mice on Isle Royale increased to higher levels than on the mainland, suggesting release from competition and/or predation on the island. The genetics of small isolated populations of deermice on islets off the main island are of particular interest. M.S. student Michelle Plante-Olson is also conducting *a* study of food habits in these mouse populations.

Ranger Larry Kangas observed one set of marten tracks near Washington Harbor in January 1996. During the ^Wte TOaUen tracks have been observed near our Windigo base camp during three winters, and one photo of'a marten was taken by a park visitor in the middle of the *island,* suggesting persistent but precarious estab-

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Weather, Snow and Ice Conditions

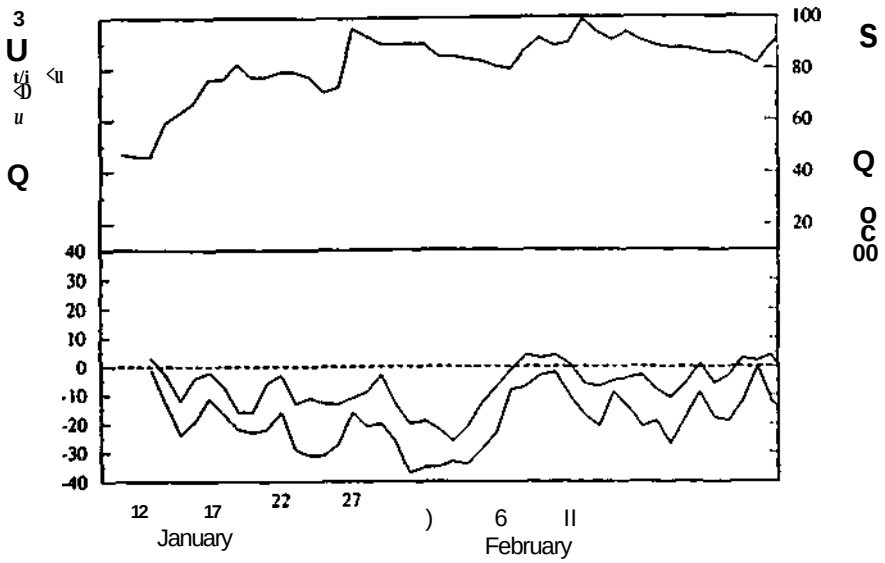

Figure 22. Snow depth (top) and temperature extremes during the 1996 winter study on Isle Royale.

Winter weather was extreme in many respects in 1996, with record-breaking snow and cold temperatures. There were severe snowstorms in the region before our arrival on Isle Royale in lanuary. so Isle Royale was probably snow-covered by early November. Blizzards in lanuary brought snow depths up to almost one meter, and cold temperatures and frequent snowfall maintained high snow depths until well after our departure on February 29 (Fig. 22). Deep snow persisted at Isle Royale into April. exacerbating the shortage of forage for moose

In early February temperatures plummeted to new depths, producing daily minima lower than -30 degrees C for five days in a row at Isle Royale. The unofficial low on Isle Royale was -4'J degrees C During this period Thunder Bay, Ontario, set an all-time record low of -44 degrees C while a new state record for Minnesota was set at Tower, where official temperature dropped to -51 degrees C (-60 F)

Most of Lake Superior became ice-covered in February and Isle Royale was locked in fast ice for most of the study period An ice bridge formed to mainland Ontario in early February but wind soon opened up leads of water that extended parallel to most ol Isle Royale, precluding movement of terrestrial animals We were aware ol no wolf movements to or Irom Isle Royale in 1996

"Let us permit nature to have her way. She understands her business better than we do" —**Michel de Montaigne**