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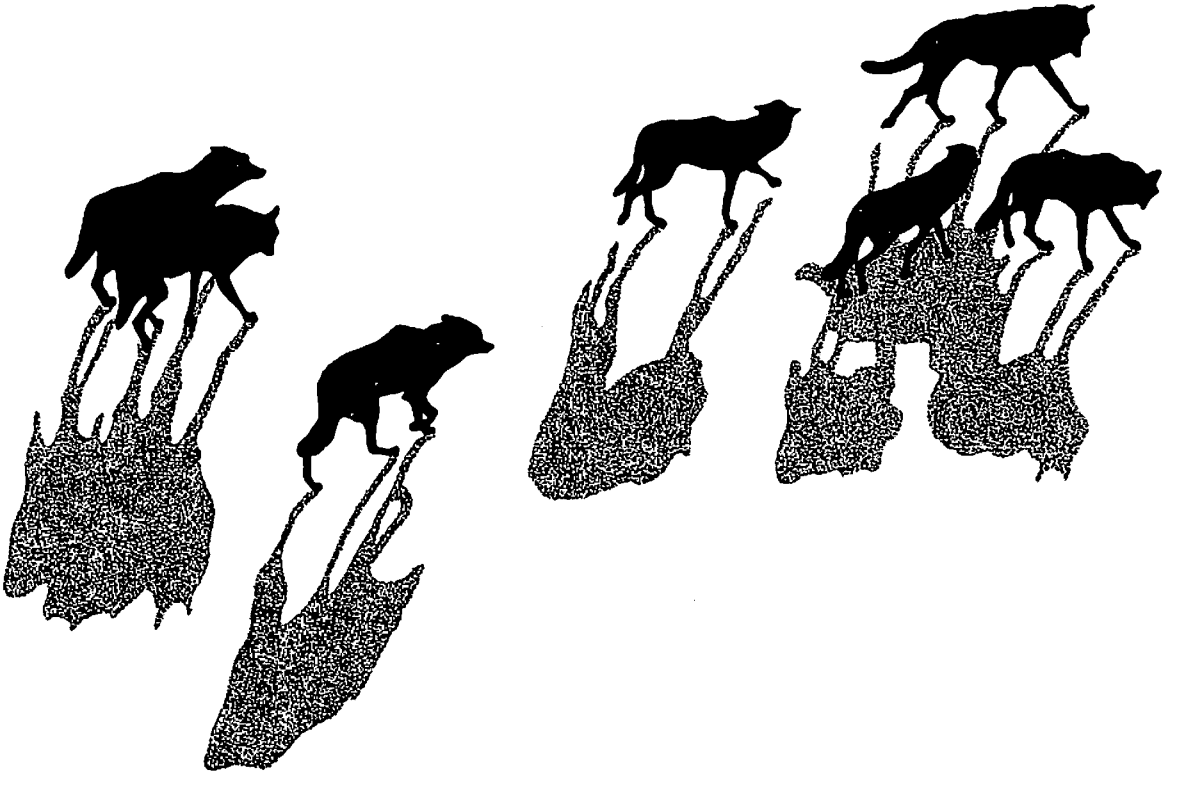
ECOLOGICAL STUDIES OF WOLVES ON ISLE ROYALE

ANNUAL REPORT

1988-89



Ecological Studies of Wolves on Isle Royale*

Annual Report - 1988-1989

(Covering the thirty-first year of research)

by

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(prepared with the assistance of Joanne M. Thurber)

31 March 1989

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Team 1	Team 2	Team 3	Team 4	Team 5	Team 6
Frank Catano	Frances Bartelt	Susan Allman	Ronald Berlin	Leslie Bishop	MacGregor Blewer
David Cromer	Tom Hess	Ursula Brandon	Tanya Childs	Nancy Brockway	David Brooks
Kristin Kohler	Kathy Scieszka	James Deignan	Elizabeth Danforth	Chris Bullock	Sharon Brooks
Walter Harris		Paul Dobrowolski	Frank Gudas	Leslie Cieplechowicz	Kent Davis
Lynn MacLean		Elizabeth Hawley	Louis Hammer-Keshner	Gerard Clausen	Ralph Di Gaetano
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			Nathan Nebbe	Charlie Knapp	Susan Keiser
			Geryun Nigogosyan	Mike Lampsa	Barbara Pitman
			Robert Phreaner	Jenny Lloyd	Tom Specht
			Bernice Popelka	Gena McCafferty	Michael Thomas
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				Ethel Wright	Susan Willsrud

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(Results reported here are preliminary, and in some cases represent findings of collaborators; please do not cite in publications without consultation with the author.)

In the sense of maximum security for wildlife, our "purest wilderness is in the custody of the National Park Service, and this is likely to continue. It is on such areas that the wolf should be privileged to survive, pursue his system of free enterprise, entertain people with his howling, and husband the dependent herds. On this continent and in the world, Isle Royale is an almost unique repository of primitive conditions. Like a priceless antique, it will be even more valuable in times not far ahead.

quoted from Durward Allen's book
"The Wolves of Minong"

Summary

Isle Royale wolves declined for the fifth consecutive year, reaching an all-time low of 11 individuals in 1989 (Fig. 1). The decline, while not as great as expected, continues to result from inadequate reproduction. Annual mortality declined from ca. 40% in recent years to just 17% in 1988-1989, possibly due to a lack of very young wolves that would be most susceptible to mortality. With the entire population now at risk, more intensive studies were initiated during the past year.

In order to assess the possible roles played in the wolf decline by food shortage, disease, and genetic losses, in 1988 four Isle Royale wolves were live-trapped, blood-sampled, and released wearing radiocollars. The animals were in excellent condition, but neither of the two adult females we examined had ever had young. Blood antibodies revealed that some of the wolves had been exposed to two diseases, canine parvovirus (CPV) and Lyme disease. There is no clear evidence that CPV is responsible for the current decline, but the possibility exists that Lyme disease might contribute to reproductive failure. No treatments for disease or other human intervention are presently being recommended.

Genetics studies are very preliminary but early results are consistent with the idea that the entire population arose from a single colonizing female with no subsequent immigration of successful reproducers. The wolves examined were all closely related and loss of genetic variability may be substantial.

Wolf food supply in 1989 was relatively high, probably adequate for successful reproduction in at least one pack. Continued low reproductive success in 1989 will indicate that other factors are likely responsible for the decline. Without improved reproduction the population is headed for extinction. Five adult males and five adult females remain, and subdivision of the population into four distinct pairs maximize the probability of reproduction.

The moose population was estimated at 1,397 +/- 211 in 1989, suggesting that growth ceased during the past year. Malnutrition was prevalent among dead moose examined in 1989, probably because of heavy infestation by winter ticks coupled with above-average snow depth and scarce forage. Wolves scavenged many carcasses in 1989, and pairs of wolves had little difficulty making kills. Surviving calves were not abundant in 1989, but the moose population may yet resume its positive rate of increase if the tick "hazard" is diminished by environmental influences (weather).

