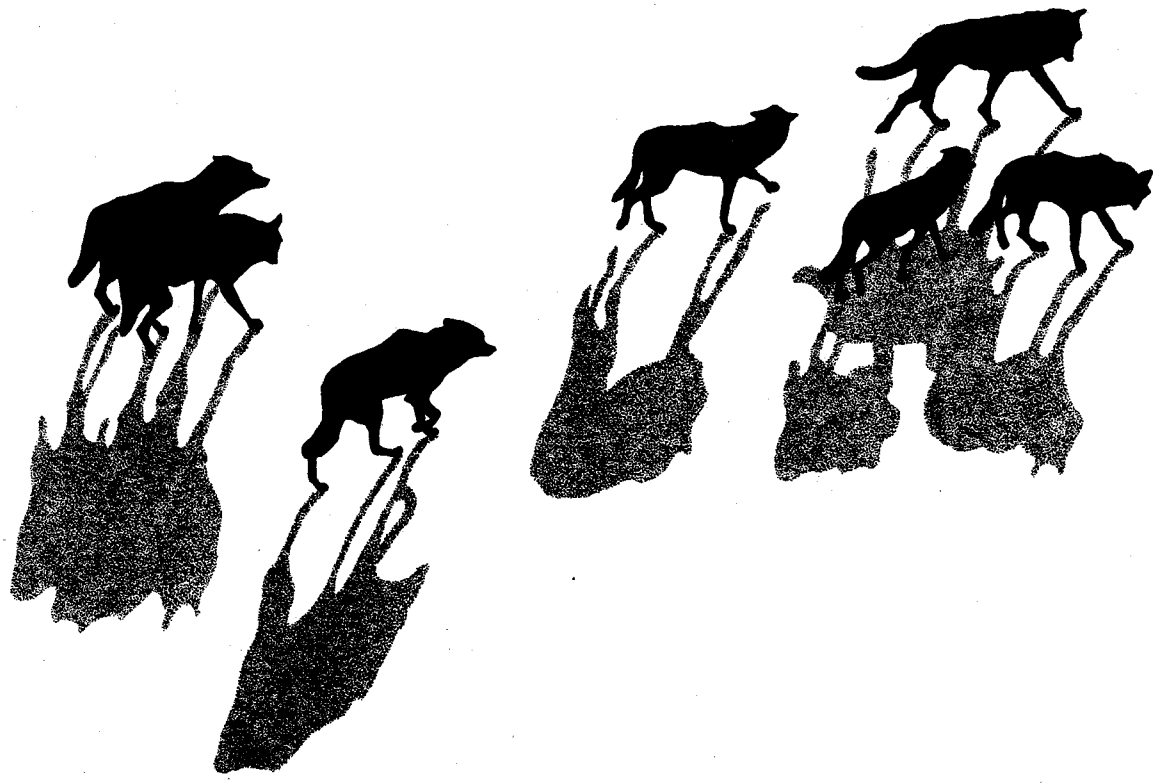
ECOLOGICAL STUDIES OF WOLVES ON ISLE ROYALE

ANNUAL REPORT

1985-86



Ecological Studies of Wolves on Isle Royale*

Annual Report - 1985-86

(Covering the twenty-eighth year of research)

by

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31 March 1986

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Tax-deductible donations (urgently needed!) 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(Results reported here are preliminary; please do not cite in publications without the permission of the author.)

Summary

Mechanisms of population regulation for Isle Royale wolves and moose remain the central interest in this long-term, continuing study, now entering its 29th year. Research efforts are focused on wolf-moose and moose-vegetation interaction. Although the fluctuations of this system (Fig. 1) suggest a classical predator-prey cycle, recent findings confirm the important role played by moose nutrition in determining wolf predation impact on this high-density moose population.

