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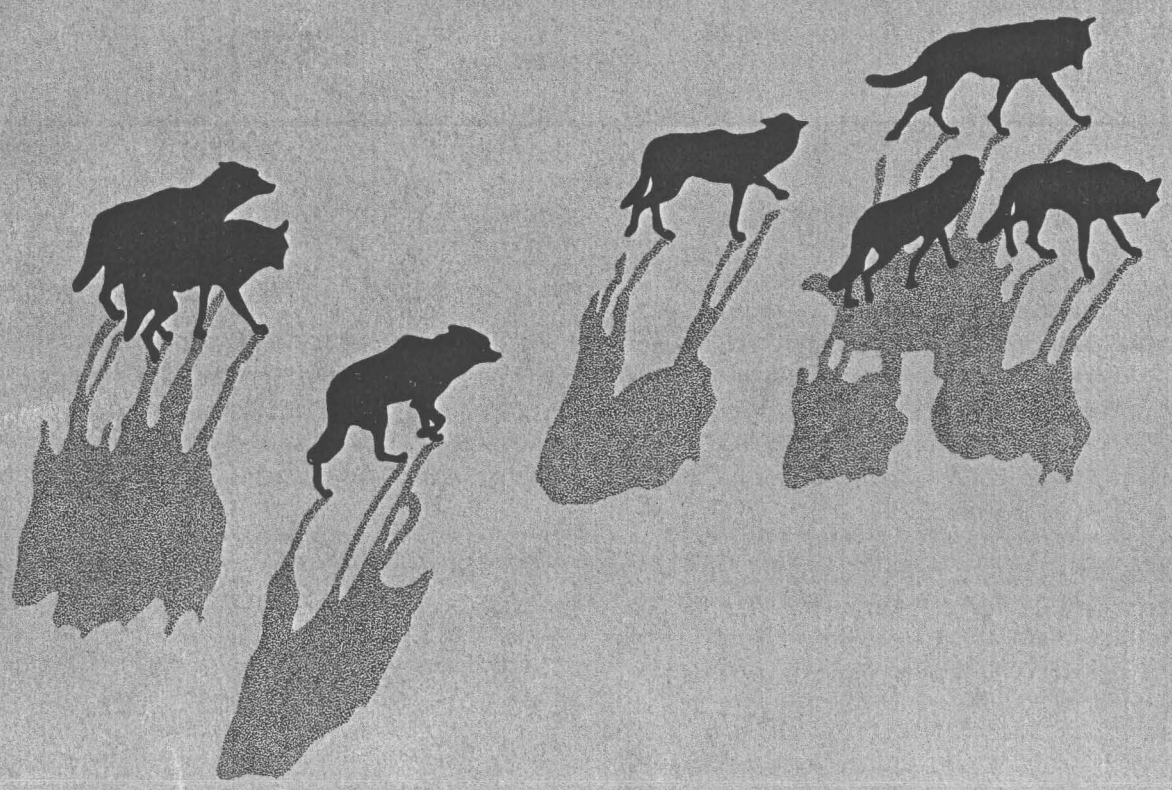
ECOLOGICAL STUDIES OF WOLVES ON ISLE ROYALE

ANNUAL REPORT

1986-87



Ecological Studies of Wolves on Isle Royale*

Annual Report—1986-1987

(Covering the twenty-ninth year of research)

by

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31 March 1987

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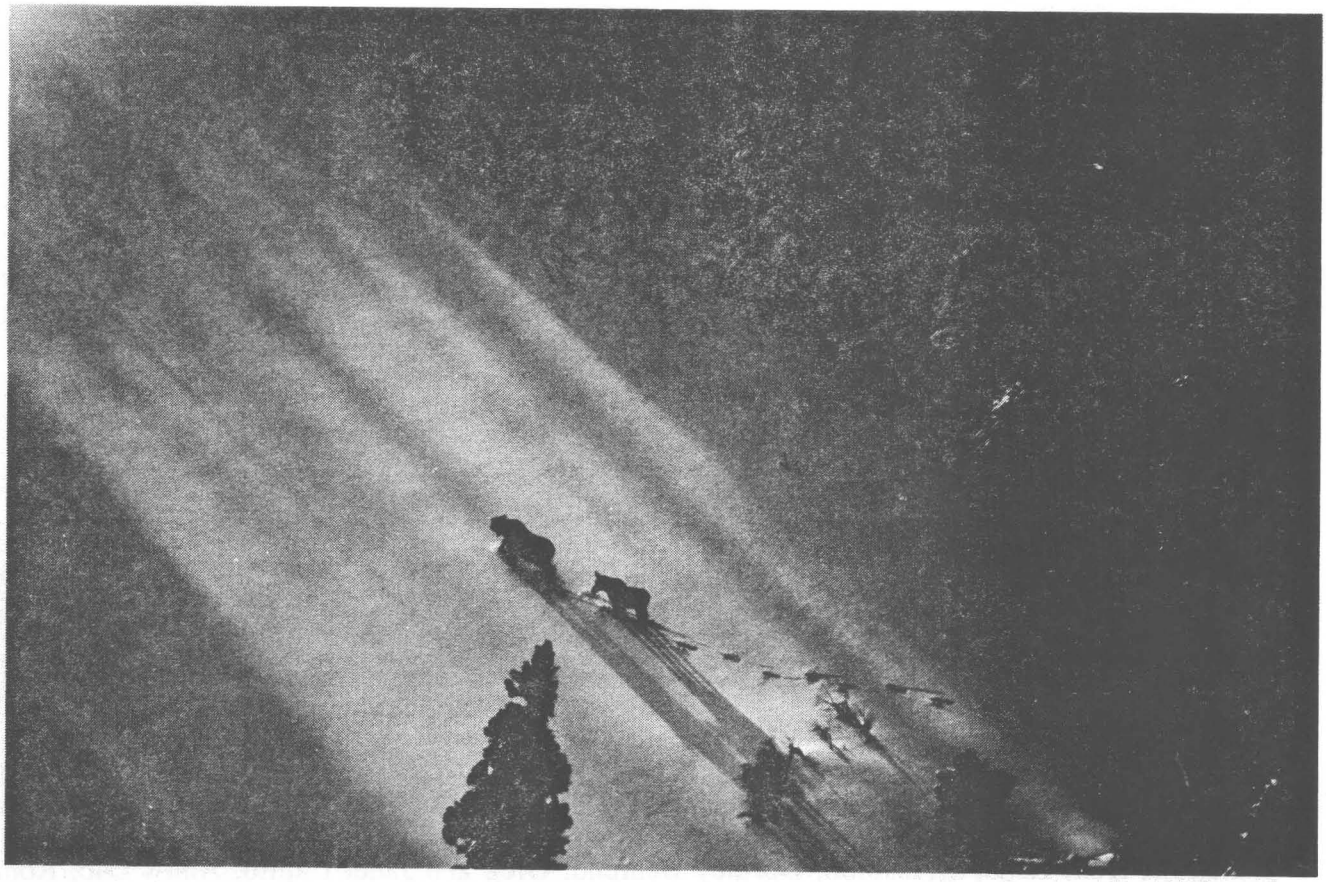


Cow and calf with shadows

Summary

Wolves declined while moose and beaver increased during 1986-87, the 29th consecutive year of research into wolf-moose dynamics at Isle Royale. We have hypothesized that this predator-prey system is slowly cycling on a very long time scale, with population peaks approximately every 3 decades (Fig. 1). According to this hypothesis, wolves are expected to remain stable at a relatively low level through the 1980s, while moose steadily increase.

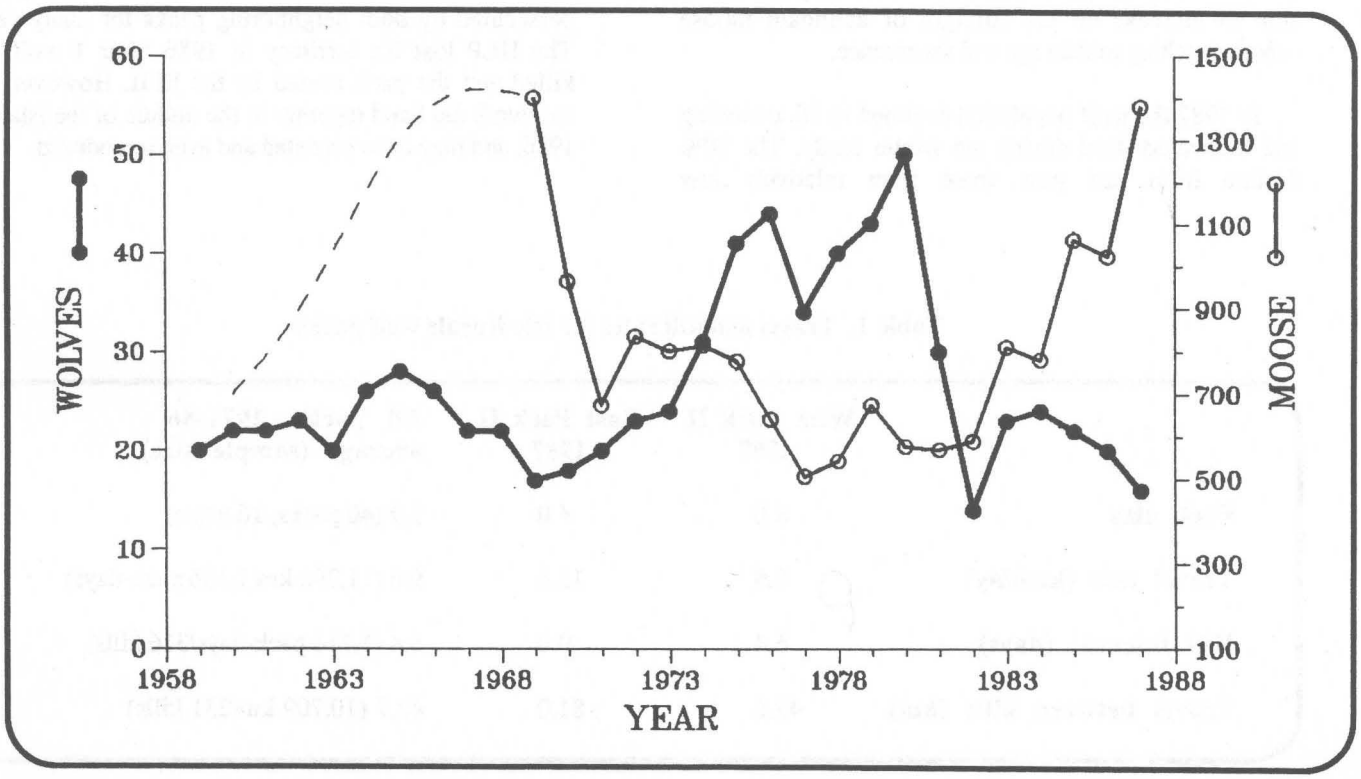
Wolf numbers stood at only 16 in 1987, the second lowest total documented for this population. Mortality rate for the wolves present last year was 40-45%, very high for a protected wolf population. The nature of this mortality is unknown, but low kill rate, extensive trespassing and continued interpack conflict all point to a chronically low food supply. We expect that the current food shortage will continue until the end of the 1980s, when abundant cohorts of moose born since 1981 will begin to attain middle age and hence be more vulnerable to wolves.