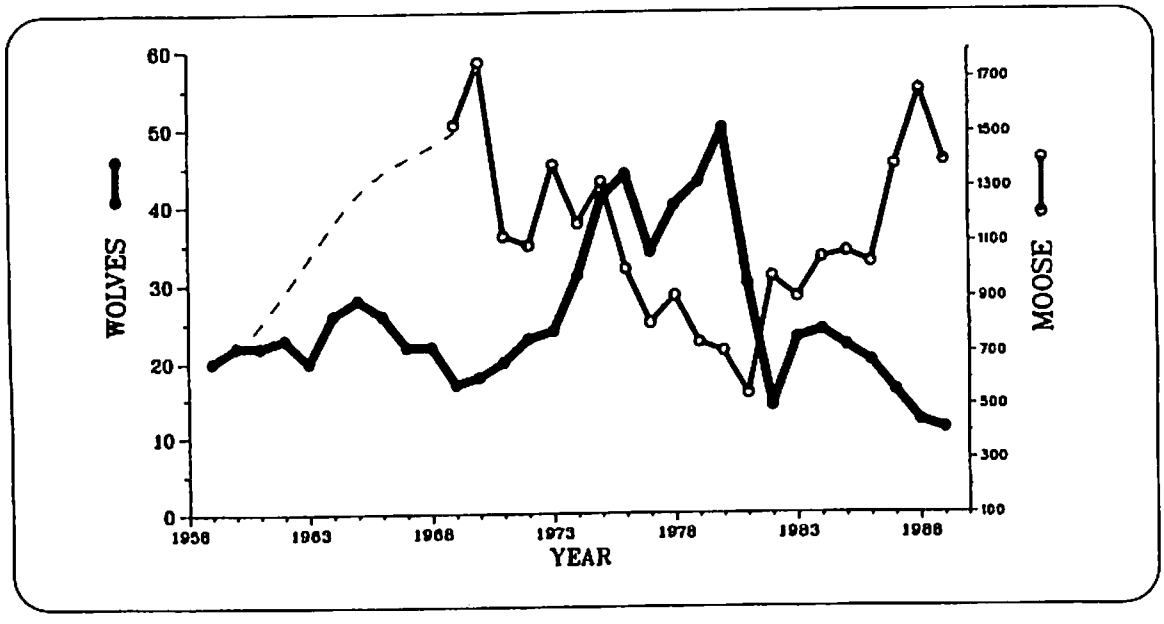

Fig. 1. Wolf and moose fluctuations, Isle Royale National Park, 1959-1989.

Personnel and Logistics

Field work during the past year was conducted from late April through August 1988 plus the usual 7-week winter study beginning in mid-January 1989. Field assistants during summer were Daniel Fehringer, Andrew Metzgar, Carolyn C. Peterson, Douglas W. Smith, and Joanne M. Thurber. During wolf capture efforts in spring and early summer we especially appreciated the help contributed by Kendrick (Kim) Trostel, Robert J. Krumenaker, and the following veterinarians who donated generously of their time: Terry Kreeger, Jeff Zuba, Linda Glaser, and Kent Kruse.

Peterson, Thurber, and pilot Don Glaser participated in the entire 7-week winter study, when flight time totaled 132 hours. National Park Service personnel who assisted during this time were: Ramon G. Brende, Robert J. Krumenaker, Christian J. Martin, Stuart L. Croll, and Barbara Nelson-Jameson. Supply flights to the island and telemetry flights were flown by the Ely Aviation Unit of Superior National Forest, with additional telemetry flights flown by Isle Royale Seaplane Service (Houghton, MI) and Portage Air (Buyck, MN).

The Wolf Population, 1988-1989

In 1989 the 5-year decline of Isle Royale wolves led to the lowest count ever obtained, just 11 wolves. During the past year studies of these wolves were expanded and intensified in an effort to explain the decline and assess population viability. For the first time, Isle Royale wolves were handled, blood-sampled for disease and genetics studies, and radiocollared in order to monitor survival (Figs. 2-5). Only a few of the scientists collaborating in this study are named in this report. Results are still very preliminary, but the findings reported here were discussed at length by two dozen participants in a meeting in March 1989, a group which represented National Park Service management and research, wolf ecology, disease and genetics specialties, and conservation biology.

The goal of the intensified study of Isle Royale wolves is to maximize our opportunities to learn from this valuable test-case in small population viability. Thus scientific and educational opportunities are considered most important. This is not a rescue operation designed to save a wolf population, as it is not

Fig. 2. Female 450, the first living wolf ever examined on Isle Royale.

Fig. 3. Female 590, who formed a pack with female 450 and male 470.

Fig. 4. Male 550 remained a loner but was able to kill moose by himself.

considered critical for survival of the species. However, public interest and scientific values are obviously very high.

The original 3 hypotheses set forth to explain the decline all remain as possibilities, and to this list a fourth possible cause should be added:

1) *Food shortage,* caused by moose age structure heavily skewed toward young moose.

2) *Disease,* with exposure to canine parvovirus (CPV) and Lyme disease confirmed.

3) *Genetics,* as preliminary findings suggest that the entire population may be closely related and that loss of genetic variability may be substantial.

4) *Stochastic events,* with numbers now so low that random individual or population events may jeopardize the entire population.

Wolf Demography

During the past year the wolf population declined from 12 to 11 wolves with one new pup surviving. Thus annual mortality over the previous year was only 17%, down considerably from the average of 40% over the previous three years. A greater decline in wolf numbers had been expected because in the summer of 1988 we found no evidence of reproduction and we projected a continuation of high mortality. The decline in mortality rate might be a hopeful sign that the population may yet recover, but reduced mortality might also be attributed to a scarcity of pups and yearlings, the age groups suspected to be most at risk from mortality agents that remain unknown. Reproduction continues to be inadequate to sustain the population. Neither of the radiocollared females has ever had young, even though they are both approaching middle age.

