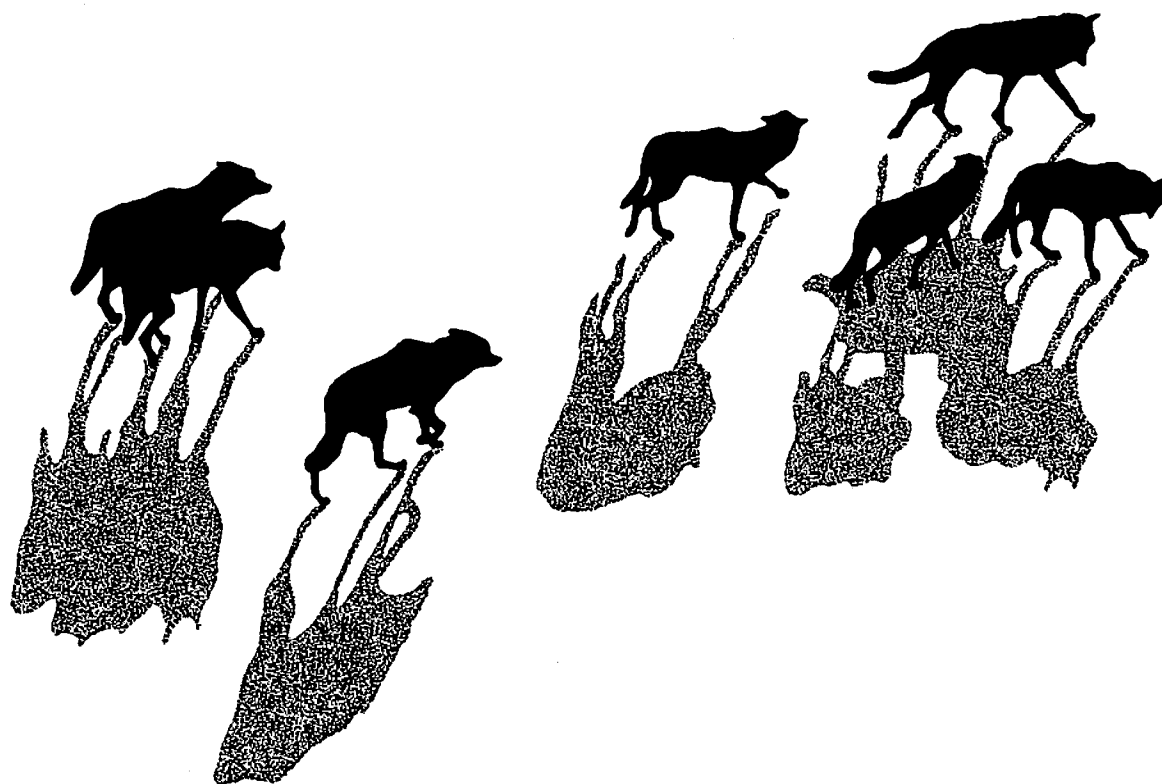


ECOLOGICAL STUDIES
OF WOLVES
ON ISLE ROYALE

ANNUAL REPORT

1987-88



Ecological Studies of Wolves on Isle Royale*

Annual Report - 1987-1988

(Covering the thirtieth year of research)

by

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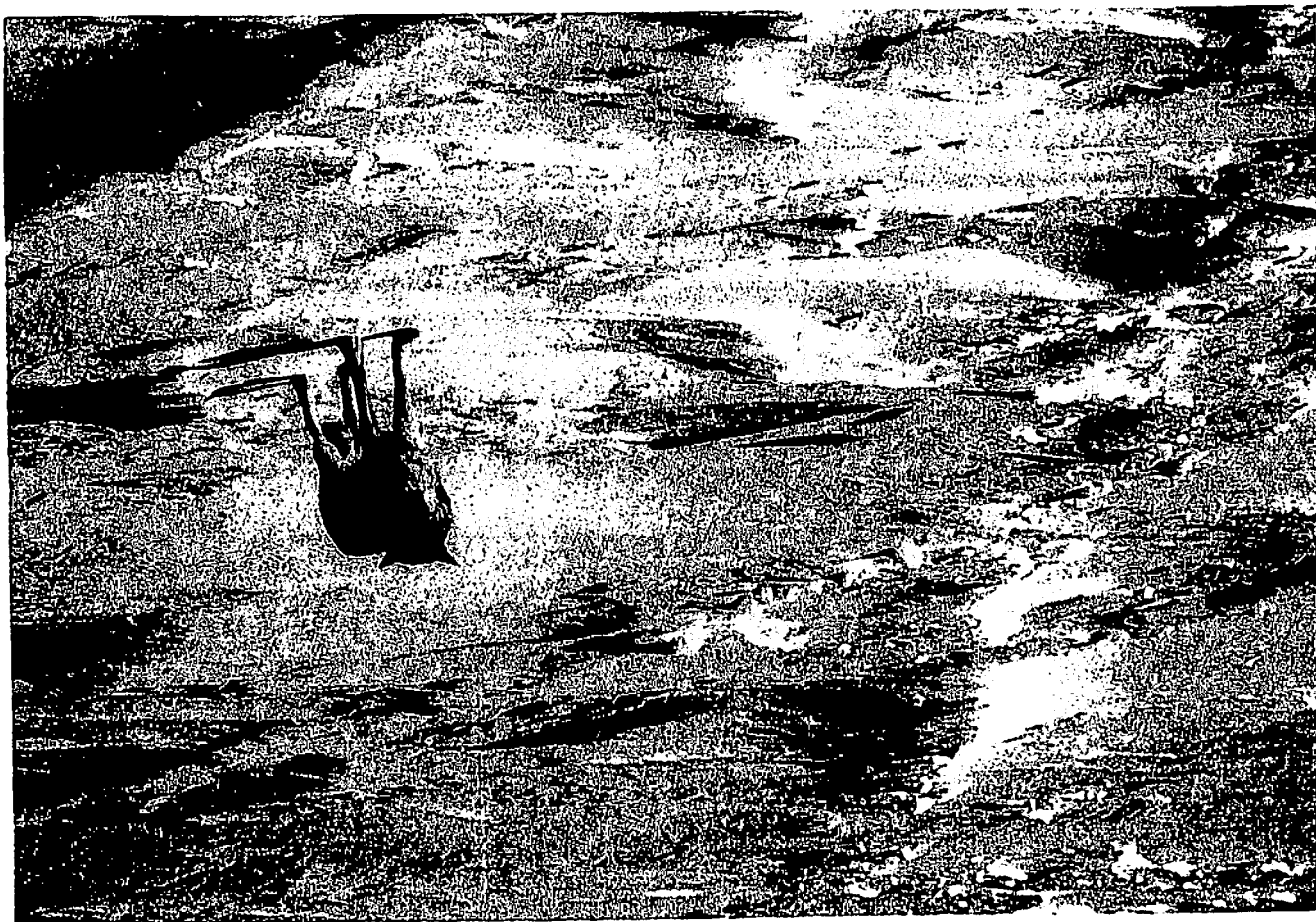
31 March 1988

*During the past year this research was supported by funding from the U.S. National Park Service (Supplement #CA6310-6-8004), National Geographic Society, Boone and Crockett Club, Campfire Conservation Fund, Quaker Oats Foundation, and National Wildlife Federation, plus donations from Randall F. Absolon, Dorthey L. Behrend, Greg and Janet Capito, Howard and Jean Clarke, Alison J. Clarke, Thomas Dunlap and Susan Miller, James and Adela Elwell, Ronald L. Felzer, Edith N. Greene, Bedo Hobbs, Peter Rigor, Darcy R. Rutkowski, Philip C. Shelton, Billie Smith, Pat and David Toczydlowski, and Emma C. Ware. Typesetting and layout donated by Robert M. Linn, Hancock, Michigan. Cover page drawing by Fred Montague, RFD #5, Monticello, Indiana 47960. THANK YOU to all who have helped!!

Tax-deductible donations to support continuing research on Isle Royale wolves and moose can be sent to: Wolf-Moose Study, Michigan Tech Fund, Alumni House, Michigan Technological University, Houghton, Michigan 49931.

[Results reported here are preliminary; please do not cite in publications without the permission of the author.]

East Pack II alpha male, 1988



Summary

In the 30th year of research focusing on population regulation in this isolated wolf-moose system, wolves declined for the fifth consecutive year, reaching the lowest level ever documented (Fig.1). The moose population continued its upward spiral, impeded little by wolf predation.