Only two wolf packs persisted through the 1987 study. The East Pack II (EPII) enlarged it's territory considerably to about half of the land area of Isle Royale. Researchers witnessed an attack by the EPII on a group of 3 wolves, apparently a remnant of the Harvey Lake Pack (HLP). The alpha male in the latter group was killed and the two surviving wolves were dispersed.

The moose population was estimated at 1380 ± 204 (95% confidence interval), suggesting a substantial increase over last year. Calf recruitment in 1986 was strong, especially on the eastern half of the island where wolf density has plummeted within the last 2 years. Overall, moose mortality is low, and malnutrition remains a significant source of mortality for very old moose.

Radio-collared moose were used in 1987 to continue an assessment of moose "sightability" on census plots, or the proportion of moose seen and counted on plots. After moose have moved into conifer cover and midwinter distribution has stabilized, 75% of the moose on plots can be detected from circling fixed-wing aircraft. Radio-collared moose exhibited a wide range of movement types—some showed year-round fidelity to small areas, while others migrated from one end of the island to the other.

Figure 1. Wolf and moose population fluctuations, Isle Royale National Park, 1959-1987.



Personnel and Logistics

Summer field work at Isle Royale during 1986 extended from June through August. Most of the findings reported here resulted from a winter study which extended from 22 January through 11 March 1987, when light aircraft were used to census and observe the island's wolves and moose. Donald E. Glaser again piloted his Super-Cub superbly throughout the winter study period.

Four graduate students progressed toward completion of their research and theses during the past year:

Richard Page, Ph.D. student, wolf-moose dynamics (1988 completion);
Kenneth Risenhoover, Ph.D. student, moose foraging behavior in winter (spring 1987 completion);
Timothy Ackerman, M.S. student, response of moose to summer heat stress (spring 1987 completion);
Thomas Brandner, M.S. student, moose-balsam fir interaction (spring 1986 completion).

During the past year valuable assistance in the field was provided by the following individuals:

Douglas Smith, Summer 1986
Kim Trostel, Winter 1987

The following National Park Service personnel assisted on the island during the winter study: Andy Anderson, Stu Croll, Bob Krumenaker, Bob Nobles, Bruce Reed, and Gregg Yarrow. NPS staff at Isle Royale National Park in Houghton and Grand Portage National Monument in Grand Marais, Minnesota, provided logistic support. Supply flights to the island were flown by the Ely Aviation Unit, Superior National Forest, U.S. Forest Service. Thanks and appreciation are extended to all of the above for these many and varied contributions.

The Wolf Population, 1986-87

The size of the Isle Royale wolf population has generally followed trends in food supply, or moose vulnerability. Presently the moose population consists primarily of young, vigorous individuals born since 1980. Because they are not readily killed, these moose currently provide little food for wolves in winter. We predict that the wolf population will remain stable at a low level through the 1980s, after which they should be able to increase on the strength of abundant moose cohorts reaching middle age and senescence.

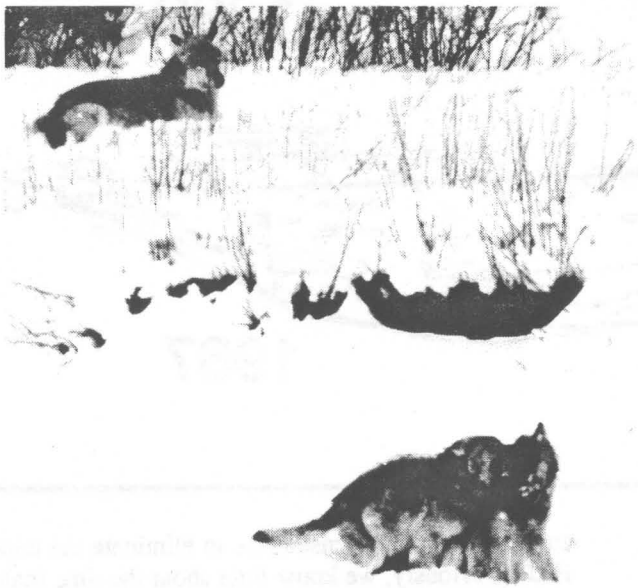
In 1987 the wolf population declined to 16, including one recovered dead during the winter study. The 20% decline from last year arose from relatively low reproduction coupled with high mortality. The West Pack II (WPII) declined from 11 to 8 wolves, even with 4 surviving pups, while the East Pack II (EPII) had no pups and declined from 5 to 4 (Table 1). An additional group of 3 wolves, consisting of an alpha pair and possibly one pup, were located early in the winter study in the middle of the island. This group appears to have been a remnant of the Harvey Lake Pack (HLP), persecuted by both neighboring packs for many years. The HLP lost it's territory in 1986 after 1 wolf was killed and the pack routed by the EPII. However, two survivors did band together in the middle of the island in 1986, and may have persisted and even reproduced.

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

	West Pack II 1987	East Pack II 1987	All packs, 1971-86 average (sample size)
Pack size	8.0	4.0	7.9 (40 packs, 16 years)
Travel rate (km/day)	8.5	12.6	9.6 (11,396 km/1,186 pack-days)
Kill interval (days)	6.4	9.0	5.4 (1,716 pack-days/316 kills)
Travel between kills (km)	42.6	81.0	42.7 (10,709 km/251 kills)

From changes in total population size and the number of pups present, survival rate can be determined for the wolves counted each winter. Included among the 16 wolves present in 1987 were four pups in the WPII and no more than 1 pup in the HLP. Pup identification is usually based on small size or behavioral cues, such as lack of sexual behavior, lack of incorporation into the pack dominance hierarchy, and/or exuberant play (Fig. 2). In 1987 WPII pups were small and showed typical pup behavior. The third wolf in the HLP could have been a pup but observations were infrequent and not conclusive. Thus 11-12 of the 20 wolves present in 1986 were still alive in 1987, implying a mortality rate of 40-45%. Although we have evidence of chronic food shortage for this wolf population, we have little knowledge of the causes of this high mortality rate.

Figure 2. Two pups in West Pack II play while their mother rests. Each year wolves at Isle Royale are closely observed from aircraft using a 15x gyro-stabilized monocular. Pups are identified by small size or behavioral cues (1986 photo).