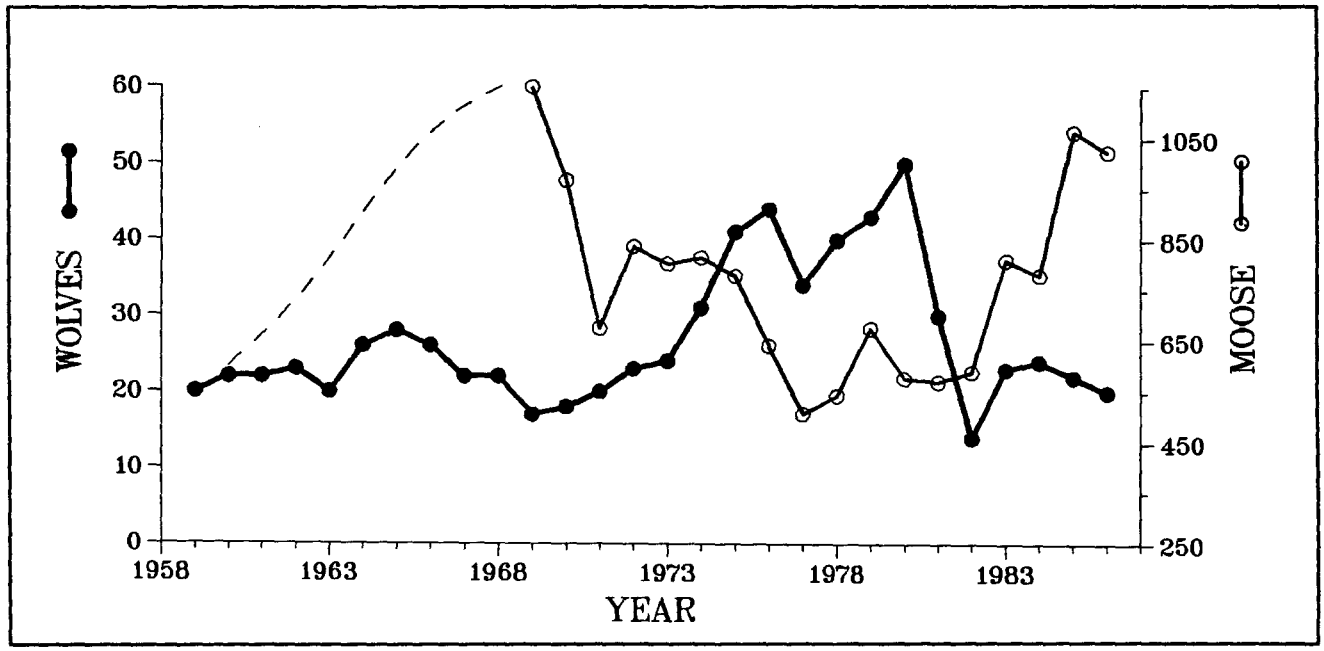
Moose vulnerability is a key determinant of wolf predation effects. Vulnerability, in turn, appears to be largely dependent on early development, that is, early nutritional plane. This is most clearly demonstrated by life-long survival patterns of Isle Royale moose born during periods which differed in winter nutrition.

Wolves on Isle Royale decreased slightly to 20 individuals in 1986 as one of the three territorial packs was displaced completely by a dominant pack. We expect the eventual outcome to be a two-pack division of the island. Survival rate for wolves present last year was 77%, not counting an adult female wolf killed by a pack during the winter study in 1986.

Moose numbers in 1986 were estimated at 1025 plus-or-minus 108 (95% confidence interval). The moose population has generally increased since 1982, although the rate of increase has apparently been slowed by wolf predation. Calf survival has remained relatively high since wolves crashed in 1982, and moose mortality is stable at a low level.

Studies of radio-collared moose at the southwest end of the island will be largely concluded in 1986. In addition to comprehensive studies of moose foraging and activity patterns in both winter and summer, these instrumented moose enabled us to determine the "sightability" of moose during our midwinter census, that is, the proportion of existing moose that are actually seen and counted on plots. Under present conditions, moose sightability during our winter census ranges from 75% to 95%, depending on the extent to which moose have moved into conifer cover.

Figure 1. Wolf and moose population fluctuations, Isle Royale National Park, 1959-86.



Personnel and Logistics

Field work at Isle Royale during the past year (starting May 1) extended from early May through October in 1985 and mid-January through April in 1986. Most of the findings reported here arise from a winter study extending from 14 January through 7 March 1986, when Peterson and pilot Donald E. Glaser used light aircraft to survey the island's wolves and moose.

Four graduate students are currently studying various aspects of wolf-moose-vegetation interaction:

Richard E. Page, Ph.D. student, wolf-moose dynamics;
Kenneth L. Risenhoover, Ph.D. student, moose foraging behavior in winter;
Timothy N. Ackerman, M.S. student, influence of thermal stress on moose activity and behavior in summer;
Thomas A. Brandner, M.S. student, moose-balsam fir interaction.