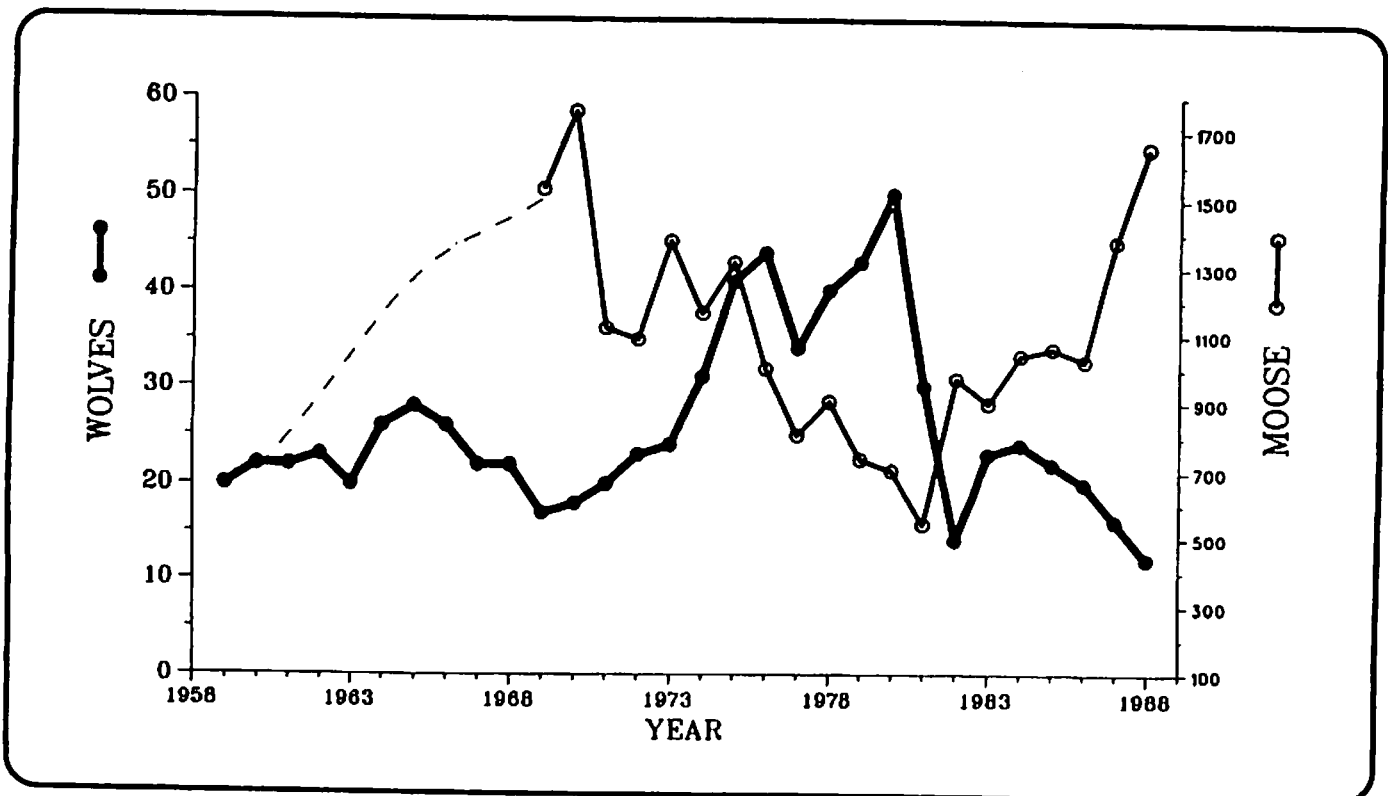
In 1988 only 12 wolves remained on Isle Royale. Pups were recruited in one pack, and survival rate for all wolves over the past year was only 60%. No carcasses were recovered, and there was no evidence pointing to specific causes of death. Wolf food level, indicated by predation rates in winter, was unchanged from previous years. The moose population contained few vulnerable prey because of its young age structure, but the wolf decline was not clearly attributable to a decline in available food.

Variations in available food in winter have, in the past, adequately explained wolf population fluctuations. However, disease and/or limited genetic variability may

be contributing to current declines in this isolated population. In order to evaluate these possibilities before further decline occurs, in 1988 several wolves will be live-trapped, blood-sampled for disease and genetics studies, and released wearing radio-collars with mortality sensors. Any subsequent management actions will be based on early results of these studies.

With continued strong recruitment and a declining mortality rate, the moose population continued to rise, to an estimated 1653 ± 224 (95% confidence interval) animals in 1988. This was the highest moose estimate ever obtained from aerial census of this population, and moose numbers are probably at least comparable to those of 20 years ago. Although malnutrition deaths were recorded in 1988, midwinter fat levels in calves killed by wolves were not seriously depleted. Calf recruitment has not yet diminished and the population is probably increasing at a historic high rate. Moose cohorts born in the early 1980s are approaching an age when mortality from wolf predation should increase, and we expect declines in calf recruitment as forage depletion progresses. Nonetheless, the moose population should continue growth into the 1990s.

Fig. 1. Wolf and moose fluctuations, Isle Royale National Park, 1959-1988.



Personnel and Logistics

Field work during the past year was conducted in June-August 1987 and the usual 7-week winter study beginning in mid-January. This report focuses on findings from the winter study, which extended from 14 January through 3 March 1988.

Field assistants during summer 1987 were Douglas Smith and Joanne Thurber. Peterson and pilot Don Glaser were present for the entire winter study, and were assisted by Thurber (4 weeks) and Barb Nelson-Jameson (1 week). National Park Service personnel who participated during the winter study were the following: Bob Krumenaker, Ray Brende, Jerry Case, Stu Croll, and Chris Martin. Supply flights to the island were flown by the Ely Aviation Unit of Superior National Forest.

The Wolf Population, 1987-1988

A further wolf decline in 1988 was anticipated after summer field work suggested that only one small litter of pups was present in 1987, in the West Pack II. The East Pack II failed to reproduce for the third consecutive year. After the ousting of the Harvey Lake Pack in 1987, the East Pack II and West Pack II divided the island along rather traditional lines (Fig. 2). A wolf pair of unknown origin occupied the northeastern end of the island, and 2 single wolves rounded out the total population of 12 animals.

Early in 1988 the West Pack II contained 6 wolves, including 3 pups plus 2 adult males and one female (Fig. 3). The East Pack II was reduced to just a male and female (Fig. 4), and the remaining duo was also a male-female pair. The single wolves were of unknown

sex. Based on change in total numbers and the presence of 3 pups, 7 of the 16 wolves present in 1987 died in the past year, for an overall survival rate of 60%. Only 1 of these wolves was accounted for, a male killed by other wolves during the 1987 winter study. Also recovered in 1987 was the skeleton of one West Pack II pup that died in 1986. Based on its small skeleton, body weight at the time of death was estimated at about 10 kg. Although it apparently crawled into thick vegetation before dying, there was no clue as to cause of death.

The alpha male of long-standing in the West Pack II, present since at least 1982, was replaced in 1988 by a new alpha male who apparently came from within the ranks of this pack (Fig. 5). It was uncertain if the alpha female in 1988 was the same wolf as in 1987. The 3 pups in the West Pack II were noticeably smaller than the adults, suggesting retarded growth rates in summer.

The East Pack II was identified only by the similarity in pack travels with previous years. It completely overlapped the movements of the other duo, the NE pair. Both pairs scent-marked, an important form of territorial behavior.

Food availability, based on the number of moose that died during the winter study period, has not changed substantially since 1981. There was no evidence of acute food shortage for any of the wolf groups in winter. Their kills were cleaned up well, but not totally reduced to bones, as a decade ago when wolf numbers were higher. The West Pack II, even with fewer wolves than average, killed moose more often than the average pack over the past 18 years (Table 1). The size of this pack has dropped from 11 to 6 wolves in the last 2 years, in spite of producing 7 pups, implying virtually complete

Fig. 2. Wolf Pack territories and moose carcasses, 1988.

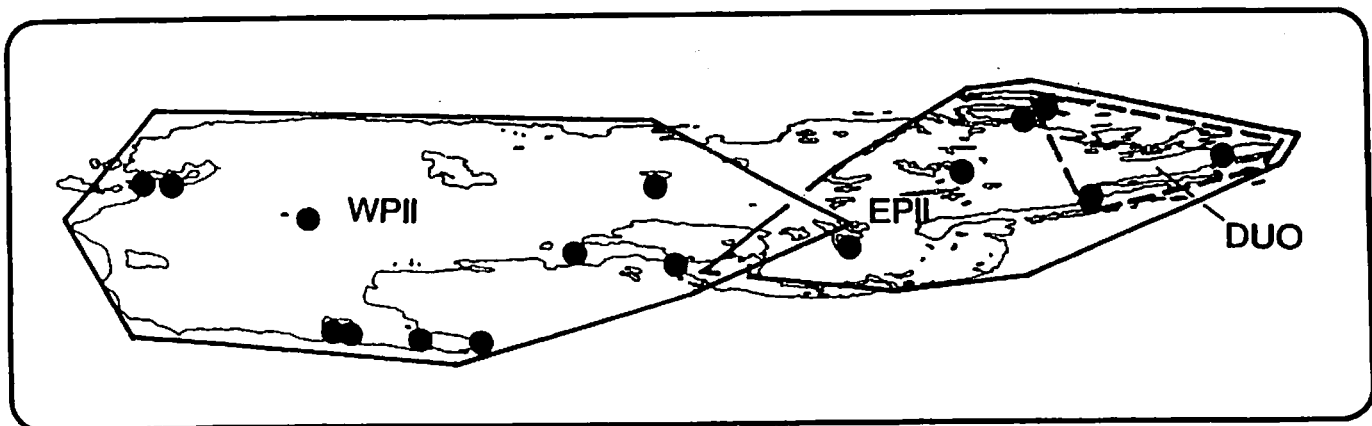


Fig. 3. West Pack II wolves in 1988.