The adult population, partitioned into three male/female pairs, one trio with one male/two females, and one loner, afforded near maximal opportunities for reproduction. The West Pack II declined from six wolves last year to just three in 1989, the same alpha pair plus one surviving pup. They continued to occupy most of their former territory (Fig. 6). The two radiocollared females (450 and 590) plus one radiocollared male (470) formed another pack, primarily centered in the middle of the island. There were additional uncollared male-female pairs at each end of the

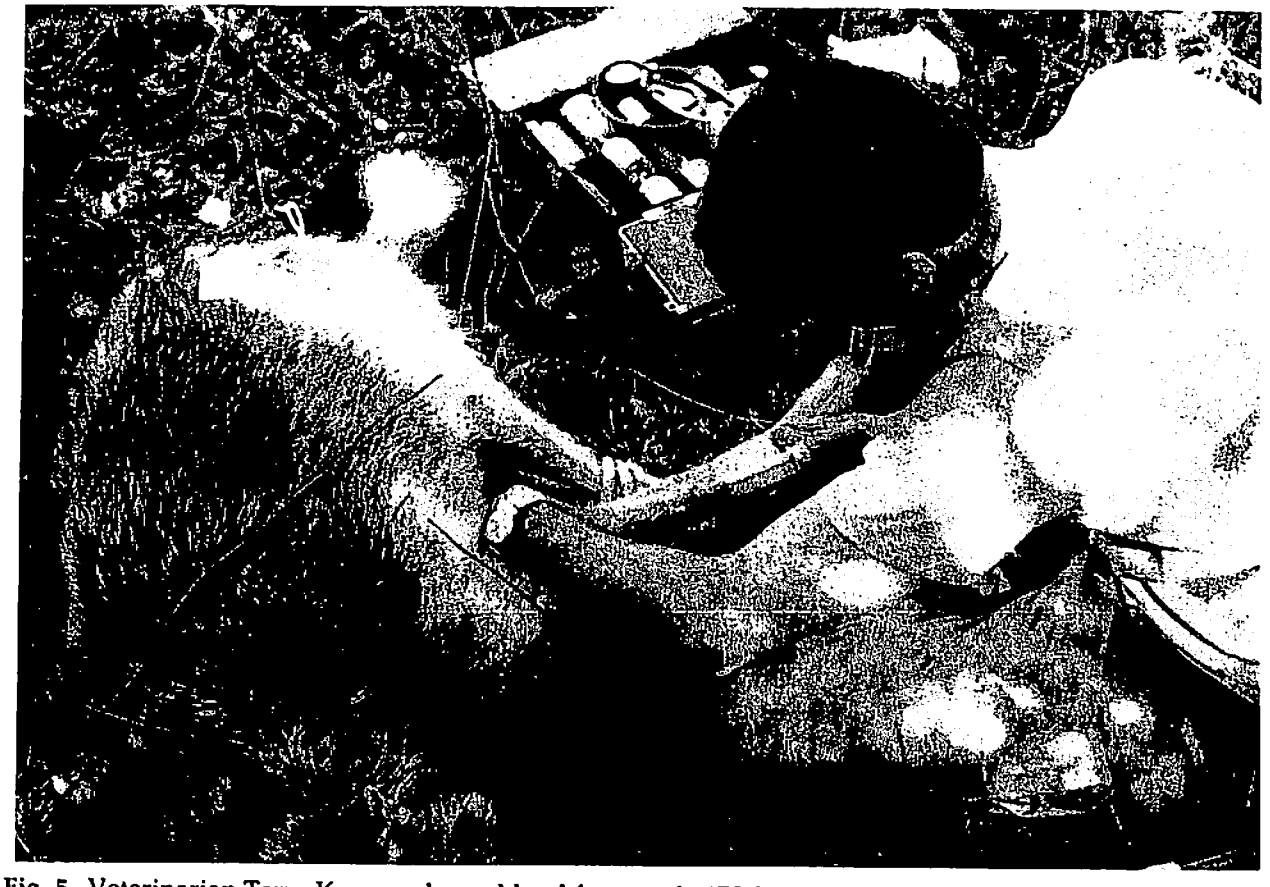

Fig. 5. Veterinarian Terry Kreeger draws blood from male 470 for disease and genetics studies.

island, and one radiocollared male (550) was a loner throughout the study. Courtship behavior or vaginal bleeding indicated that all four females paired with males were in estrus in late February (Fig. 7).

Wolf food supply

Food supply has been low throughout most of the 1980's because the moose population contains primarily young and invulnerable moose, born after 1980. Because of a dearth of moderately old moose (9 - 14 years old) that usually provide most food for wolves, wolves have had to rely heavily on very old moose that were rare in the population. By the early 1990's young moose will be growing into age groups where they should be vulnerable to wolf predation, so wolf food supply will soon increase steadily. In 1988 wolf-killed moose were generally younger than those killed

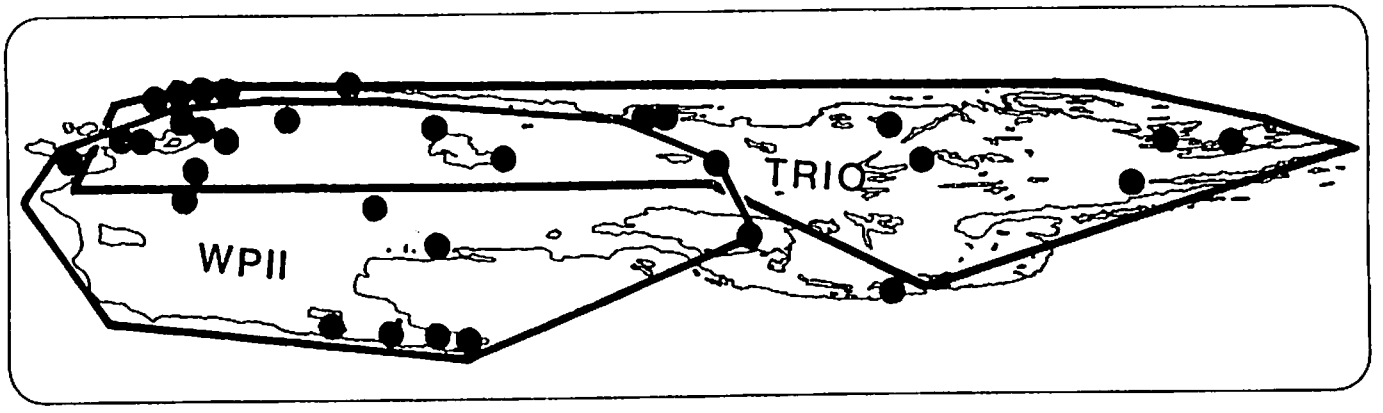

Fig. 6. Wolf pack territories and moose carcasses, 1989. WPII = West Pack II, TRIO = radio collared wolves 450, 470, and 590.

Fig. 7. Radiocollared female 590 and male 470 curled up together during the height of the breeding season.

during 1986 and 1987 (Fig. 8), perhaps indicating increased vulnerability in the moose population.

Food supply in 1989 is considered adequate for wolf reproduction in at least one pack (Fig. 9 and Table 1). Wolf pairs had little trouble finding carcasses to scavenge or vulnerable moose they could kill, and wolf 550 killed two adult cow moose by himself. The food shortage hypothesis can probably be rejected if there is reproductive failure this year, as other factors must be responsible. The four wolves examined from Isle Royale had high body weights and were in excellent condition, suggesting that food levels were adequate both at the time of capture and previously, during the critical developmental period. Notably, they were heavier than nutritionally-stressed wolves studied in Minnesota by L. D. Mech.