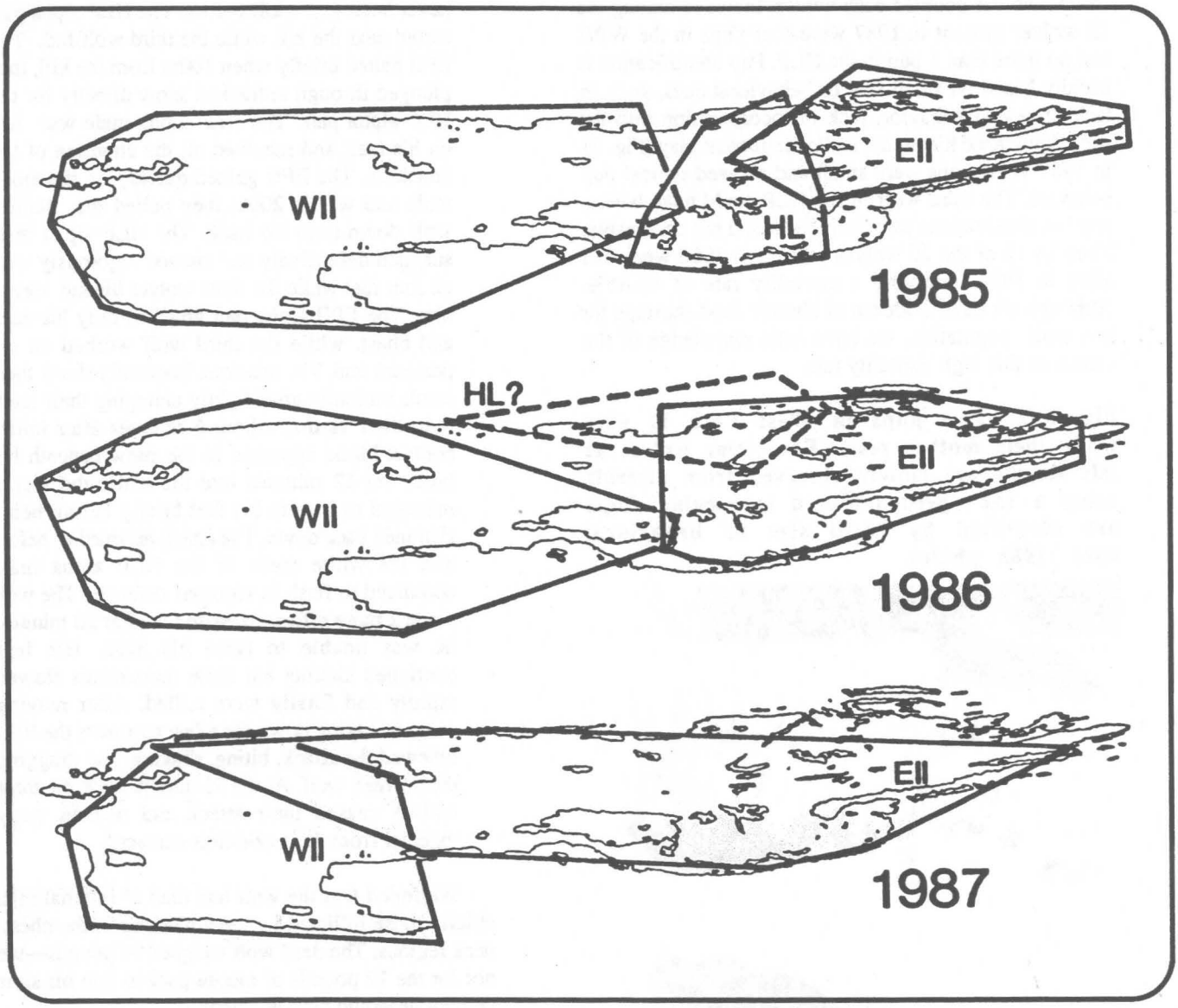
The wolf recovered dead in 1987 was the alpha male in the HLP, killed by 3 wolves from the EPII on 25 January. The fatal attack was witnessed in its entirety from the research aircraft by Glaser and Peterson:

> "The 3 wolves in the EPII were led by the alpha male as they followed a wolf trail toward the moose kill where the HLP rested. The EPII alpha male often stopped to wait for the alpha female, who greeted and excitedly rubbed sides with the alpha male. From the number of dead end trails explored, we judged that the EPII had never been to the kill before. The HLP alpha pair rested near the kill while the third wolf fed. The EPII halted briefly when 100m from the kill, then plunged through untracked snow directly for the HLP alpha pair. The HLP alpha male was last on his feet, and received all the attention of the attackers. The EPII gained quickly on the alpha male and within 200m they pulled the hapless wolf down onto his back. The HLP alpha male snapped defensively and shoved vigorously with all four feet while the three wolves bit and tore at him. The EPII alpha pair attacked only his neck and chest, while the third wolf worked on the posterior end. The attackers frequently shook their heads violently after tightly clamping their teeth onto their victim. About 5 minutes after initial contact blood appeared in the snow beneath his head, yet 12 minutes into the battle the victim managed to leap to his feet briefly before being slammed back down. The attack resumed as before and the white teeth of the HLP alpha male continued to flash in vigorous defense. The wolf made 2 more efforts to arise but after 20 minutes he was unable to raise his head. His legs continued kicking but these movements slowed rapidly and finally were stilled. After moving away and lying down for a few moments the EPII renewed the attack, biting, shaking, and dragging the downed wolf. At the 30 minute mark the three wolves ceased their attack and walked away together from the motionless carcass."

We found that the wolf had died of internal injuries, chiefly those inflicted by the alpha pair in the chest and neck regions. The dead wolf weighed 94 pounds—were it not for the 12 pounds of moose packed into his stomach perhaps he would have escaped!

The surviving alpha female was seen alone the day after the attack, scent-marking and apparently trying to find her associates. Days later she was seen with the other survivor, and for the remainder of the winter study they usually remained, often together, in the territory of the WPII. For almost two weeks following the attack the EPII traveled back and forth across the island in trails left by the 2 HLP survivors. During this time the EPII made 2 overnight "raids" into WPII territory, each time killing a moose, feeding, and returning to the middle of the island by early the next day. The expansionist tendencies of the EPII were matched by a reciprocal reduction in the territory claimed by the WPII, which in 1987 greatly reduced the range of its travels (Fig. 3). Lake Desor, heavily scent-marked by both packs, appeared to be the dividing line between the two groups. At different times

Figure 3. Isle Royale wolf pack territories indicated by movements, 1985-1987. EII = East Pack II, WII = West Pack II, and HL = Harvey Lake Pack.



on 28 January wolves from all three social groups (EPII, WPII, and the fugitives from the HLP) were found on Lake Desor, yet no further direct contact between packs was detected during the winter study.

Travel and kill rates of EPII and WPII in 1987 were comparable to those observed in recent years (Table 1). Daily travel for the EPII, actively patrolling and expanding its territory, was 50% higher than that of the WPII. It is evident that wolf food supply has been stable at a low level throughout the 1980s (Fig.4), a period marked by frequent interpack conflict and occasional killing. While the aggressive behavior of the EPII in 1987 was unusual, it was not a response to an abrupt decline in food availability. Perhaps it was a unique manifestation of chronic food stress for the EPII, which culminated in an intense drive to eliminate the adjacent HLP. Obviously, we know little about the time scale for wolf behavioral responses to chronic food shortage.

Lack of shoreline ice caused a preponderance of wolf-killed moose in the island's interior, primarily in the southwestern half where both packs concentrated their activities (Fig. 5). With the virtual disappearance of the HLP and the expansion of the EPII toward the southwest, wolf density on the eastern end of the island has been reduced considerably in the last two years.

Three mature females existed within the 1987 population, but we expect that only two are likely to reproduce this year. The EPII alpha female exhibited vaginal bleeding during 10-17 February and tracks

Figure 4. Wolf food supply on Isle Royale, 1971-87.

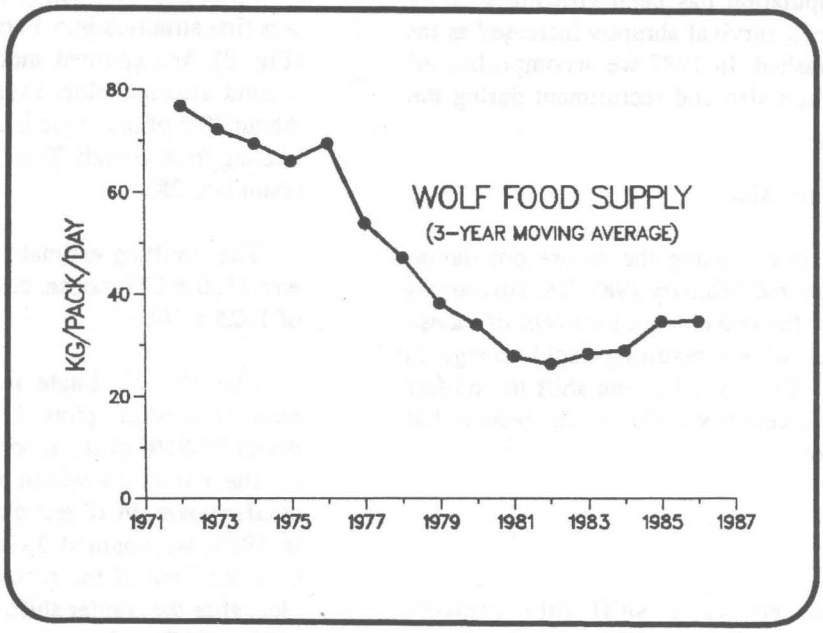
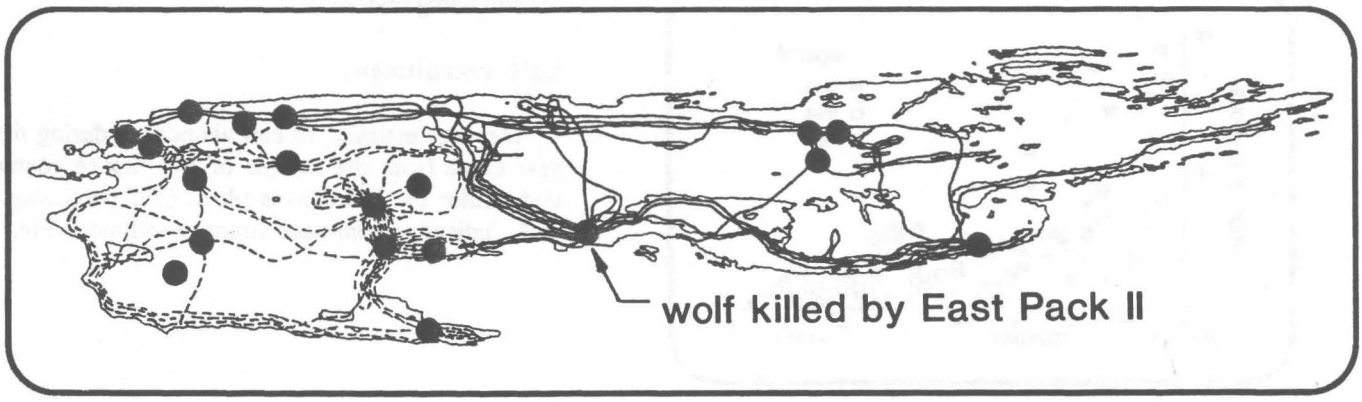


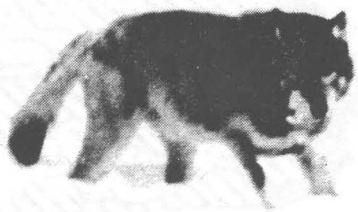
Figure 5. Distribution of travels and kills for the East Pack II and West Pack II in 1987.



suggested that she mated on 12 February. In 1987 the WPII had a new alpha female, but the alpha male in this pack has remained the same at least since 1982 (Fig. 6). The WPII alpha female showed estrous bleeding in early March, but when last seen on 3 March she was still strongly rejecting the courting alpha male.