Fig. 4. East Pack II wolves in 1988.

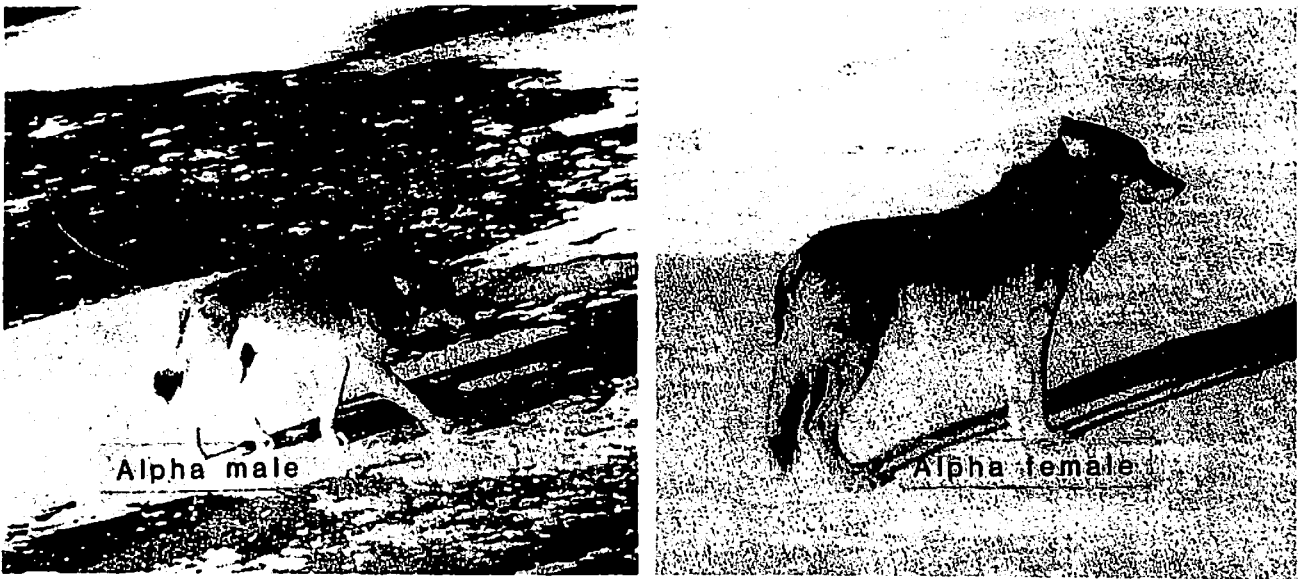


Fig. 5. (Left) West Pack II alpha male in 1988; (right) same wolf in 1986. Urination posture shown is unique to male wolves and is useful for determining sex of unmarked wolves.

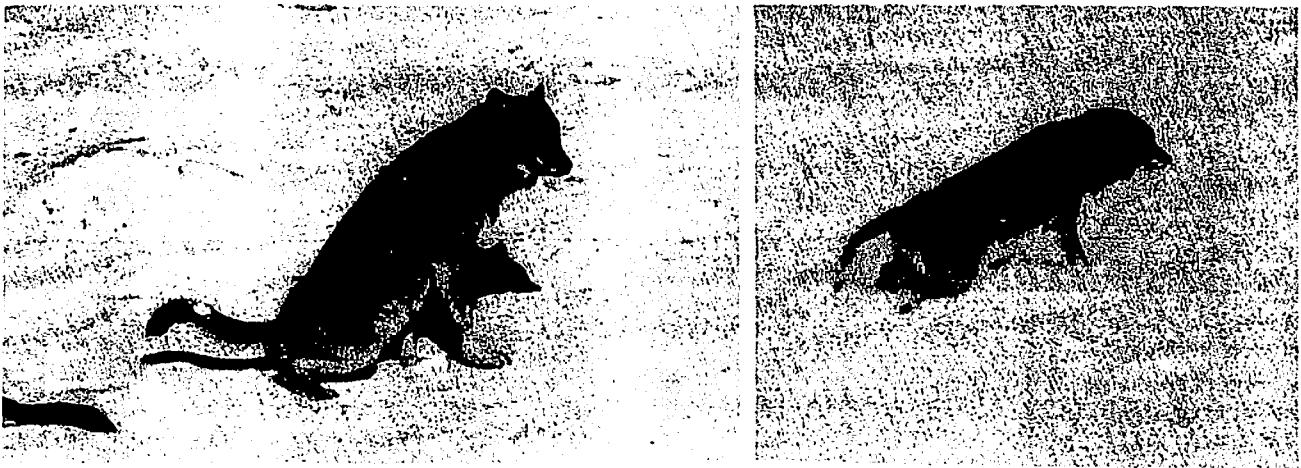
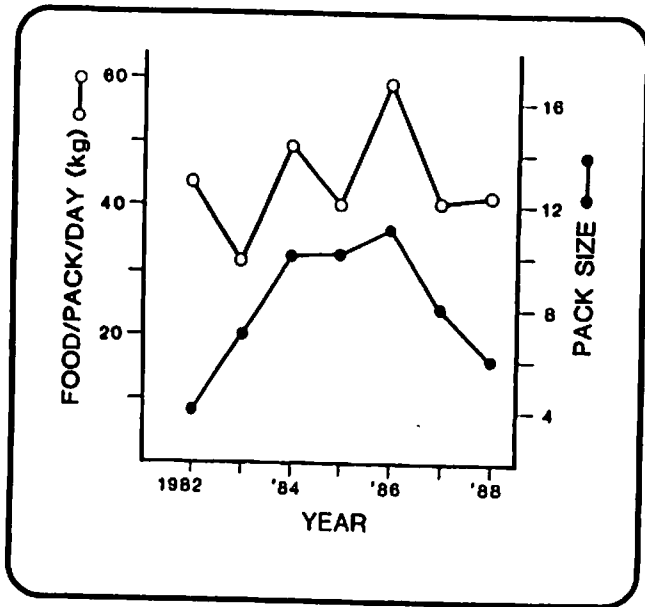


Table 1. Travel and kill rates for Isle Royale wolf packs.

	West Pack II	East Pack II	All packs, 1971-87
	1988	1988	average (sample size)
Pack size	6.0	2.0	8.1 (47 packs, 18 years)
Travel rate (kn/day)	10.5	-	9.5 (12,329 km/1,302 pack days)
Kill interval (days)	4.9	7.3	5.4 (1,894 pack-days/351 kills)
Travel between kills (km)	51.3	-	43.7 (11,917 km/273 kills)

Fig. 6. Food availability and pack size, West Pack II, 1982-1988.



turnover. Simultaneously, food availability in winter for this pack has remained rather stable (Fig. 6).

Thus food supply no longer provides a ready explanation for present wolf population trends. Alternate hypotheses include disease and reduced genetic variability. Neither can be addressed without examining and obtaining samples from the wolves themselves, a research approach which has not been allowed at Isle Royale. In late March 1988, after a thorough review, the National Park Service agreed to permit handling of up to six wolves this year to (1) obtain blood samples for disease assessment, especially canine parvovirus, (2) provide cell samples from blood to compare genetic variability in Isle Royale and mainland wolves, (3) assess current nutritional status, and (4) determine causes of mortality through the use of radiocollars. Cooperators in this effort include U. S. Seal (U.S. Veterans Administration Medical Center), Terry Kreeger (University of Minnesota), Nancy Thomas (U.S. Fish and Wildlife Service Wildlife Health Center), Robert Wayne (University of California at Los Angeles), and Dave Mech (U.S. Fish and Wildlife Service). Subsequent management actions are still under review; of course, much will depend on early findings.

Two females exhibited estrous bleeding this winter (Fig. 7). The female in the East Pack II showed slight bleeding on 11 February, but we observed no courtship behavior in this pair. The alpha female in the West Pack

II showed heavy bleeding on 26-27 February, and actively courted the alpha male. The alpha male was only mildly interested during our observations, but did tolerate inspection of the alpha female by the other adult male in the pack. Pups in this pack often mounted other packmates during this time, especially the alpha male! -- perhaps they witnessed behavior that we did not. Based on production of pups in recent years, we expect no more than one litter of pups in 1988.