Disease screening

An extensive survey of diseases and parasites from Isle Royale wolves has been directed by Nancy Thomas, of the U.S. Fish and Wildlife Service National Wildlife Health Research Center in Madison, Wisconsin. Two of the four wolves handled on Isle Royale have been exposed to canine parvovirus (CPV), but the virus itself does not seem to be prevalent in the environment. Thirteen red foxes were negative for CPV antibodies, and the disease may currently not even be self-sustaining among wolves. Long-term persistence of the virus in traditional dens is possible, as is continued low-level introduction of the disease by humans. Since it appears that some wolves in the population have not even been exposed to CPV, this disease is probably not responsible for the consistently high

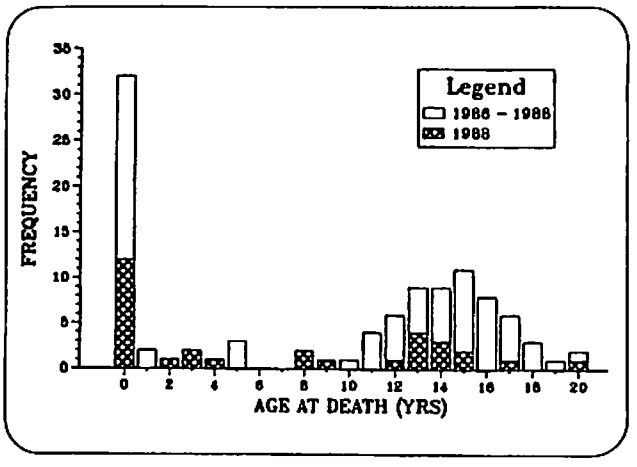

Fig. 8. Age distribution of moose dying in 1986-1988 (last year highlighted).

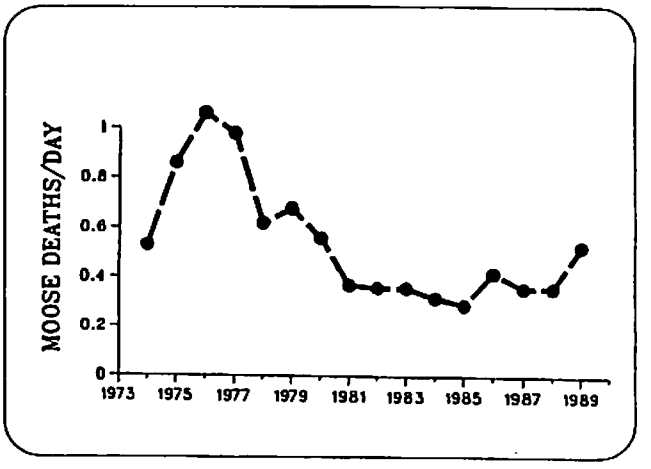

Fig. 9. Moose mortality rate in winter increased in 1989.

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

	West Pack II 1989	Radioed 3 1989	All packs, 1971-1988 average (sample size)
Pack size	3.0	3.0	8.0 (49 packs, 19 years)
Travel rate (km/day)	-	5.4	9.5 (12,791 km/1346 pack-days)
Kill interval (days)	6.2	8.5	5.4 (1,982 pack-days/366 kills)
Travel between kills	-	45.9	43.9 (12,379 km/282 kills)

mortality documented in recent years among wolves at least 8 months old. However, data on global and regional spread of the disease suggest that it was probably present on Isle Royale during the wolf crash of 1980-1982, when at least 52 wolves died.

Lyme disease antibodies were present in 3 of 4 wolves from Isle Royale, suggesting current infection by the spirochete Borrelia burgdorferi. This was the first evidence that Lyme disease had reached Isle Royale. Dogs can become afflicted by Lyme disease and limited captive studies in other areas suggest that wolves may be susceptible. Studies by Elizabeth Burgess, University of Wisconsin, indicate that the prevalence of Lyme disease exposure among wolves in the Great Lakes region has increased substantially during the 1980's, correlating with a steady decline in the number of reproducing females on Isle Royale (Table 2). Lyme disease has been linked to reproductive failure in several species, but this has not been confirmed for wolves. We hope to stimulate more experimental studies of Lyme disease effects on wolves, as well as conduct field surveys for vectors of the disease. Isle Royale red foxes were negative for Lyme disease - it is possible that the disease might be maintained by moose and moose ticks, both now very abundant. At present the role of Lyme disease in the wolf decline is speculative.

Wolf genetics

If Isle Royale wolves have been completely isolated from mainland populations, we estimate that current loss of genetic variability may exceed 50%, a level where a decline in reproductive success has been shown in other species. Data are very preliminary as sample sizes are small and laboratory studies by Robert Wayne (University of California, Los Angeles) are still underway, but protein electrophoresis revealed that there is still genetic variability retained in the current population. Analyses of mitochondrial DNA (mtDNA), a maternally transmitted portion of the genome that typically exhibits maximal variability, revealed a surprising amount of variation among North American wolves. All Isle Royale wolves sampled are of a single mtDNA haplotype, consistent with the idea that the entire population resulted from a single female colonizer. DNA "fingerprinting" revealed a high degree of similarity among the Isle Royale wolves sampled, equivalent to a captive pack we analyzed that arose from a single pair. Certainly loss of genetic variability remains a possible cause of the wolf decline.

The outlook for wolves

The Isle Royale population is now reduced to the point where random population or individual events may lead to extinction. In collaboration with Tom Drummer, Michigan Technological University, we have estimated extinction probability at about 50% currently, incorporating only the normal fluctuations exhibited by the population during the last 30 years (excluding possible genetics problems). We expect that the population will soon reverse the decline in reproduction and rise to a more secure level, or it will continue to dwindle to extinction, probably within a decade.

At present it is recommended that no treatment or intervention be attempted, aside from intensive study of this natural experiment. Vaccination of pups for canine parvovirus is possible, but there is no evidence that CPV is a current problem and with so few wolves available it would not be possible to evaluate the results of such treatment. Scientific and educational values are receiving priority management consideration by the National Park Service. Isle Royale wolves will provide an invaluable test of small population viability. The number of endangered species that exist in small, isolated populations is increasing rapidly worldwide - in such cases an entire species may be in the same situation as are Isle Royale wolves presently. Until recently the risks facing small populations have been considered largely theoretical - Isle Royale wolves will provide a prominent example from which both scientists and the general public will learn much that will be applicable elsewhere

Table 2. Reproducing female wolves on Isle Royale, 1970-1988.

1970 - 1	1977 - 4	1984 - 2
1971 - 2	1978 - 4	1985 - 2
1972 - 2	1979 - 3	1986 - 1
1973 - 2	1980 - 3	1987 - 1
1974 - 3	1981 - 3	1988 - 1
1975 - 3	1982 - 4	
1976 - 3	1983 - 3	

The Moose Population, 1988-1989

The upward spiral in moose numbers that has prevailed during the 1980's ceased in 1988-1989, at least temporarily (Fig. 10). Calf abundance was relatively low and mortality higher than the recent average. While density-dependent nutritional distress will ultimately lead to such developments, it appears that winter ticks may have placed an unusual stress on the population during the past year, probably due to weather exceptionally suitable for tick reproduction in 1988. It remains to be seen how temporary this influence will be.