A third mature female existed in the HLP when it was attacked by the EPII in late January. She and the alpha male showed mutual courtship behavior on the day he was killed. Thereafter, we saw no evidence that she attracted or even actively sought a new mate. We saw her once in the company of another loner, but they soon separated.

Figure 6. West Pack alpha male, identified since 1982 by eyes of different color.



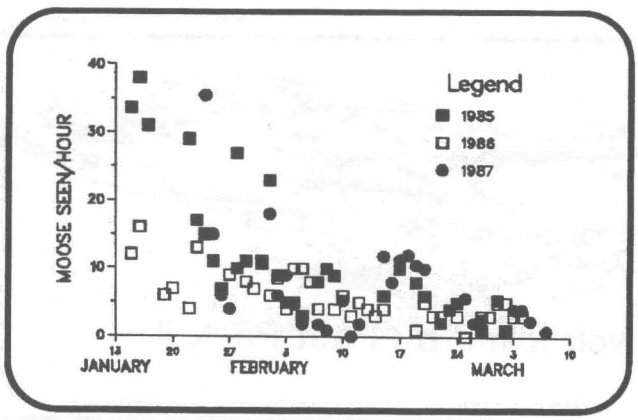
The Moose Population, 1986-87

The moose population has been growing steadily since 1981, when calf survival abruptly increased as the wolf population crashed. In 1987 we accomplished all surveys of population size and recruitment during the annual winter study.

Moose population size

We succeeded in censusing the moose population twice during January and February 1987. The first survey was confounded by the coincident movement of moose into conifer cover, with a resulting rapid change in moose sightability (Fig. 7). After the shift to conifers had occurred another census was flown, with reduced but constant sightability.

Figure 7. Moose regularly shift into coniferous cover in midwinter. This leads to a decline in moose sightability, the extent to which moose on census plots are actually seen and counted.



As in previous years, before each census the island was first stratified into 4 zones of relative moose density (Fig. 8). We counted moose on 100 plots during the second attempt, plots averaging about 1 km^2 in area. About 20% of the entire island was covered by intensive circling from aircraft. Total moose seen during the second count was 281.

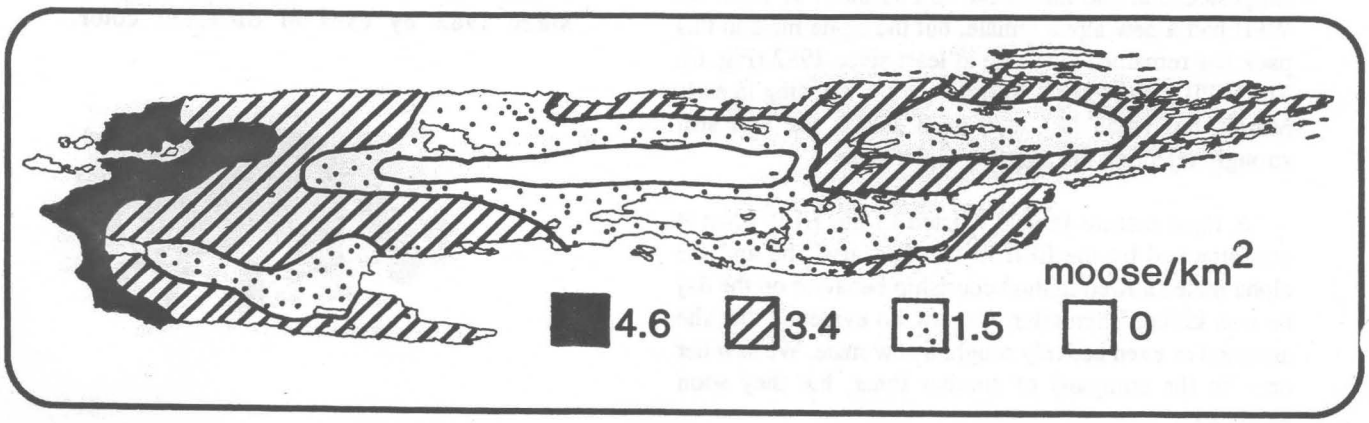
The resulting estimate and 95% confidence interval was 1380 ± 204 moose, compared to last year's estimate of 1025 ± 108.

The 1987 estimate incorporates a correction for moose missed on plots. Recent testing indicates that we detect 75-95% of the moose on census plots, depending on the extent to which moose have shifted toward conifer cover. In 18 test plots over radio-collared moose in 1987, we counted 78% of the moose. In 1986 we detected 75% of the moose on a larger sample of test plots after the conifer shift, so this correction was used in 1987. If 95% of the moose were observed during the first census, the resulting estimate is identical to that of the second census. Moose estimates shown in Fig. 1 for 1969, 1986, and 1987 have been corrected to reflect an estimated 75% sightability; data from intervening years are still being reviewed.

Calf recruitment

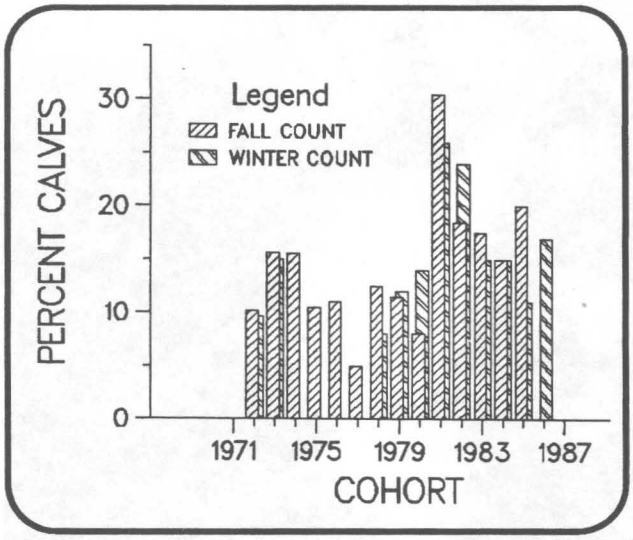
Our best estimate of calf abundance during the past year came from the sample of 477 moose counted in mid-winter on 156 census plots. Calf percentage was 18%, indicating continued strong recruitment (Fig. 9).

Figure 8. Moose distribution during the 1987 midwinter moose census.



Twelve different sets of twin moose calves were observed during the 1987 winter study, an all-time high (only 3 sets were seen in winter during the entire decade of the 1970s). Eight of these twin pairs were found on the eastern half of the island, where wolf activity has declined abruptly, suggesting a substantial release from predation pressure.

Figure 9. Moose calf percentage on Isle Royale for cohorts born between 1972 and 1986.



Moose mortality

Snow cover on Isle Royale (required for locating dead moose) was complete for barely the length of the winter study, but we succeeded in determining total mortality for 45 days beginning on 20 January. Sixteen moose died during this time, about one every three days (Fig. 10). Thirteen moose were killed by wolves, two died directly from malnutrition, and one died after falling off a cliff. Two of the wolf-killed moose survived for many days after being wounded by wolves. One was finally killed by the WPII 15 days after their initial attack, and the other died on its own 8 days after being wounded by the EPII (Fig. 11).

We examined remains of 18 moose on the ground during the winter study, and found that most mortality involved very old moose. Wolves have not yet been able to exploit the vigorous young moose that comprise most of the current population. Five calves, one yearling, and one young adult were killed, but all other moose that died were middle-aged or older, similar to the 1986 pattern (Fig. 12). In 1987 all but one of these older moose exhibited arthritis or periodontitis. One had a broken leg that was in slow repair (Fig. 13).

Radio-collared moose

Radio-collars on 13 moose continued to transmit at the end of the 1987 winter study. Most were instrumented in 1984 and have served as the focus of intensive studies of moose foraging behavior during 1984-86. Some of these moose exhibited distinct migrations that included much of the length of the island, but most had year-round home ranges centered at the southwest end, where they were captured (Fig. 14). Winter home ranges for most moose were on the order of 15 km^2, or about 3% of the island area, while summer movements were more extensive. Intensive field studies of radio-collared moose in summer and winter have now been concluded, and data analysis and writing will continue through 1987 (and beyond).