The Moose Population, 1987-1988

Recruitment continued to exceed mortality by a wide margin, fueling a continued increase in the moose population. The number of moose deaths in winter has remained stable since 1981, so mortality rate has dropped steadily as moose numbers have grown. There is no reason to think that this accelerating increase in the moose population will be turned around before the 1990s. At present we can only speculate on a likely endpoint for population growth.

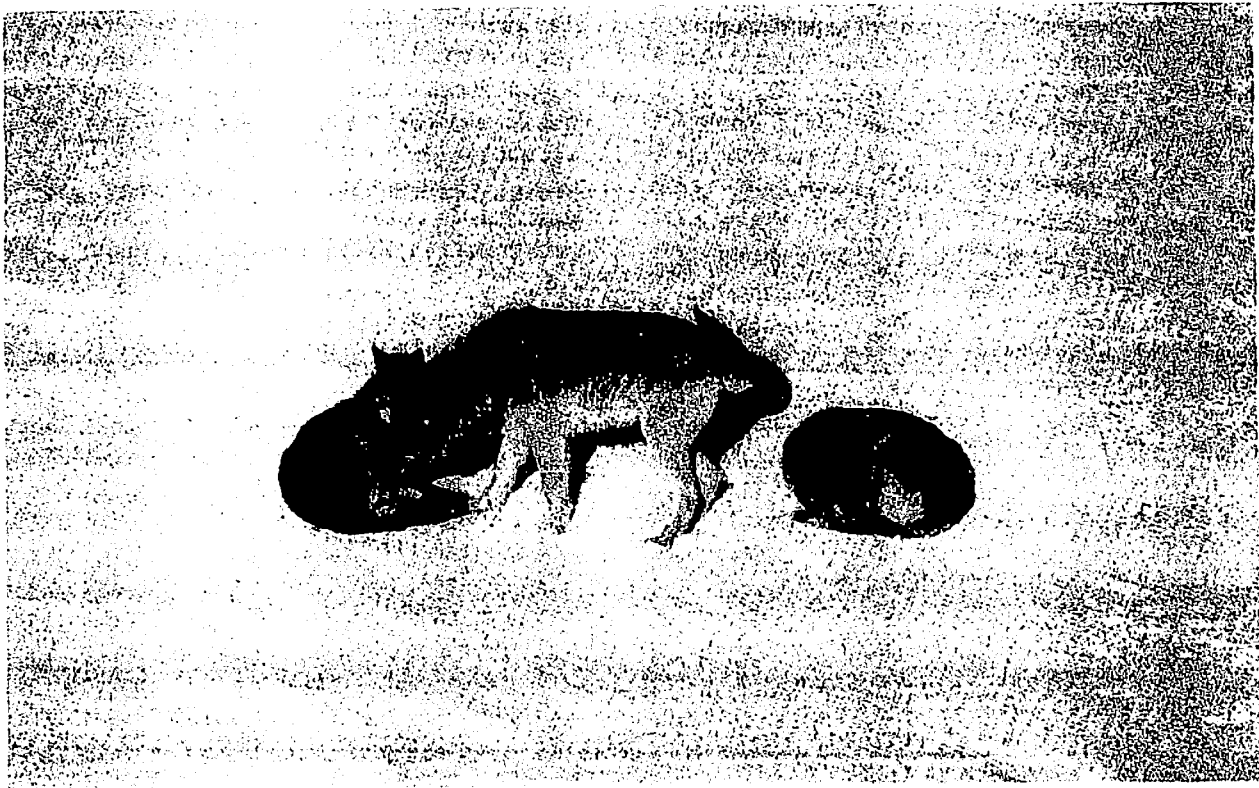
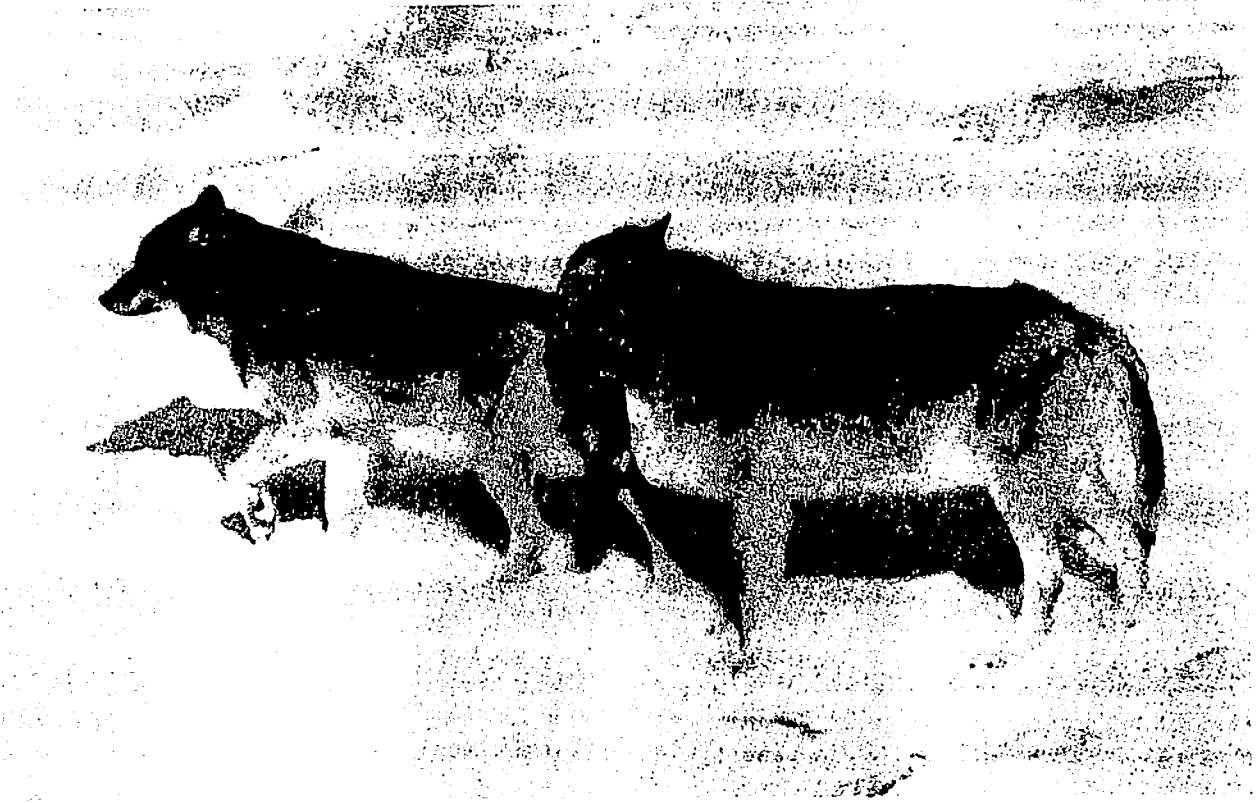
Revision of earlier moose estimates

Moose estimates for the 1970s have been re-analyzed based on more recent correlations between aerial census estimates and other indices of abundance. We now rely entirely on aerial censuses of moose in midwinter to track change in the population, but estimates for several years in the 1970s were based on the frequency of moose observations on the ground in June-August and the number of moose observed per hour in winter. The latter index has now been discarded, because it is clear that visibility variation has an important influence on aerial moose observations, and because there is no significant correlation between this winter index and census estimates. The summer ground index is significantly correlated with census estimates, however, and is the sole basis for estimating moose population size in 1970, 1971, 1973, and 1975-1978. Moose population estimates in Fig. 1 reflect these changes.

Moose census, 1988

Visibility biases during midwinter aerial counts of moose on census plots were evaluated during 1985-1987 using radiocollared moose. While 95% of the moose on plots can be observed in mid-January, only 75% were typically observed after moose shifted into conifer cover in late January. We can rarely complete a census before moose retreat to conifers, and it is difficult to estimate visibility bias while moose distribution is in transition. So in 1988 the aerial census was begun only after moose distribution had stabilized. The final estimate incorporated an assumed "sightability" of 75%.

Fig. 7. (Top) West Pack II alpha female in estrous, tended by the alpha male; (bottom) West Pack II alpha female being courted by beta male, with alpha male on right showing toleration.



The aerial census was flown during 4-13 February. On 73 plots (1 km² area) covering 16% of the island, we counted 212 moose (Fig. 8). The 95% confidence interval was +/- 18% of the uncorrected estimate. All islets were counted separately. Expanding the count to accommodate 75% sightability yielded a final total estimate of 1653 +/- 224. This is the highest estimate from any aerial census conducted at Isle Royale.