Moose census, 1989

Our current method of estimating moose abundance relies on aerial counting of plots covering 15-20% of the island, after moose distribution has stabilized in conifer-dominated habitats (Fig. 11). Sightability tests conducted with radiocolllared moose have revealed that, if counting conditions are otherwise favorable (light and snow), about 75% of moose on plots are detected, so results are corrected appropriately.

Fig. 10. Moose density remains high even though population growth ceased in 1988-1989.

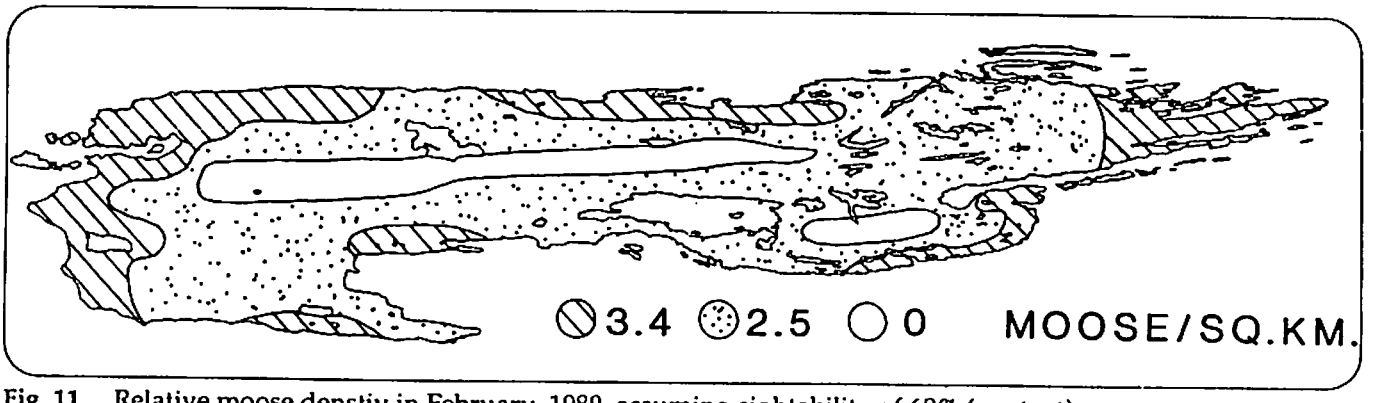

Fig. 11. Relative moose denstiy in February, 1989, assuming sightability of 68% (see text).

In 1989 snow cover was old and very poor when the census was initiated, and many plots were counted in bright sunlight (when moose are more difficult to spot). Sightability during this period was only 58% for 12 test plots over radio-collared moose. The remainder of the census was flown after conditions improved with fresh snow, when 75% sightability was assumed. For the entire census, conducted throughout February, a composite sightability of 68% was utilized for the final estimate.

The final estimate for 1989 was 1,397 moose, a decline from 1,600+ estimate of 1988. The 95% confidence interval for the 1989 estimate was +/- 211 (15%). While the decline in moose was not statistically significant, these counts suggest that the moose population did not continue to grow during the past year.

Moose mortality and condition

Carcasses of 32 moose were located during aerial surveys in 1989, twice the number found in 1988 (Fig. 6). All but six of these moose died during the seven-week winter study, reflecting a real increase in moose mortality (Fig. 9). Levels of malnutrition have risen and the age distribution of wolf-killed moose seems to be shifting away from extremely old moose.

Although above-average snow depth and very limited forage supply (Fig. 12) undoubtedly contributed to malnutrition mortality during the past winter, winter ticks seemed to play a major role (Figs. 13-14). The mid-continental region of the U.S. was extremely warm and dry in spring and early summer, 1988, with rain returning in late summer. Reports from mainland areas suggest that winter ticks were unusually prevalent on moose across a wide portion of their range. At Isle Royale, hair loss from tick infestation was apparent when the study commenced in mid-January, and during the moose census in February about one-third of all moose had hairless patches - a 10-fold increase over the usual level! Ticks were found at all moose carcasses, and about one-quarter of these dead moose died of causes other than wolf predation. One emaciated calf with a heavy tick load finally succumbed to malnutrition after its mother disappeared.

Fig. 12. Moose rely heavily on sparsely distributed forage such as balsam fir, which may be buried by deep snow.