Seven radio-collared moose have died during the past 3 seasons. Surprisingly, only one was killed by wolves. Two bulls died during the fall rutting period, and the remainder appeared to have died of malnutrition between December and April (Fig. 15). The radio-collared moose included a high proportion of very old moose, and this age group is most susceptible to malnutrition mortality.

Radio-collared cow moose have shown a very clear pattern of every-other-year reproduction, at least for surviving offspring. Two of the eight cows produced no surviving offspring at all in a three-year period, and the remaining six successfully raised 1-2 calves into winter only every other year. In early June 1986 we made an effort to locate each cow to see if calves were produced at all in the "off" years. From this small sample of cows it appears that there may be a strong tendency to give birth to calves only every other year. Most cows have allowed their offspring to remain with them for 2 years.

Figure 10. Moose mortality in midwinter on Isle Royale has been relatively constant at a low level during the 1980s.

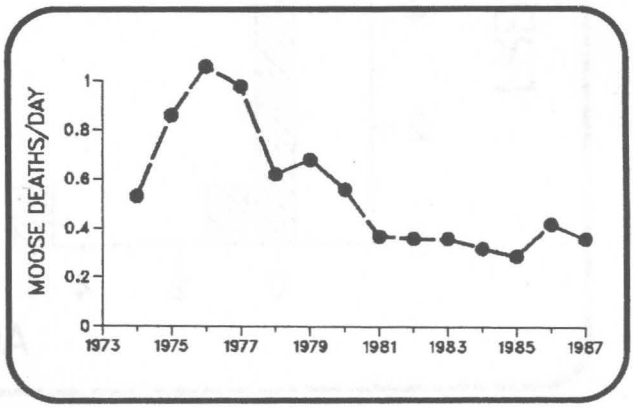


Figure 11. Cow moose stands quietly after an attack by 4 wolves in the East Pack II. She was extremely old and had arthritis in both hips, severely worn teeth, fat-depleted bone marrow, and a heavy infestation of winter ticks. She died 8 days after being wounded.

Figure 12. Age structure of moose dying during the 1986 winter study. Wolf predation accounted for 86% of this mortality.

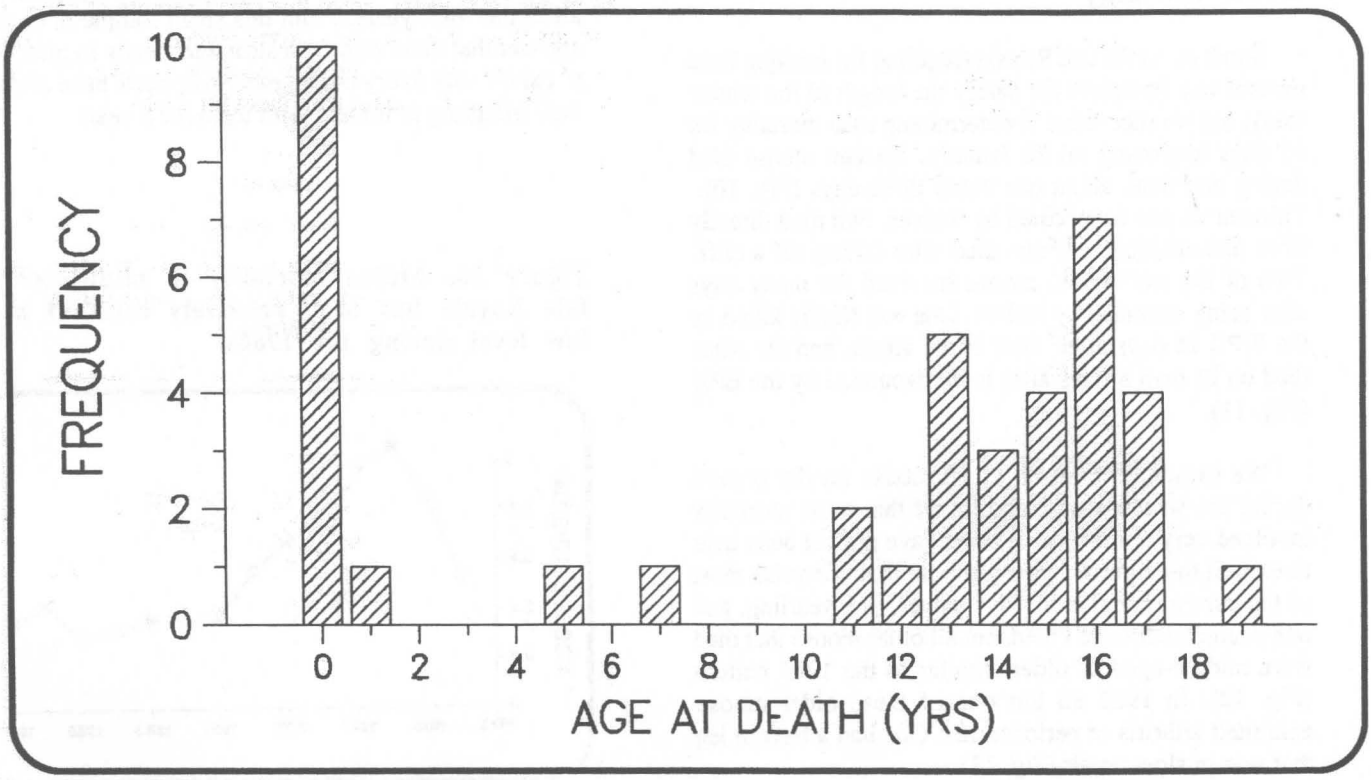


Figure 13. Remodeled femur (above) from moose #1882, killed by wolves in February 1987. The bone was broken completely in two places and subsequently set with new bone at a 90-degree angle. Normal bone appears below.

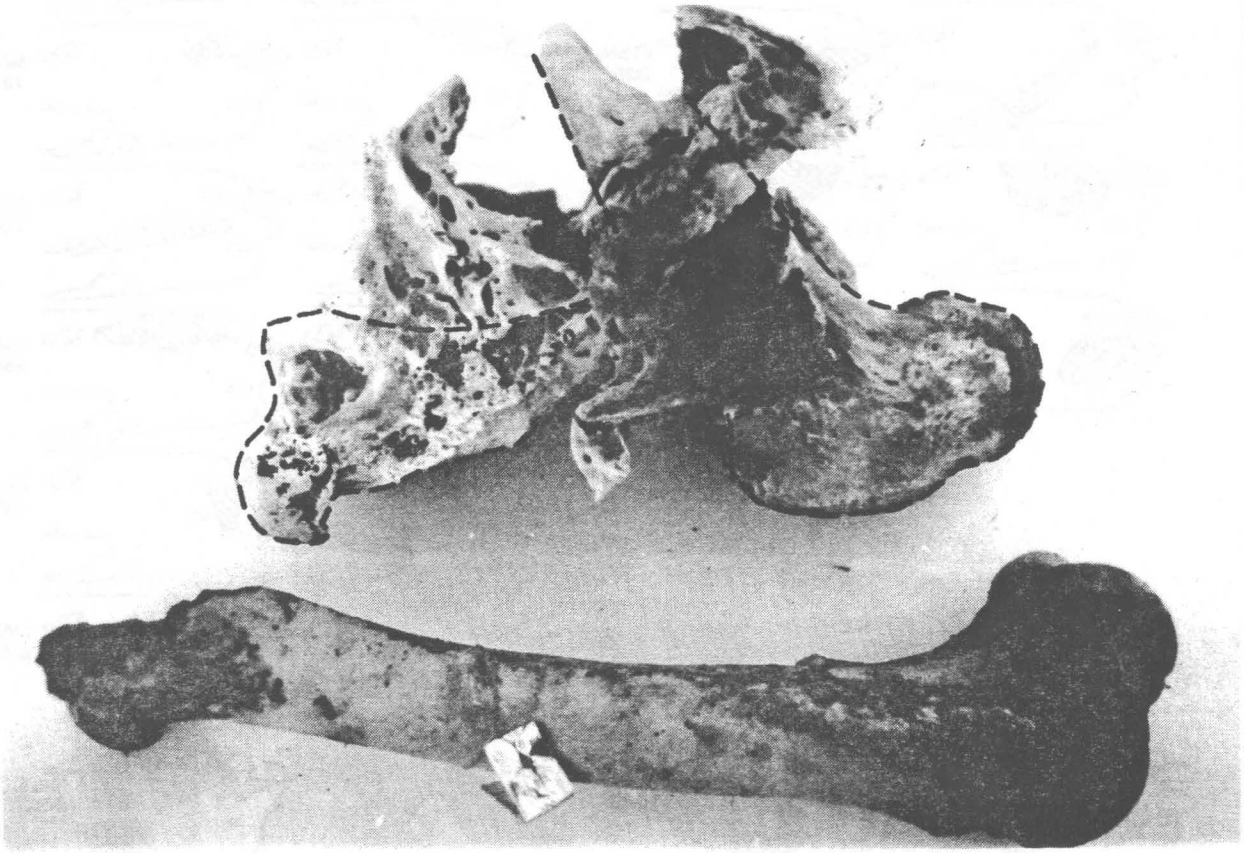


Figure 14. Summer and winter home range polygons for radio-collared moose over a two-year period.