Moose age structure

The sample of dead moose collected beginning in 1958 has now expanded to over 1,800 animals, and has proven to be a valuable means of evaluating past fluctuations in moose age structure. The maximum lifespan for moose is about 20 years, so this length of time must elapse before we are able to accurately reconstruct the life-long survival pattern for a specific annual cohort. Fluctuations in age structure over the past 3 decades have been substantial (Fig. 9), reflecting differential vulnerability to wolf predation and abundance over time.

We consider moose population age structure to be a key link between three trophic levels at Isle Royale (Fig. 10). Life-long survivorship of moose appears highly dependent on early nutrition (a reflection of forage conditions), and the resulting survivorship pattern will determine prey vulnerability for wolves. Both wolves and moose in turn have large impacts on the underlying trophic levels, especially recruitment of reproducing adults (both trees and moose).

Given the tendency toward multi-year patterns in this 3-trophic-level system, we would expect moose age structure to also fluctuate over long periods of time. The annual sample of dead moose recovered for the past 30 years provides our best indicator of these waves of successful and unsuccessful cohorts. As seen in Fig. 9, there was a lack of successful recruitment of moose in the mid-1950s, but there were ample numbers of moose

born before and after this period to provide vulnerable prey for wolves throughout the 1960s. Most moose born in the early 1970s died while very young. This produced a bounty of food for wolves in the short-term, but led in the late 1980s to a steadily shrinking pool of old, vulnerable moose. Most moose on Isle Royale are now 7 years old or less, providing very few vulnerable prey for wolves aside from calves.

Moose mortality and condition

Only 16 dead moose were recovered during a 45-day period in midwinter, 1988, a mortality rate of 0.36 moose/day for the entire population (Fig. 11). The dead moose included 8 old adults, 2 yearlings, and 6 calves (Figs. 12 and 13). In spite of the rapidly growing moose population, there are as yet no indications of severe undernutrition on a large scale, as documented in the early 1970s. Bone marrow of calves, for example, was consistently high (Fig. 14). Some moose mortality from malnutrition occurred in 1988 among very old moose (2 of 16 dead moose examined).

Winter ticks became increasingly apparent on moose during February (Fig. 15), and by early March most moose were missing patches of hair (usually < 10%). The worst case was observed on Amygdaloid Island, where one moose had lost about half its hair and had several bleeding wounds.

Radiocollared Moose

Of the 20 moose that have been radiocollared since 1984, 12 continued to transmit in 1988. Nine different cow moose have been monitored for 1 to 5 years since 1984. Successful reproduction (defined as raising a calf to at least the age of 9 months) rarely occurred in 2 consecutive years, and was rather sporadic (Table 2). Two cows, one now 4 years old (1641) and the other dead at 16 years (270), had no calves during the years they were monitored. Overall, 13 calves were successfully raised by

Fig. 8. Moose distribution during the 1988 aerial census.

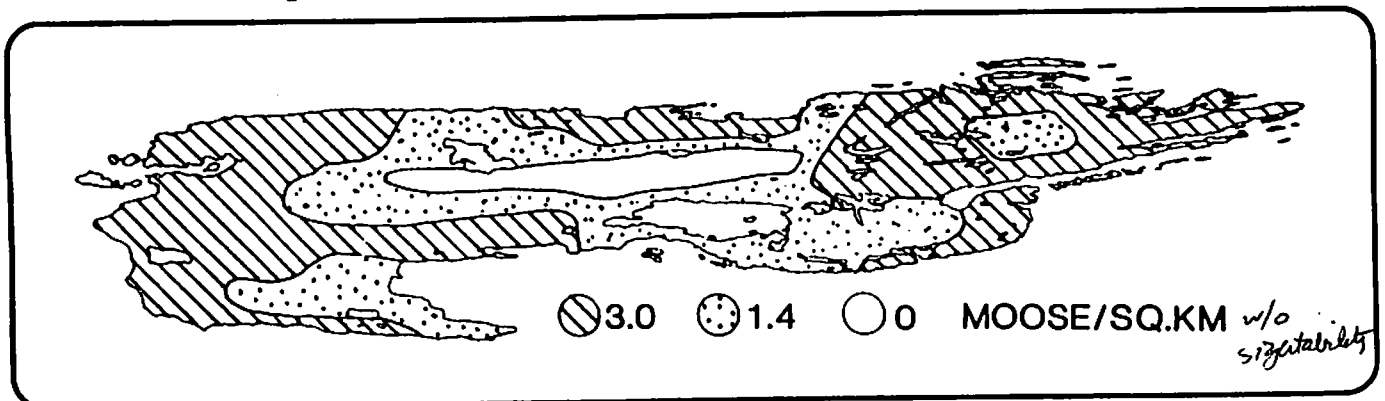


Fig. 9. Shifts in the age structure of the Isle Royale moose population are evident from annual recoveries of dead animals. Number of moose in each age group recovered each year is depicted in (A), while details of the surface contour plane are provided in (B). Annual cohorts can be followed along diagonal lines in both figures. Historical shifts in age structure are clearly illustrated by coincidence of surface contours and diagonal lines in (B).

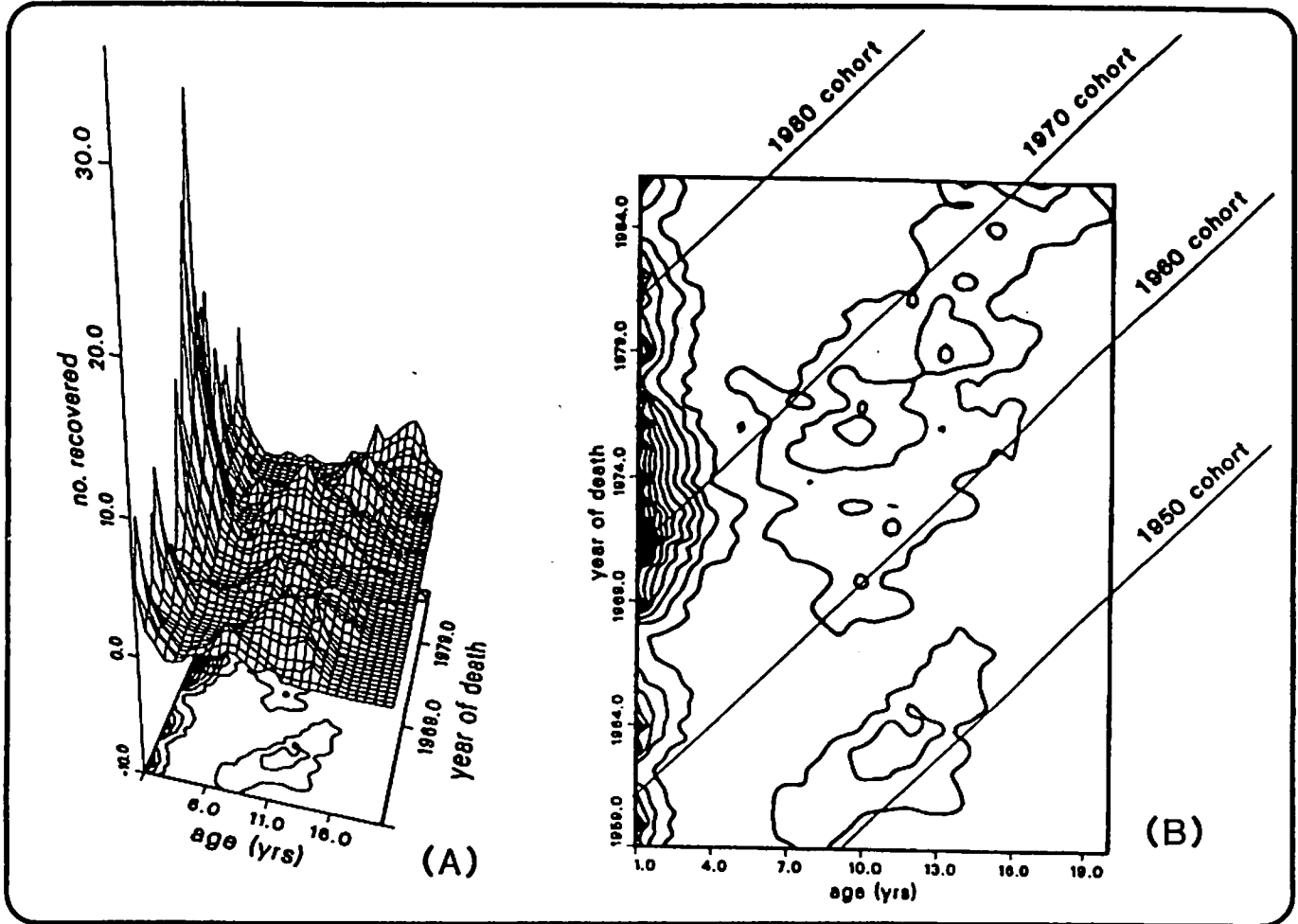


Figure 10. Three-level trophic interactions on Isle Royale.