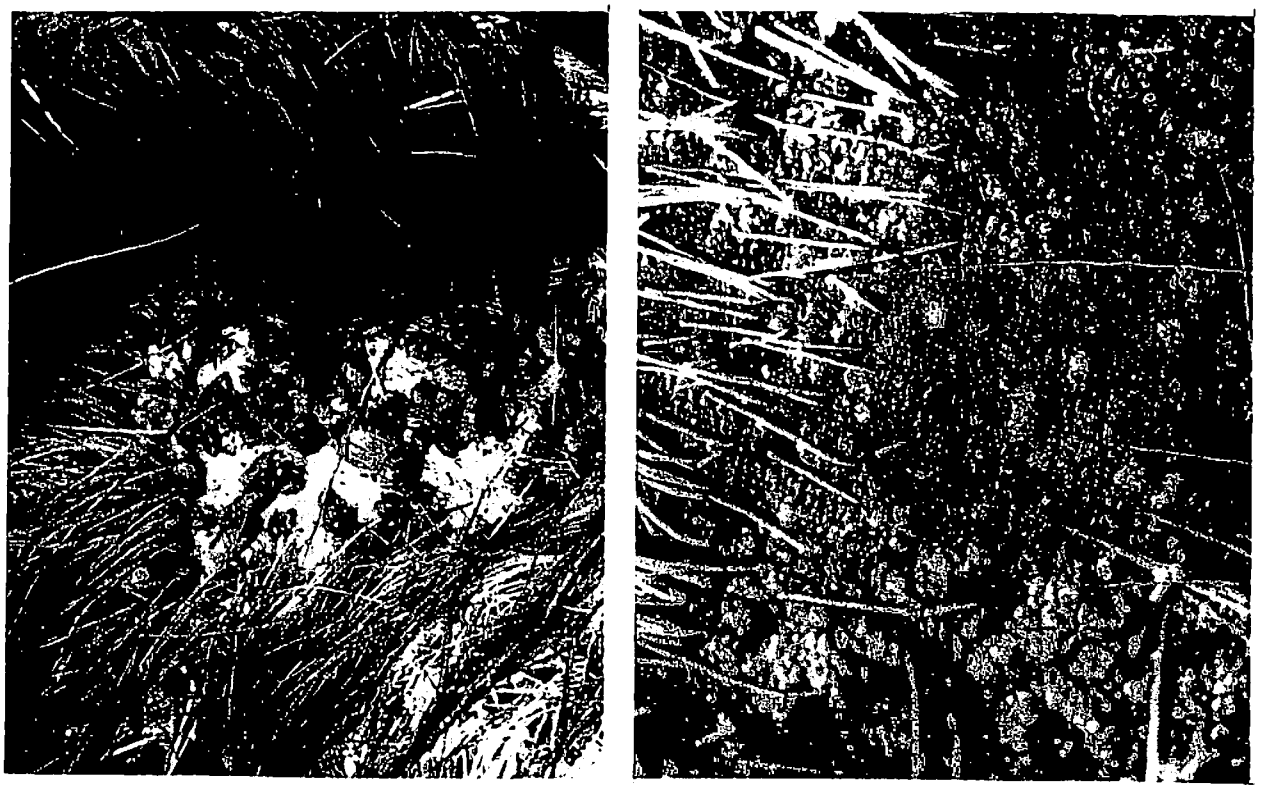

Fig. 13. Engorged winter ticks (left) and scarred, hairless skin (right) from drowned moose, April 1988.

Fig. 14. Jo Thurber collects hide from tick-bitten moose with extensive hair loss. Severely malnourished, the moose fell down an embankment and died after dislocating a shoulder.

Levels of moose bone marrow fat (the last major body fat reserve) declined in 1989. Only 3 of 14 calves and 7 of 14 adults had more than 50% bone marrow fat. Long-term data on bone marrow fat suggest that midwinter malnutrition is slowly increasing in the moose population (Fig. 15), and calf abundance may be in decline (Fig. 16).

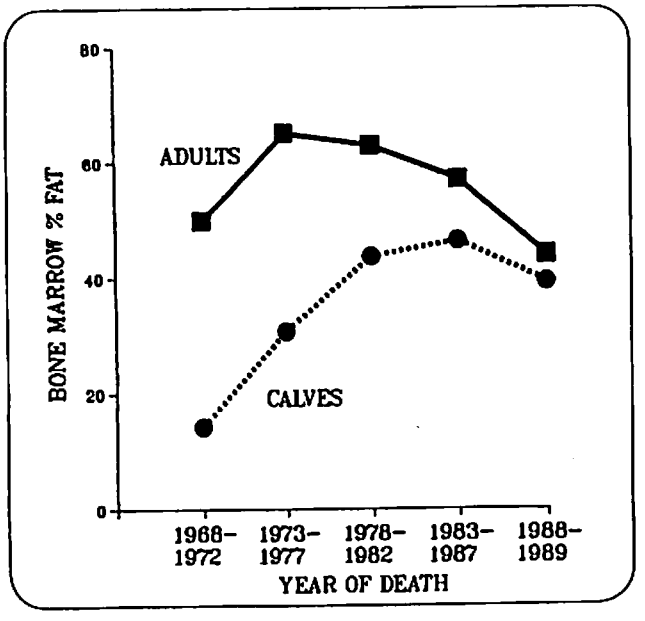

Fig. 15. Long term trends in moose bone marow fat indicate increased malnutrition in the late 1980's.

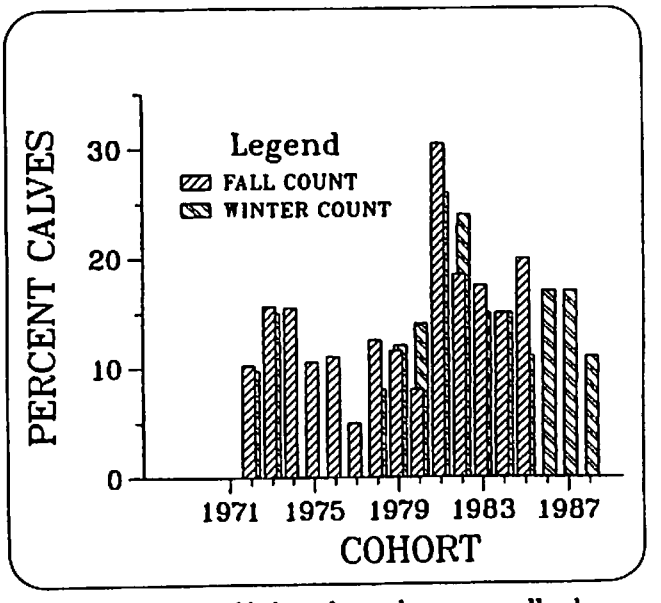

Fig. 16. Moose calf abundance has generally declined from an early 1980's peak, in spite of a dwindling wolf population.