Assistance in the field was provided by the following individuals:

John Boulanger, Summer 1985
Jeff Selinger, Spring and Fall 1985
Peter Zavell, Summer 1985
Carolyn Peterson, Summer 1985
Edward Valentine, Winter 1986
M. Lynn Risenhoover, Winter and Spring 1986.

An October aerial survey of moose population composition was flown by Peterson and Selinger, with Tom Wunderlich piloting the survey aircraft. National Park Service personnel assisting on the island during the winter study were the following: Anthony Andersen, Michael Bencic, Stu Croll, Thomas Hobbs, Lee Jameson, Robert Krumenaker, Michael Ruggiero, Dave Snyder, and Jay Wells. NPS staff at mainland headquarters for Isle Royale National Park and Grand Portage National Monument provided logistic support. Supply flights to the island were flown by the Ely Aviation Unit, Superior National Forest, U.S. Forest Service.

Wolf-Moose Dynamics on Isle Royale

We have recently characterized this wolf-moose system as following a long-term predator-prey cycle. The long period of fluctuation, on the order of 3 decades, ultimately arises from the large body size and resulting long generation time for these mammals. However, moose forage level, modified greatly in winter by snow conditions, provides a major external influence on wolf-moose dynamics. The full range of interactions among wolves, moose and vegetation involves 2-way effects at each trophic level (Fig. 2).

Recent analysis of long-term data (Fig. 3) on wolf-killed moose revealed that certain cohorts (i.e., moose born in certain years) were far more abundant than others (Fig. 4). This strong variation in annual abundance of surviving calves is believed to be a major cause of the long-term "cyclicity" in moose numbers. We believe that forage abundance for pregnant cow moose in winter largely determines the abundance of calves born the following spring. Winter nutritional plane, in the short term, is a function of snow conditions and moose density.

Figure 2. Multi-level trophic interactions at Isle Royale.

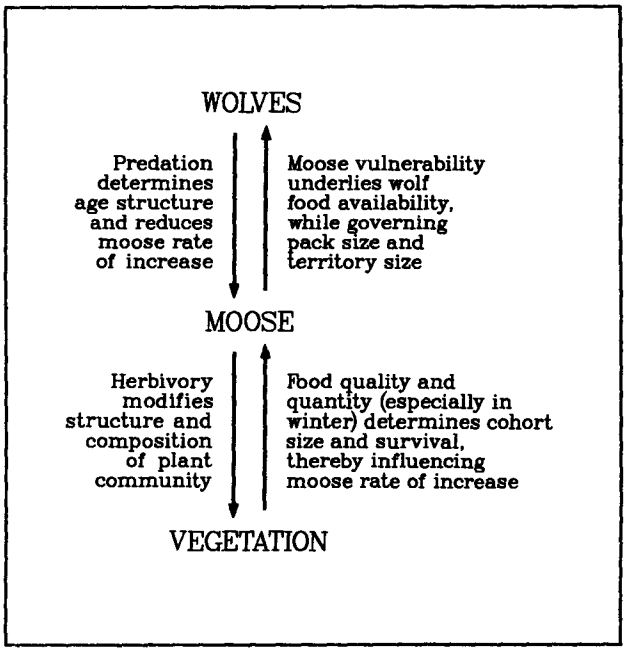
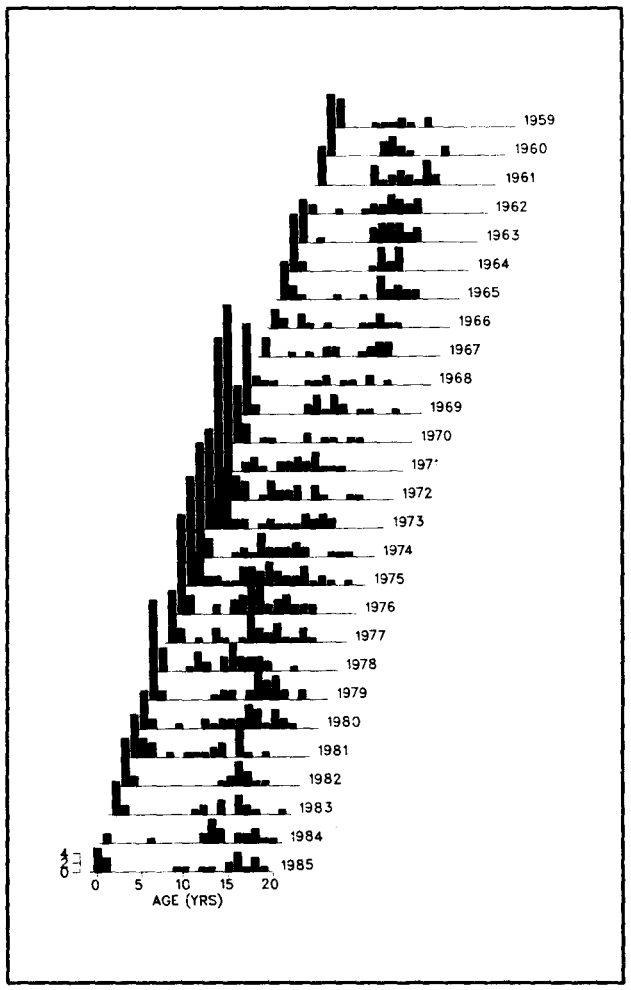