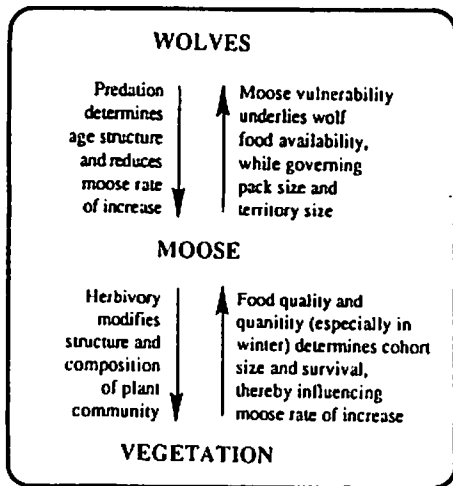


Fig. 11. Moose mortality rates in winter, 1974-1988.

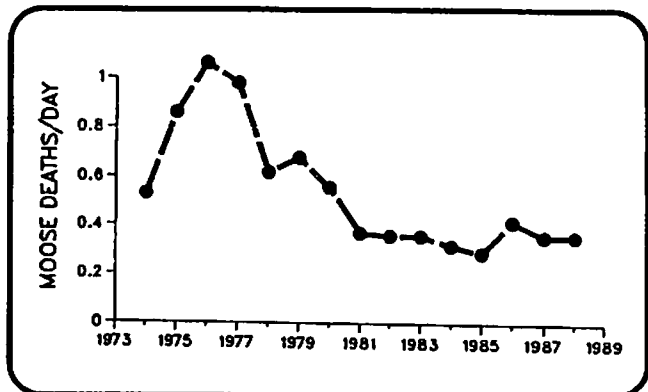
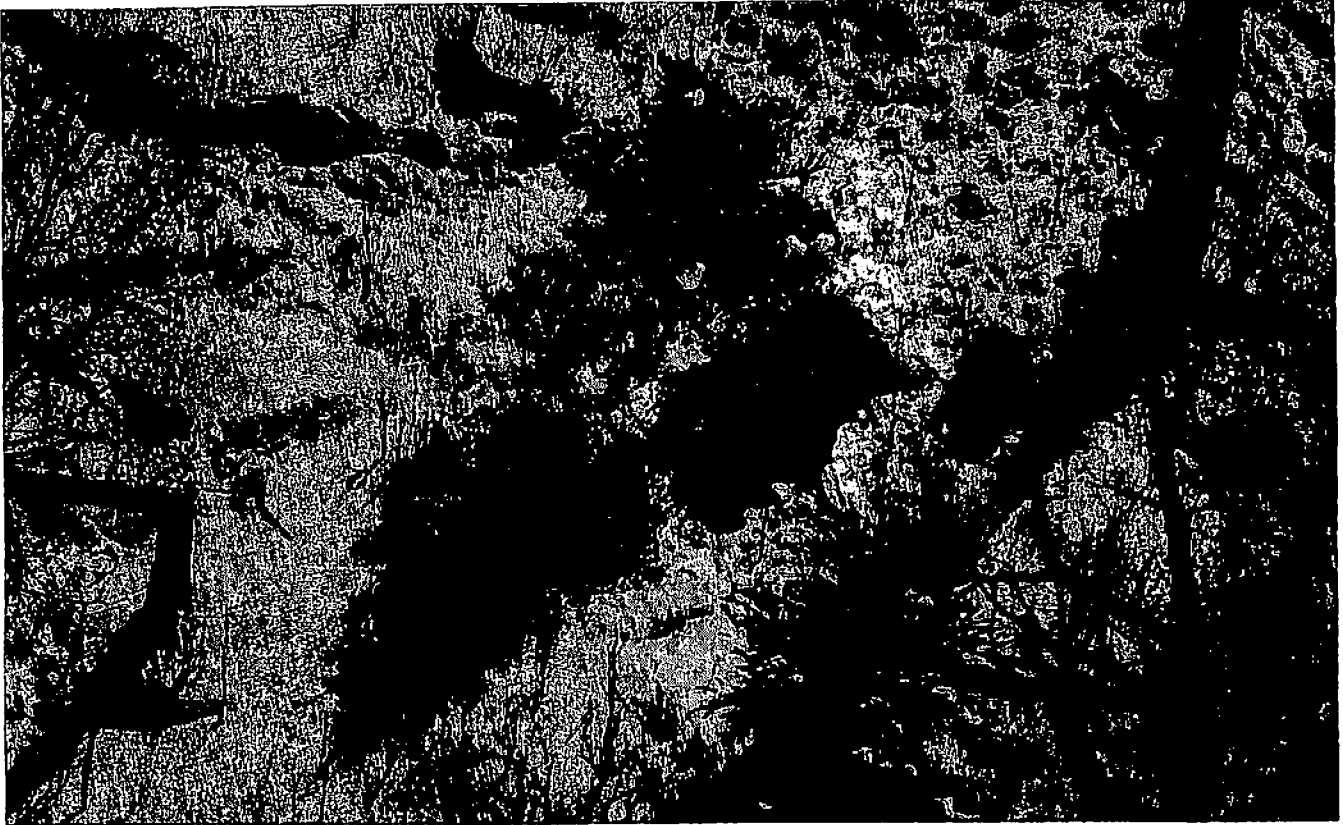


Fig. 12. West Pack alpha female resting near freshly-killed moose which had been wounded several days earlier.



the radiocollared cows in 31 moose-years. This is approximately the same as average calf production for the population during this time (about 30/100 cows).

Weather, Snow and Ice Conditions

After the unusually warm and dry winter study of 1987, we were happy to see a relatively "normal" winter pattern of snow and cold in 1988. Snow depths ranged from 40 to 70 cm and temperatures were well below the freezing mark until late in February (Fig. 16). Thereafter surface crusts formed on the snow cover, and by the end of the study period wolves began to travel unimpeded through the island's interior when the "freeze-thaw" crusts were frozen at night.

Other Wildlife Species

The most obvious change in animal abundance during the past year was an impressive increase in snowshoe hares in virtually all parts of the island (Fig. 17). The number of hares observed per km hiked in summer was the highest documented since 1973, when we began recording observations. In winter hare sign was abundant in non-coniferous habitats, instead of being confined as usual to thick cover in cedar and spruce forests.

The distribution of red fox tracks and aerial observations in winter, 1988, suggested that foxes were primarily occupied with hunting hares. Relatively few were seen on moose carcasses, probably because the carcasses themselves were sparsely distributed. Fox observations in winter were higher in 1988 than in recent years (Fig. 18).

Isle Royale supported a slowly increasing population of large raptors in 1987, apparently in slow recovery in the Lake Superior area. One pair of bald eagles and two pairs of ospreys (probably for the first time since the 1960s) nested on Isle Royale in 1987. On the south side of Lake Superior in Michigan (although not in Wisconsin), reports indicate that the number of eaglets/nest along the lake was comparable to those further inland, signaling reduced pesticide intake for at least some Lake Superior eagles. The National Park Service introduced and successfully fledged 5 peregrine falcons on Isle Royale in 1987, and plans to introduce 5-10 more in 1988 and 1989.

We anticipate that Phil Shelton will again conduct an aerial count of beaver colonies on Isle Royale in 1988. The population has been increasing steadily throughout the current decade.

Fig. 13. Severe impaction that may have developed from periodontal disease in wolf-killed moose.