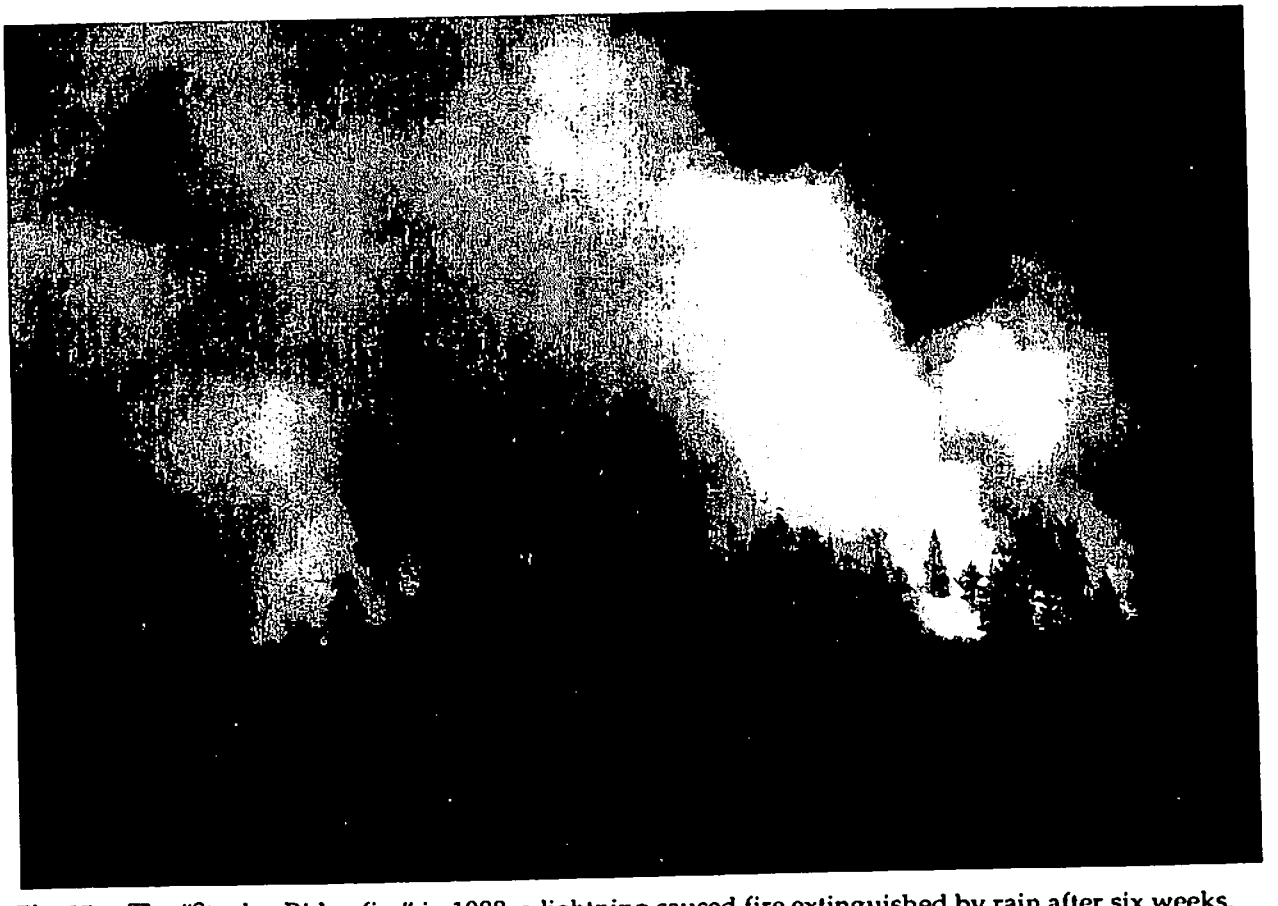

Fig. 17. The "Stanley Ridge fire" in 1988, a lightning caused fire extinguished by rain after six weeks.

Weather, Snow and Ice Conditions

Unusual weather during the past year was largely limited to the warm and dry spring and summer of 1988. In July a lightning-caused fire began burning a ridgetop at the northeastern end of the Minong Ridge (Fig. 17). After six weeks of burning along the ridge the fire was extinguished by rain. Though the burn amounted to only 80 acres, this was the largest fire on Isle Royale since 1948.

Snow depth in 1989 was above average, about 60-80 cm. Temperatures were near seasonal averages in winter (Fig. 18). Ice formation in Lake Superior may have been delayed by residual high water temperatures from last summer, but in February very rough ice finally formed between the island and the mainland. Within days it was broken up by high winds, and there was virtually no opportunity for wolf travel via ice bridge to or from Ontario.

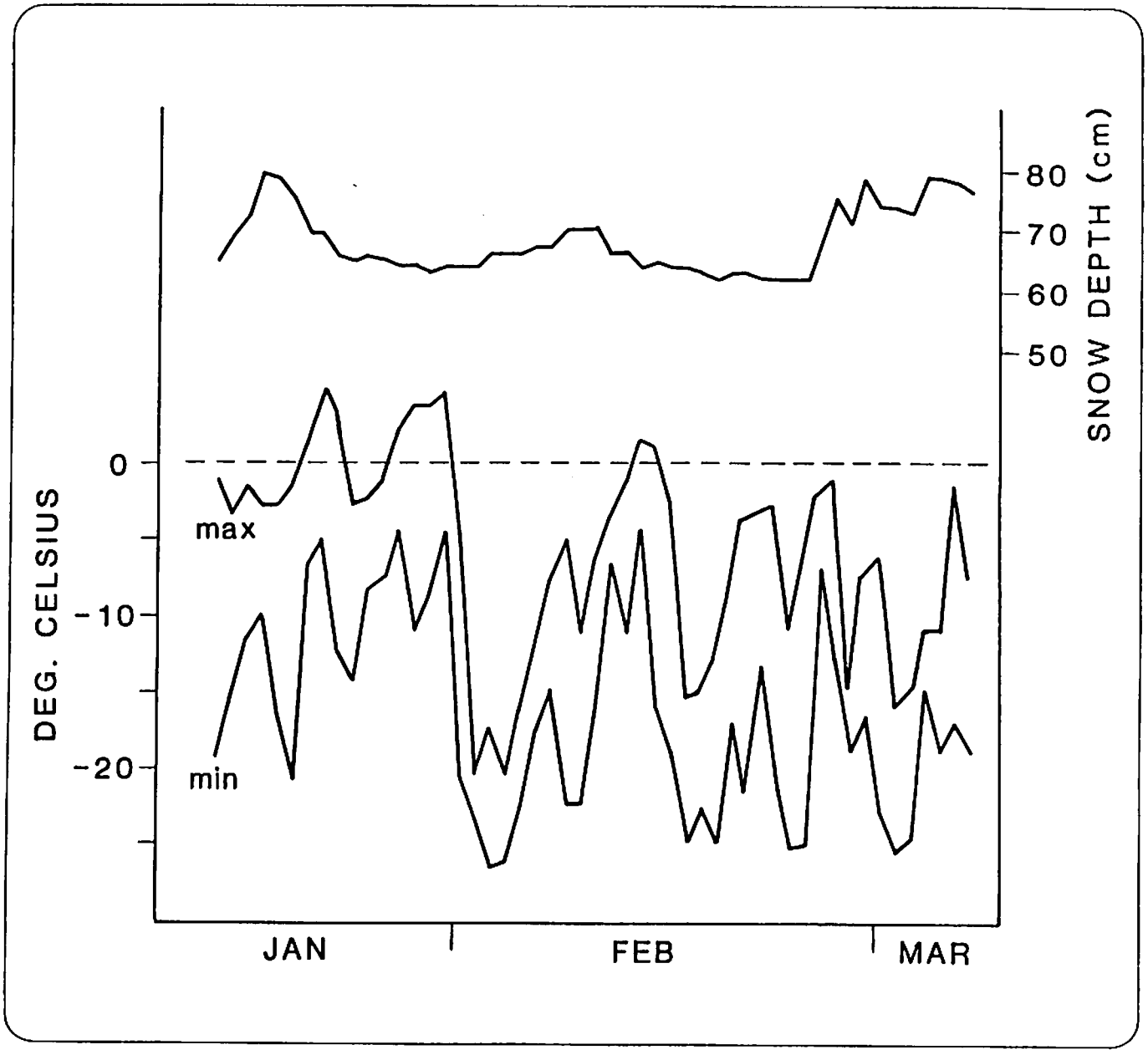

Fig. 18. Temperature extremes and snow depth during 1989 winter study.

Other Wildlife Species

Snowshoe hare abundance continued to increase, as reflected by all field observations and an index of hares encountered in summer (Fig. 19). The population increase has been obvious during the last two years, when hares have become numerous in most major habitat types.

Red fox observations were higher in 1989 than in most previous years during the current decade, probably reflecting a food increase due to the explosion of snowshoe hares (Fig. 20). Fox scavenging on dead moose continued to be rather low, and foxes appeared to subsist primarily on showshoe hares.