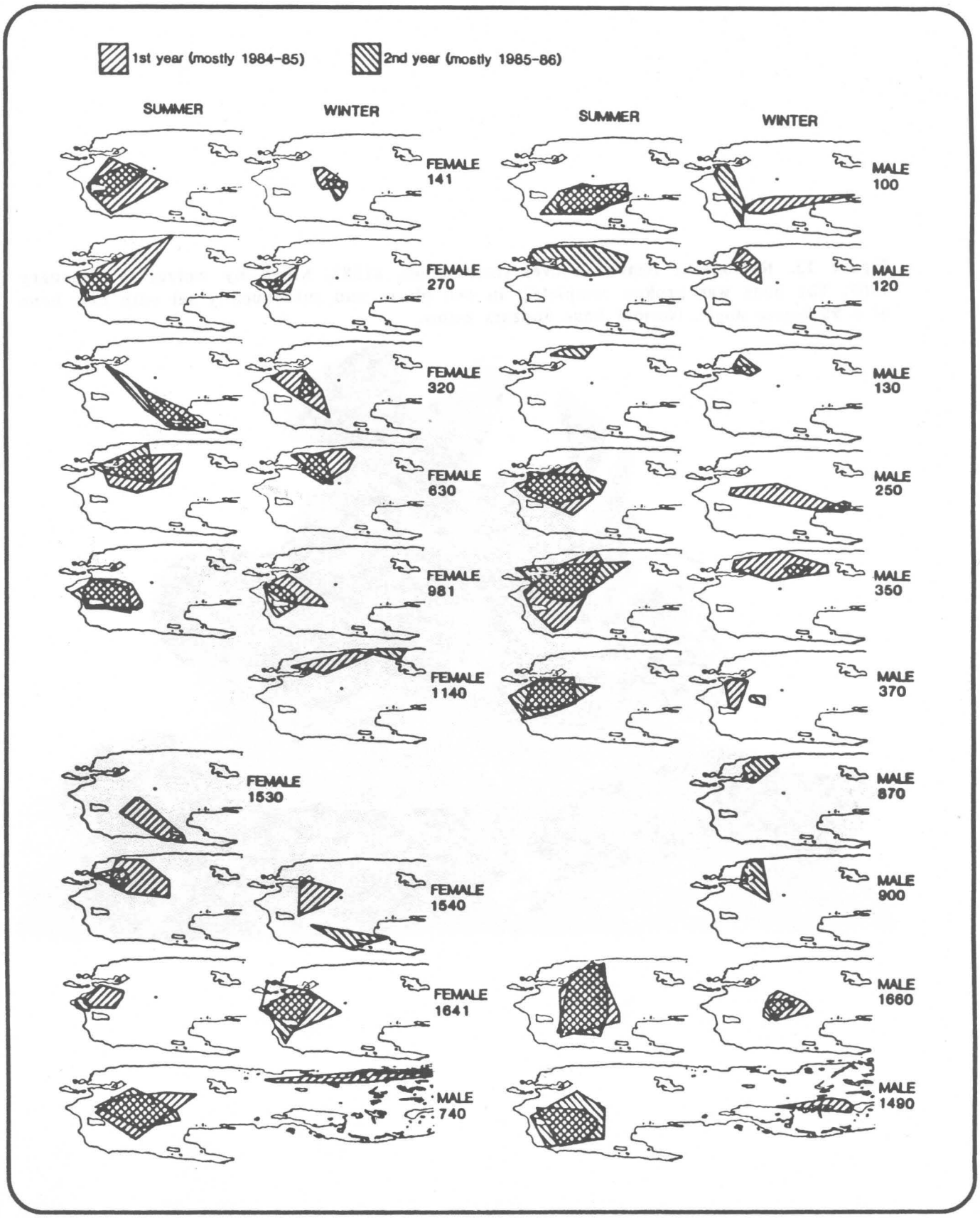
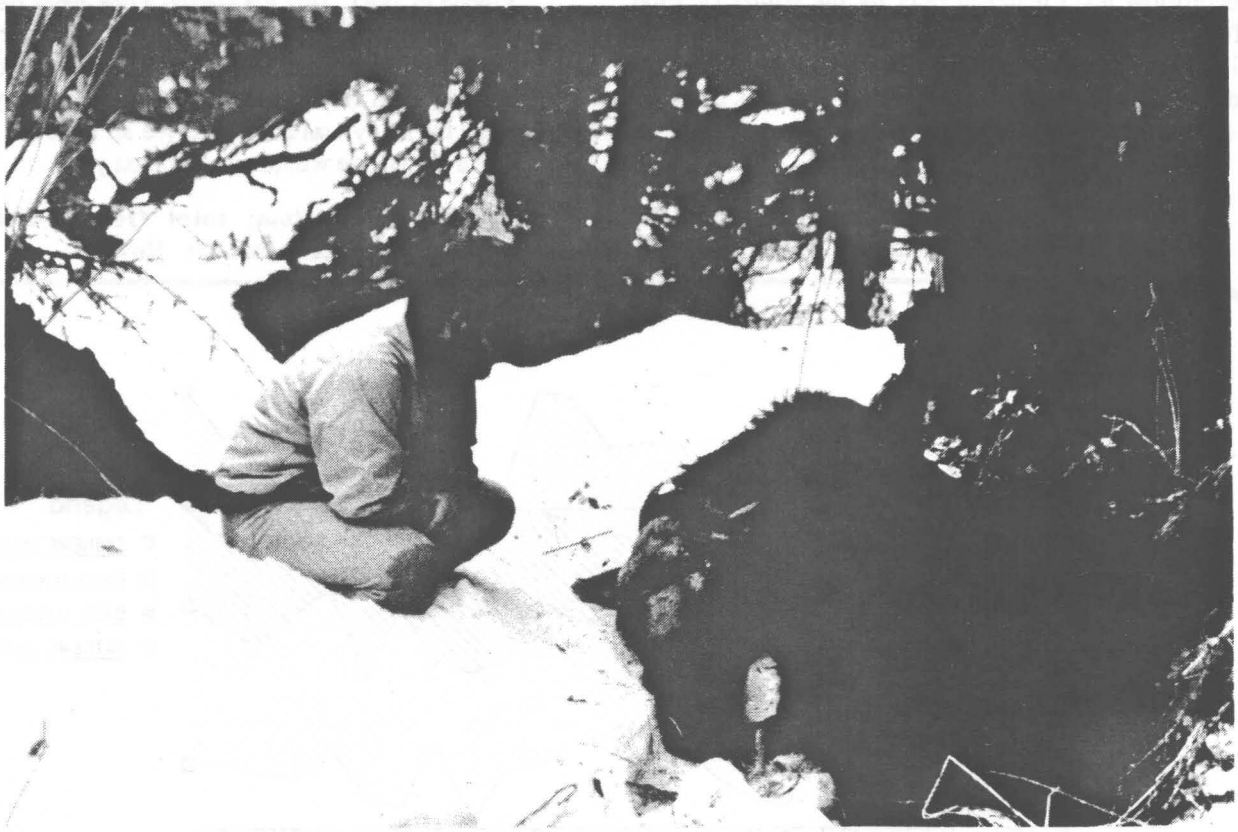


Figure 15. Mortality of radio-collared moose is readily detected. In the top photo, Ken Risenhoover inspects radio-collared moose 370 just after death from malnutrition in April 1986. Below, Kim Trostel and Don Glaser collect bones from moose 251, consumed but not killed by wolves in February 1987.