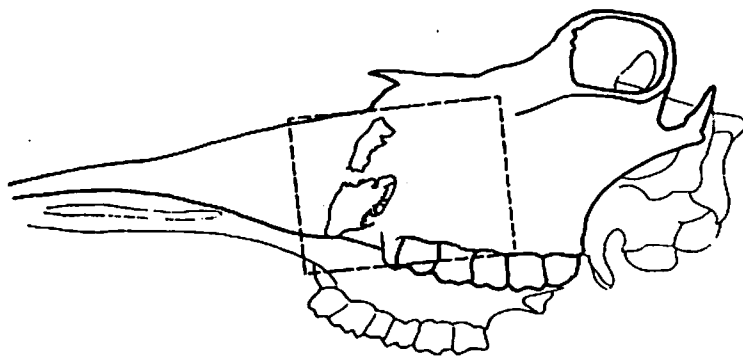
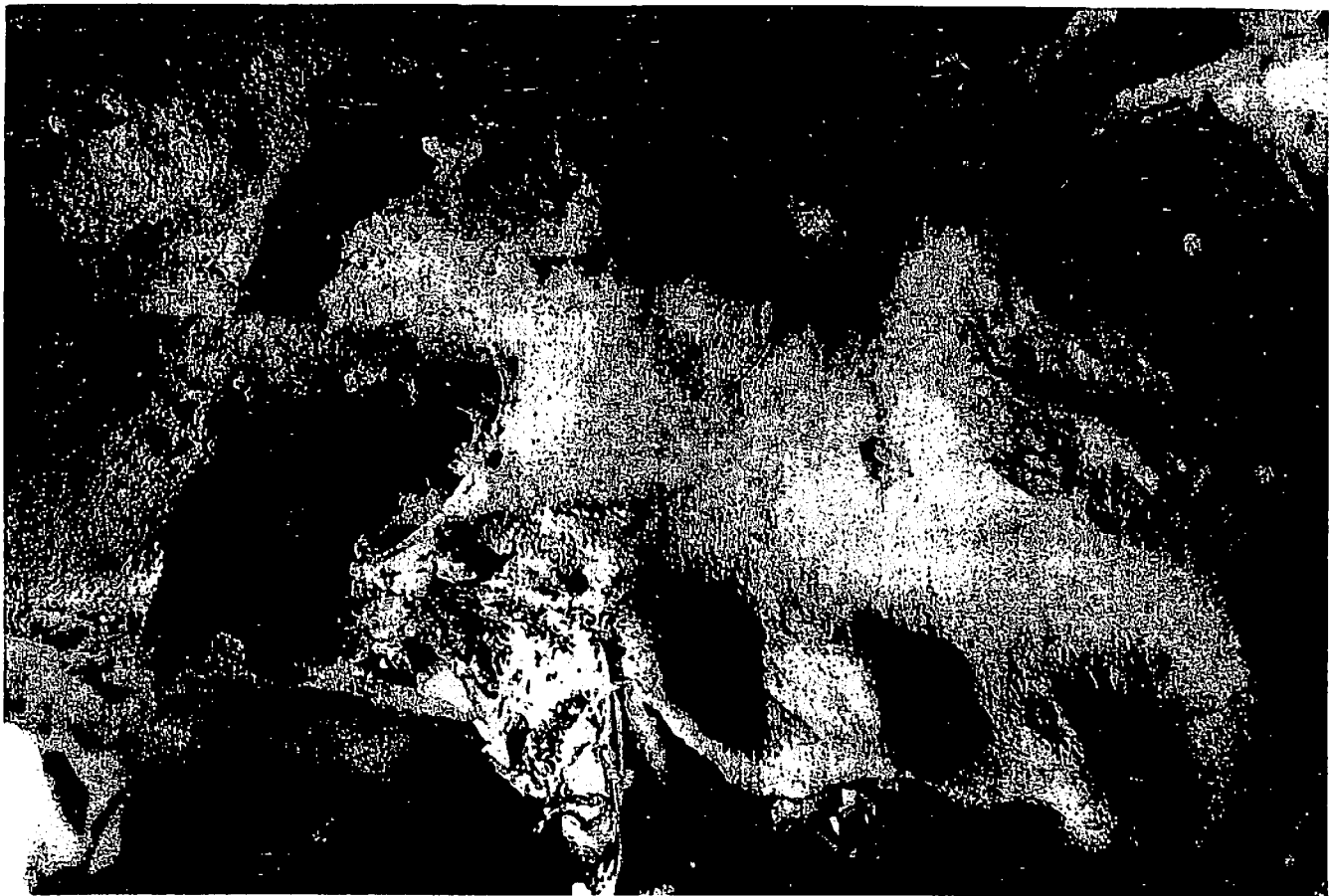


Fig. 14. Bone marrow fat levels in dead moose, 1988. Open circles represent calf moose, closed circles from older moose.

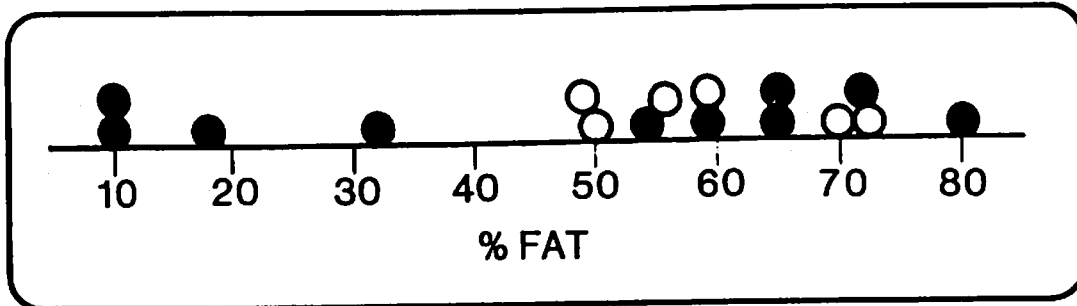


Fig. 15. Moose hair loss attributed to winter ticks. The warm, dry spring and summer of 1987 may have contributed to high tick abundance in 1988.



Table 2. List of moose radiocollared on Isle Royale. "+" signifies calf alive at the age of 9 months, while "-" indicates no 9-month offspring at heel.

Moose ID	Year of Offspring Births				
	1983	1984	1985	1986	1987
141		++	-	+	+
270		-	-	-	
320		-	+	-	-
630		-	+	+	-
981	++	-	+	-	-
1140		+	-	-	
1530		-			
1540		+	+	-	+
1641		-	-	-	-

Fig. 16. Temperature extremes and snow depth during 1988 winter study.