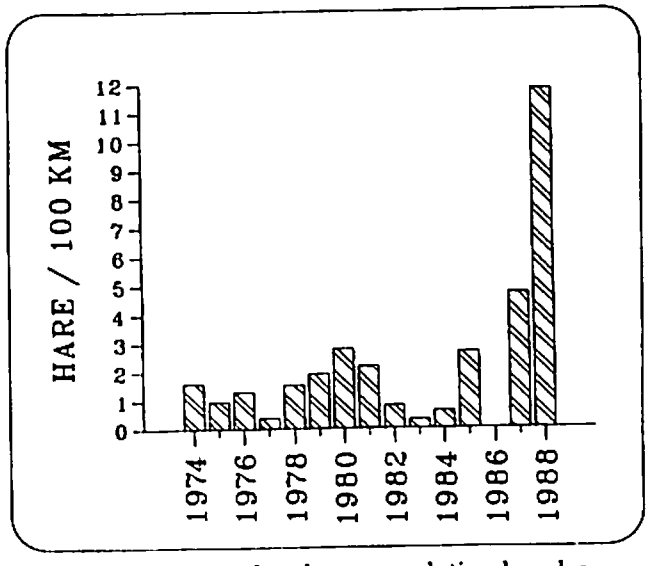

Fig. 19. The snowshoe hare population has dramatically increased for the first time in several decades.

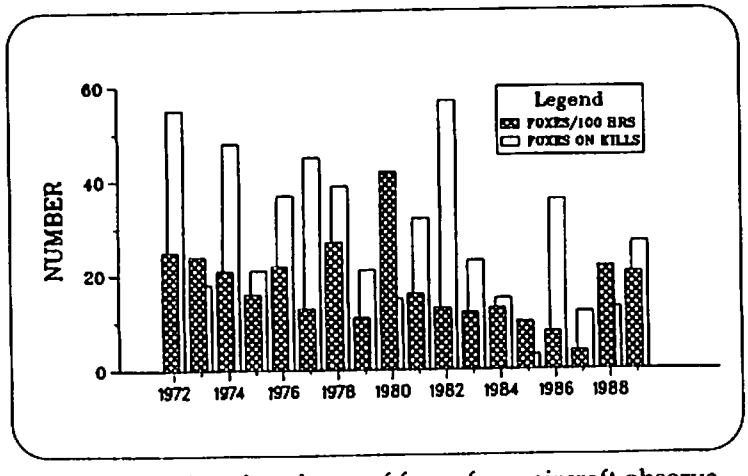

Fig. 20. Relative abundance of foxes from aircraft observations, 1972-1989. Hatched bar is the number of foxes seen away from moose carcasses/100 hours, while the open bar is the number of foxes seen on carcasses.

Raptors continued to make a slow comeback on Isle Royale in 1988. Young birds fledged in two bald eagle nests and two osprey nests. For the second year in a row, five peregrine falcons were released by the National Park Service and successfully fledged. One of the five falcons released in 1987 returned to its hack site as a year-old bird, so it is hoped that as a two-year-old it may return to breed. A third release of ten birds is to occur in 1989, probably at a different hack site.

Philip C. Shelton, who has surveyed Isle Royale beavers since 1962, conducted an aerial survey in October 1988. He found that the number of beaver colonies had declined slightly since 1986, possibly due to saturation of the relatively poor habitat available (Fig. 21).

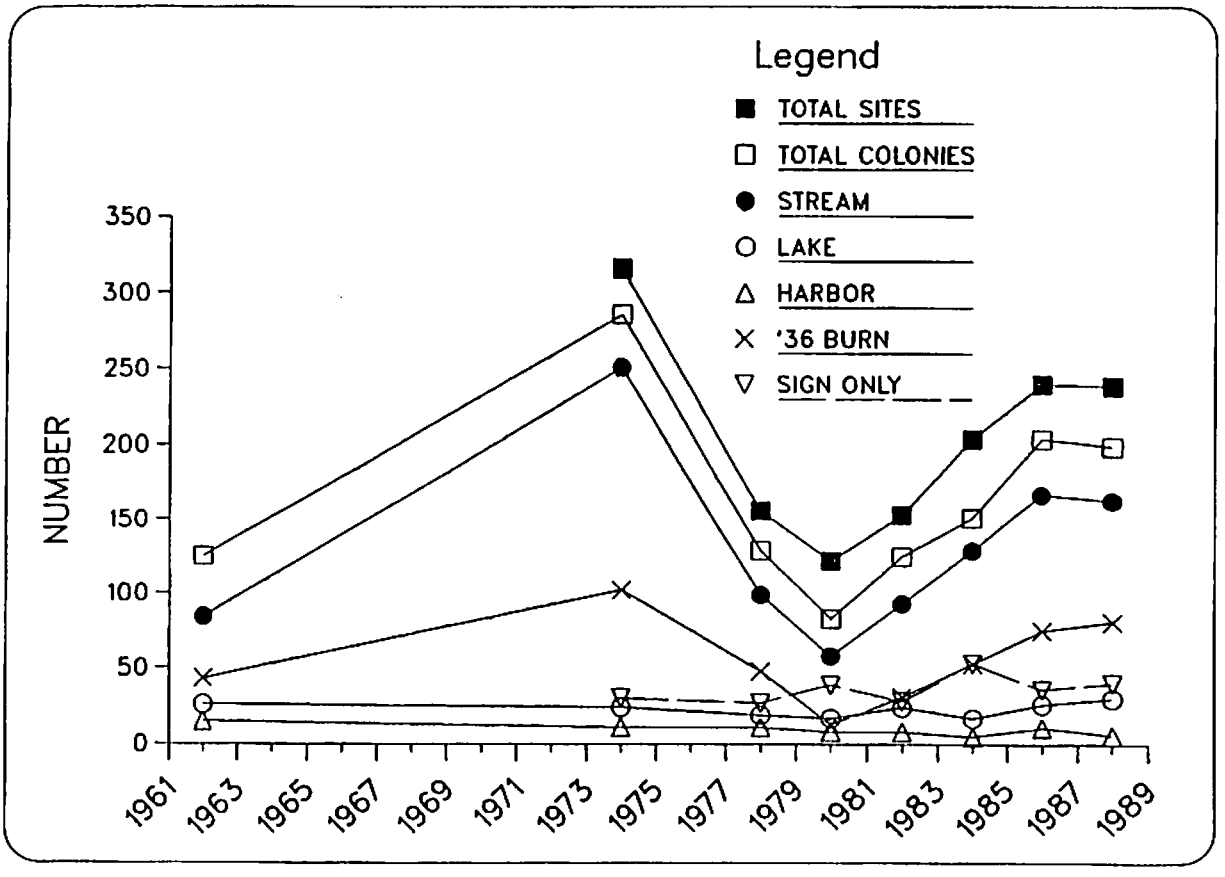

Fig. 21. Beaver population trends, determined from aerial surveys by P.C. Shelton. The 1936 burn classification is a special designation not included in the total.