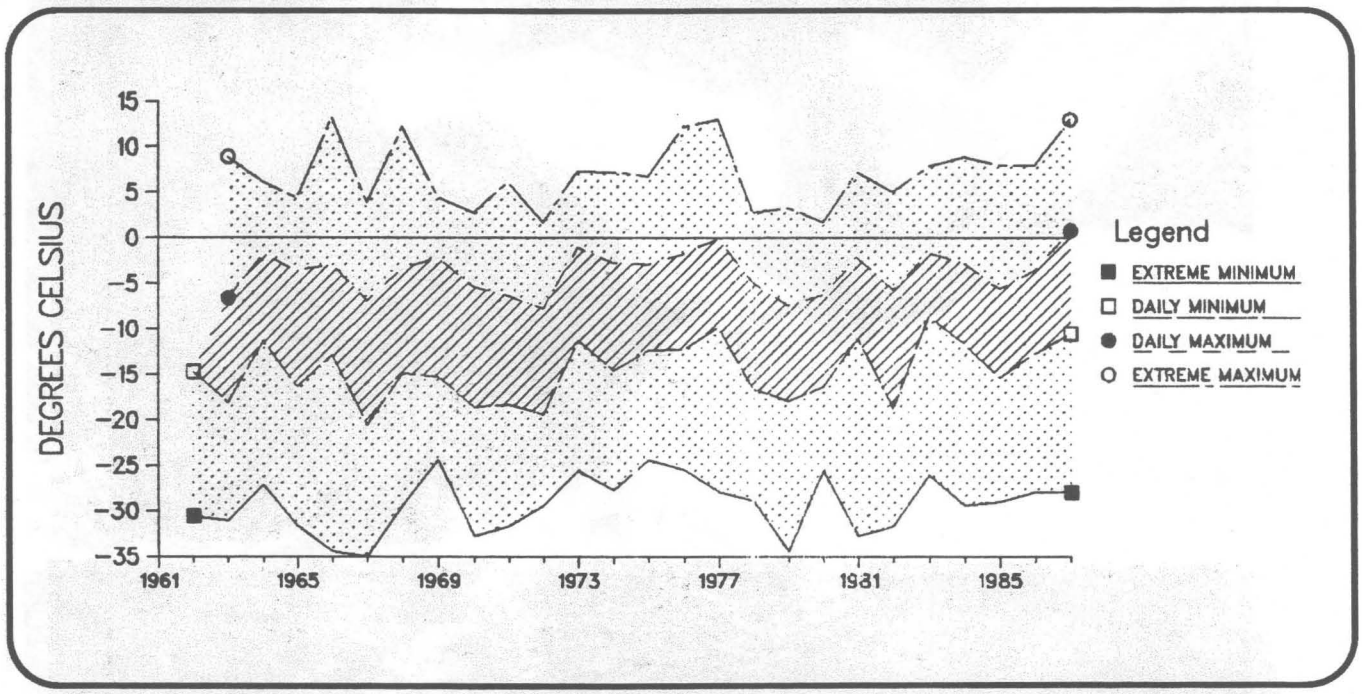


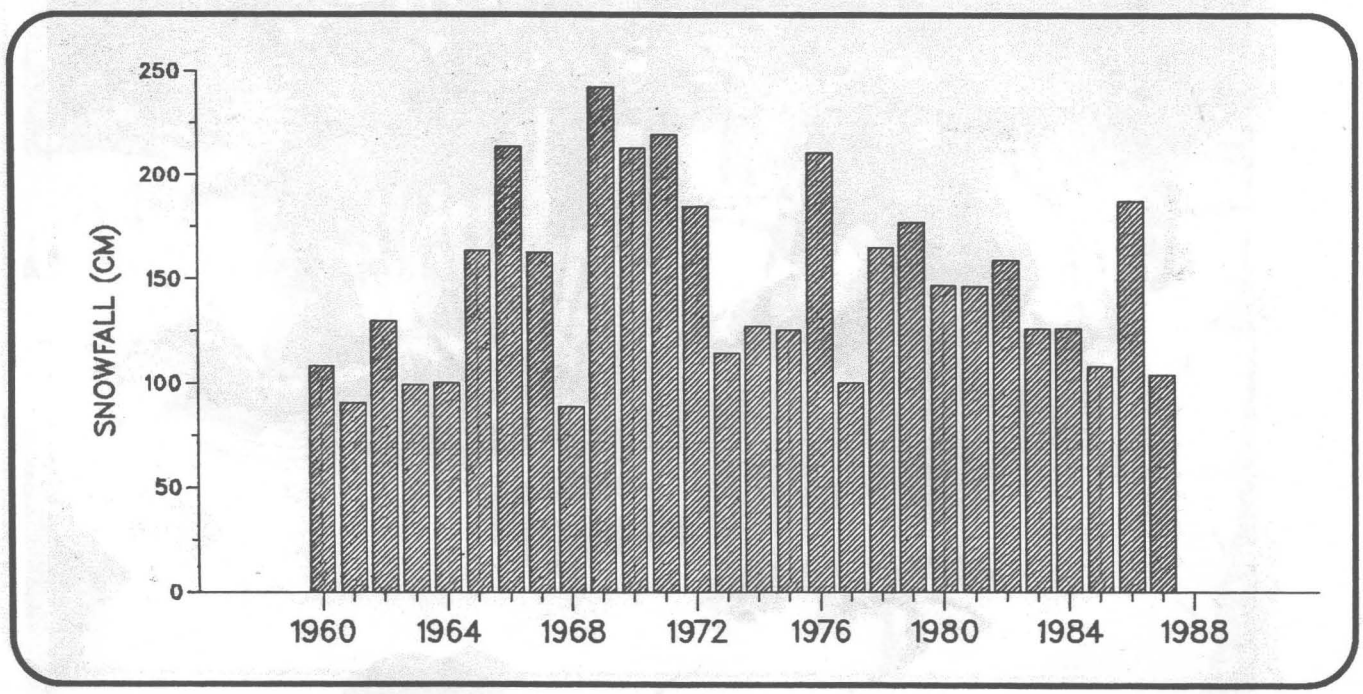
Weather and snow/ice conditions

Maximum snow depth in 1987 was only 30-40 cm for most of the winter study period on Isle Royale, a record-low level matched only by the winter of 1968. Temperatures were warmer than usual, and this was the first winter at Isle Royale when mean daily maximum temperature has been above freezing (Fig. 16). Snowfall prior to our arrival was relatively low (Fig. 16), and the combination of warm temperatures and low precipitation was unique.

There was an unprecedented lack of ice around Isle Royale in 1987. Thin ice caused a one-week delay in the initiation of winter study in January, and at our Windigo base camp there was open water within 1 km of our ice landing field on Washington Harbor in early March, when the study was complete. We all hope for a prompt return to genuine winter weather next year.

Figure 16. Top, winter temperatures at Isle Royale, 1962-87. Bottom, total October-February snowfall, 1960-87, in Thunder Bay, Ontario, on the mainland adjacent to Isle Royale.



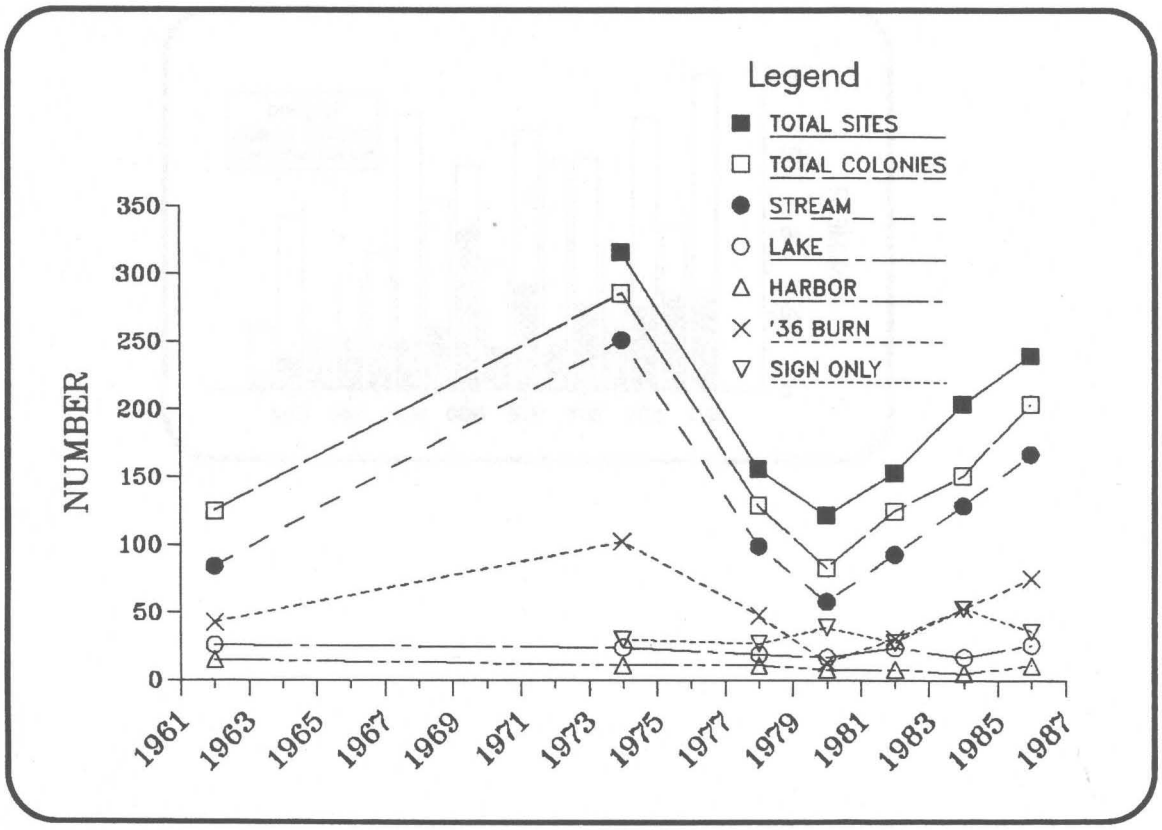


Beaver and other wildlife species

Long-term tracking of the beaver population was continued in 1986 by Philip C. Shelton, who contributed the following information for inclusion in this year's report. He determined total beaver colony numbers during an aerial survey in mid-October. This survey was flown in 16 hours, 15-18 October, in a Piper Super-Cub piloted by Tom Wunderlich.

In 1986 the total number of beaver colonies with food piles was 204, indicating continued growth of the population from its low point of 83 colonies in 1980 (Fig. 17). Trends in beaver numbers over the past decade mirror those of moose. Beaver hit a low just as wolves peaked, then immediately began to recover as wolves declined. Even though wolves prey extensively on beaver during the open-water season, beaver contribute only about 15% of the wolf food supply in summer and almost none in winter. Isle Royale wolf numbers and predation pressure are thus largely a function of the moose population, and it is clear that this interaction carries over as a strong influence on beaver numbers.

Figure 17. Beaver population trends, determined from aerial surveys by P. C. Shelton. The 1936 burn classification is a special designation not included in the total.



Beaver at Isle Royale are supported by relatively old forest habitats, undisturbed by fire for at least 50 years. Yet aspen, a prime beaver food, was still being cut at 15 of 25 sites visited on the ground by Shelton. In 1987 he plans to gather data on beaver foraging that can be compared to similar data from Voyageurs National Park in Minnesota, where graduate student Doug Smith has counted about 500 beaver colonies in more favorable habitat on a land area identical to that of Isle Royale.