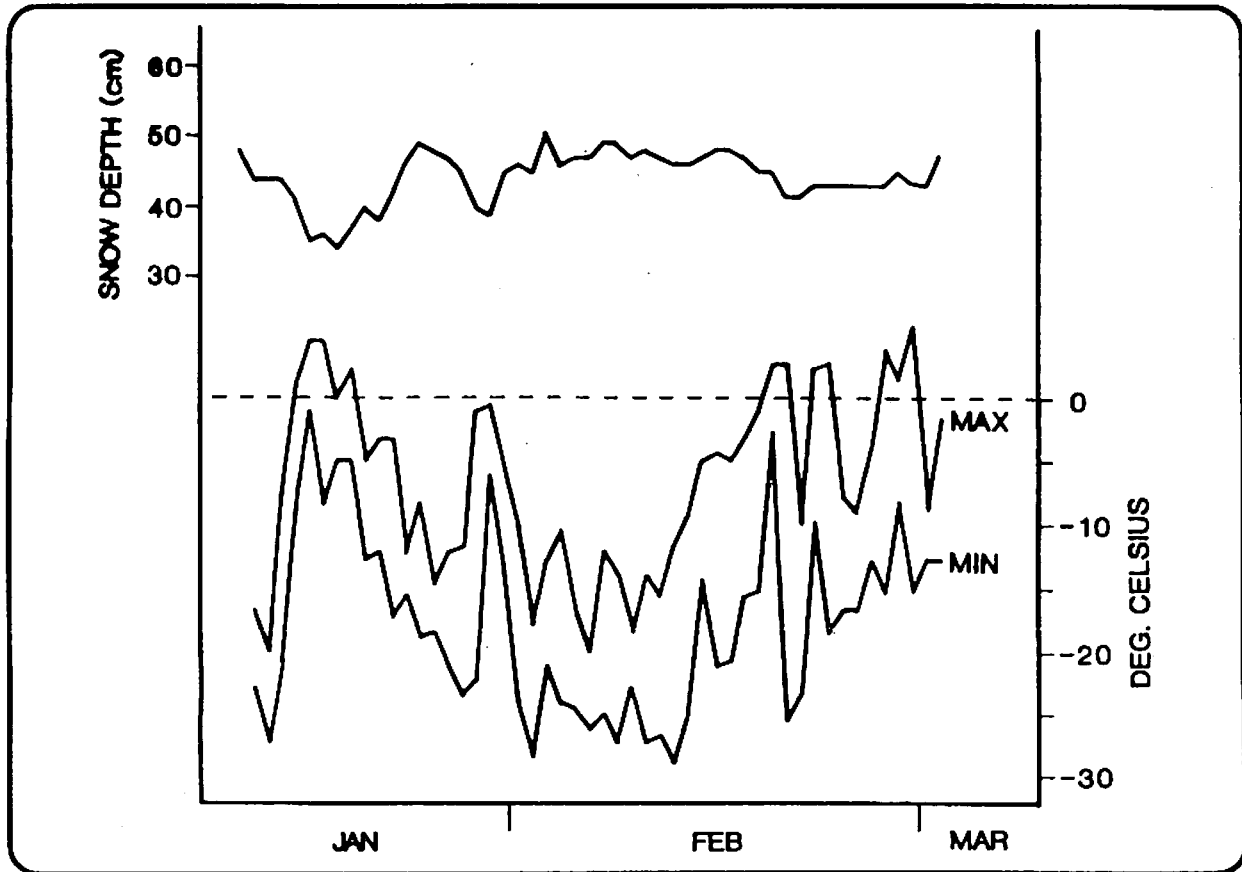
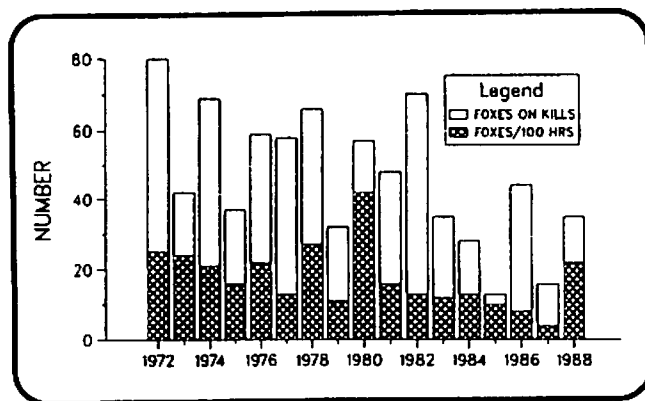
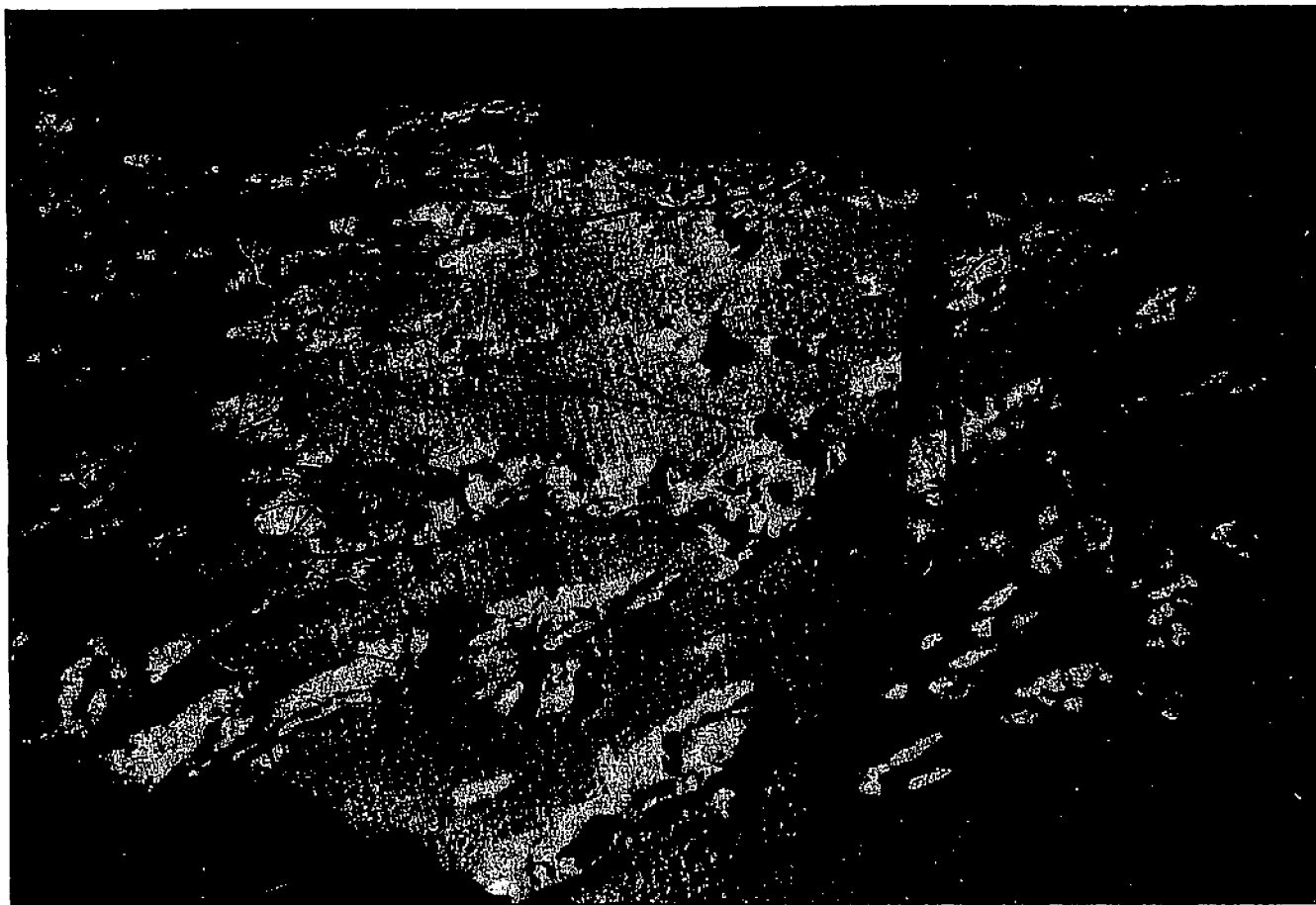
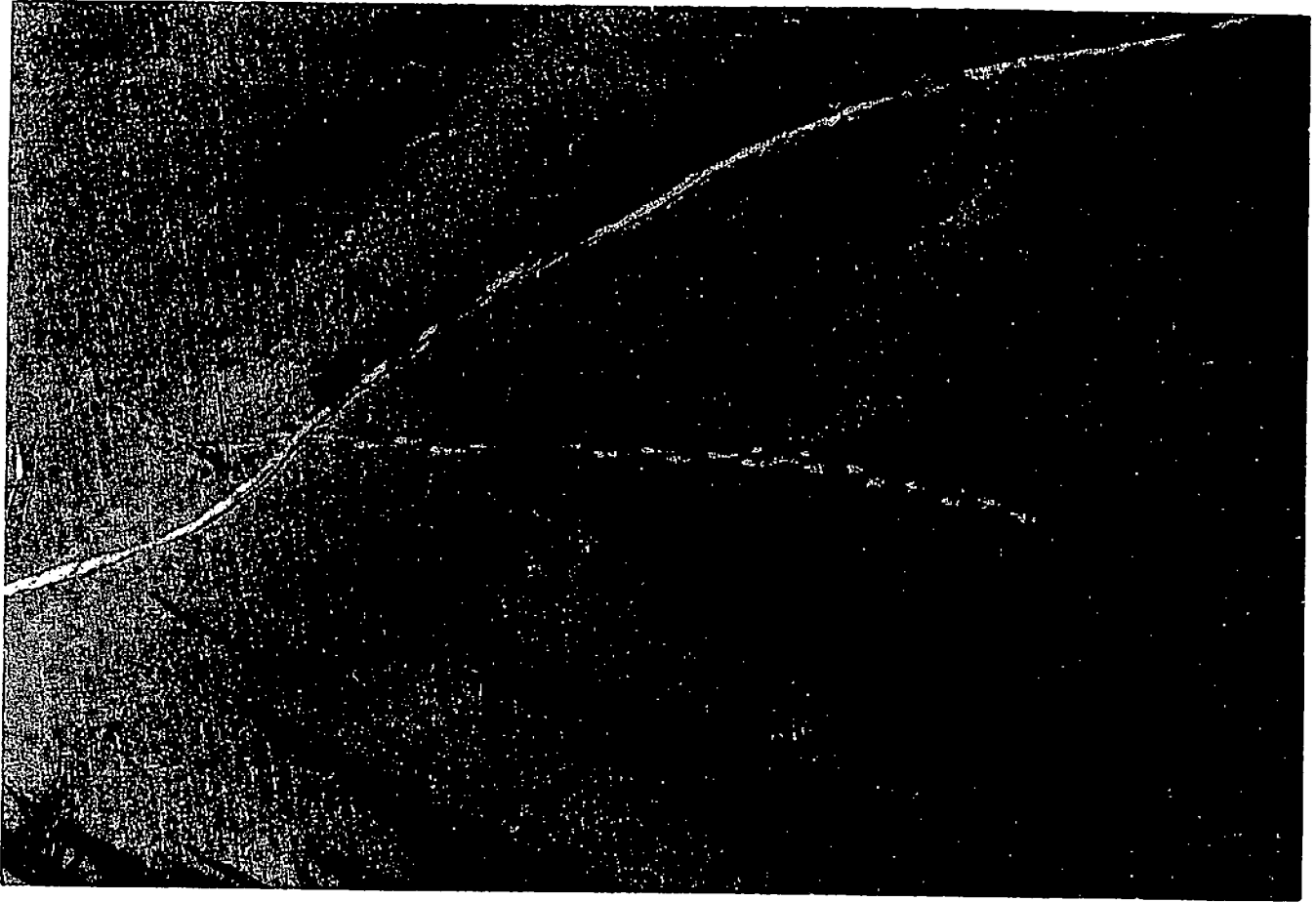


Fig. 17. Snowshoe hare tracks at Daisy Farm. Snowshoe hare numbers may have increased in 1987-88 because of the exceptionally mild winter in 1986-87.





West Pack II traveling, 1988