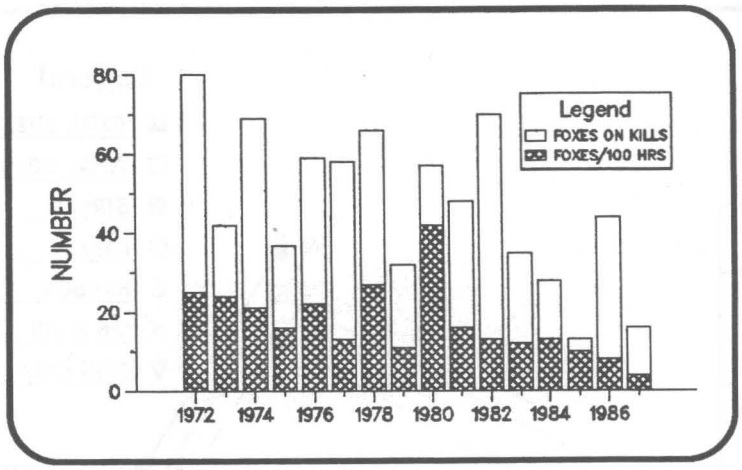
Foxes were observed on Isle Royale only infrequently in winter 1987, consistent with a general decline over the past 15 years (Fig. 18). Under conditions of chronic low snowshoe hare numbers at Isle Royale, it is possible that the gradual reduction in availability of moose carcasses has led to a fox decline.

A pair of bald eagles, monitored by Park staff, successfully fledged two offspring in both 1985 and 1986, for the first time in over 20 years. In early February 1987 one mature bald eagle was seen on Isle Royale, scavenging a wolf-killed moose. One month later we again saw an eagle near the same location. The warm winter weather allowed an unusually large number

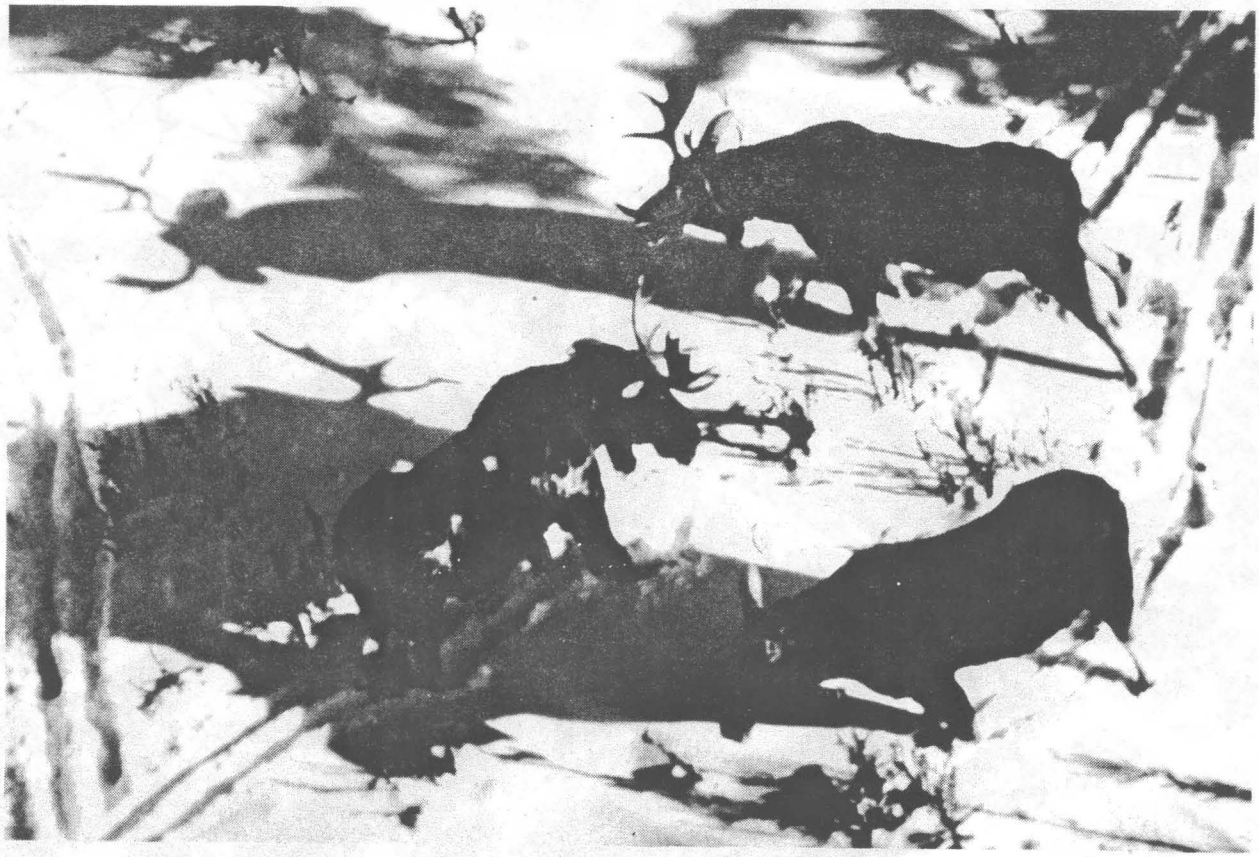
of eagles to overwinter in Michigan, according to the Department of Natural Resources, but we will have to wait and see if Isle Royale eagles make a regular habit of remaining on the island to exploit the food source generated by wolf predation. Perhaps Isle Royale ravens will at last have some serious competition.

After an impressive reappearance in 1985, spruce budworm appeared to be on the wane in 1986. Aspen defoliation by Tortix moth larvae, while extensive within the 1936 burn, was likewise contained and has not spread to older aspen stands throughout the island, as it did in 1971-73.

Figure 18. Index to fox observations from aircraft, 1972-87. Lower bar is the number of foxes seen away from moose carcasses/100 hours, while the upper bar is the sum of the maximum number of foxes seen at each carcass.



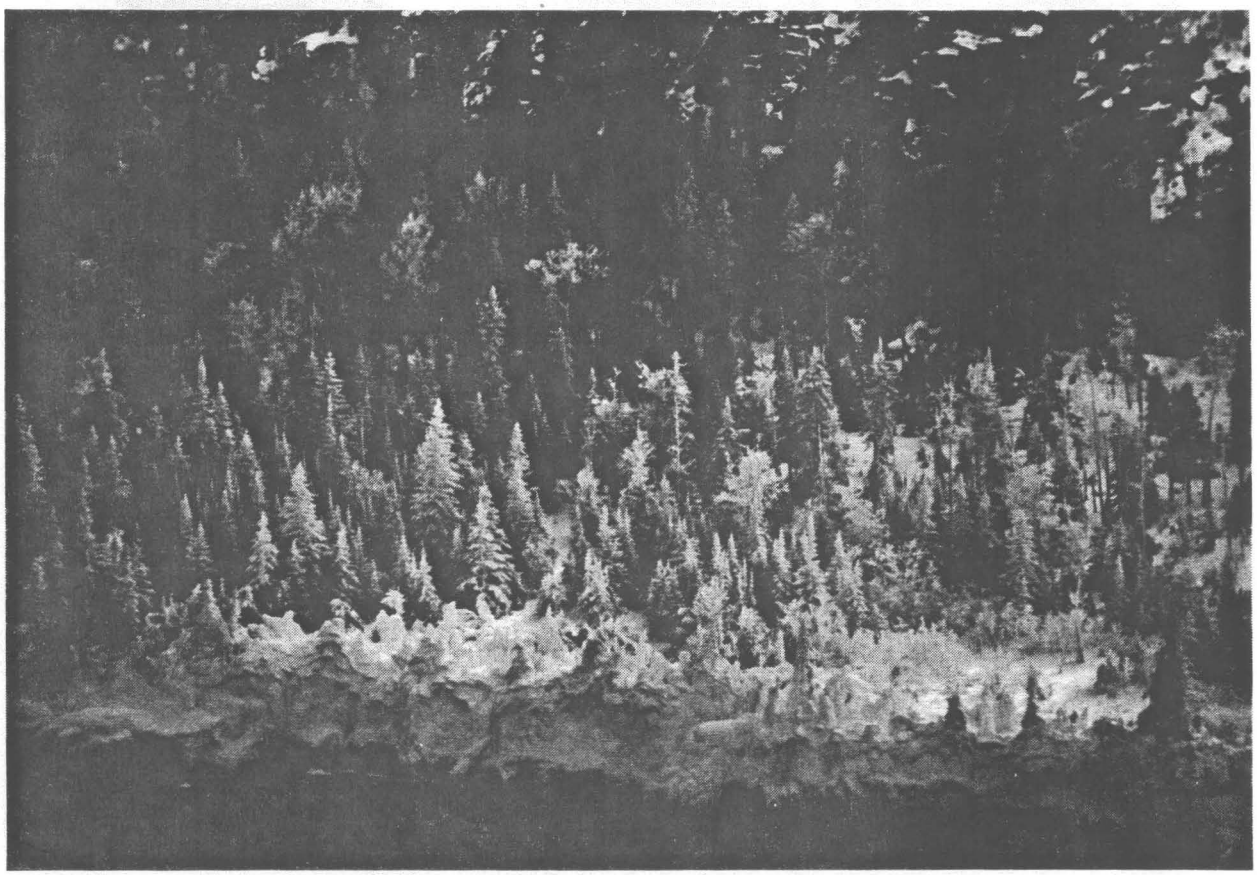
Opposite: ice patterns on Lake Superior



Two young bull moose sparring in early February, being watched by another which had just lost his antlers

West Pack II members in 1986, including three pups at the left side

Airplane



Shoreline with ice-covered trees