Figure 3. Age structure of wolf-killed moose on Isle Royale, 1959-85, arranged so that individual annual cohorts can be directly traced vertically through time.



Early nutrition has far-reaching effects on early development and subsequent survival of moose, even to the extent of determining lifelong survival pattern. Moose born after severe winters in the late 1960's and early 1970's, when the moose population was very high, have exhibited much higher vulnerability to wolves for several years early in life, before they reach the minimum body size required for reproduction (Fig. 5). It is obvious that such conclusions are possible only because of the long-term nature of wolf-moose studies at Isle Royale.

Perhaps the moose vulnerability factor of greatest interest at present is arthritis, a degenerative form associated with old age and common also in the human species. It is clear that as the moose population grew in the late 1950's and 1960's the incidence of arthritis among old moose (older than 8 years) increased steadily (Fig. 6). We hypothesize that the high incidence of arthritis among cohorts born after the mid-1960's may be explained by abnormal early development arising from malnutrition. Even for humans the cause of primary osteoarthritis remains unknown, however, and various theories are quite controversial.

Figure 4. Relative sizes of moose annual cohorts on Isle Royale, derived from data in Fig. 3. Cohorts born after the late 1960's are not yet adequately represented, since some individuals are still alive.

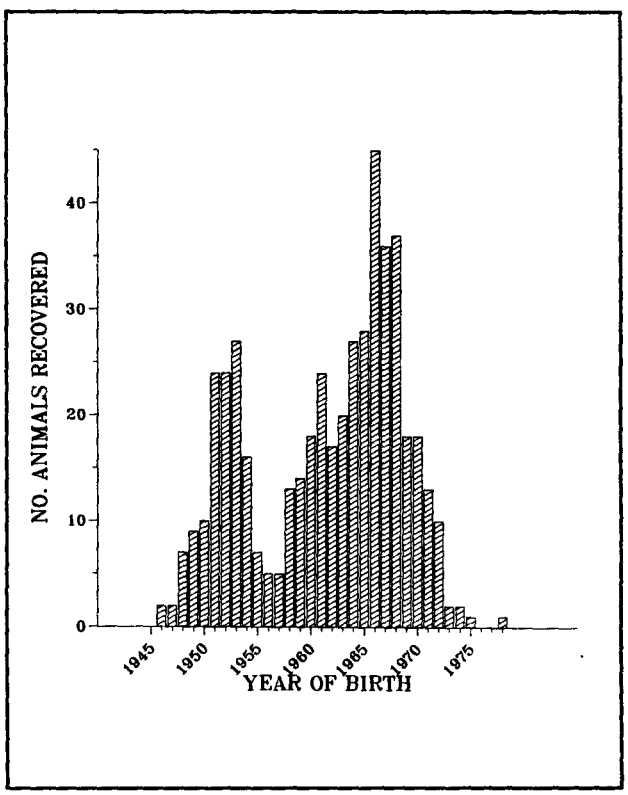


Figure 5. Life-long survival of Isle Royale moose born during 3 different time periods, derived from data in Fig. 3.

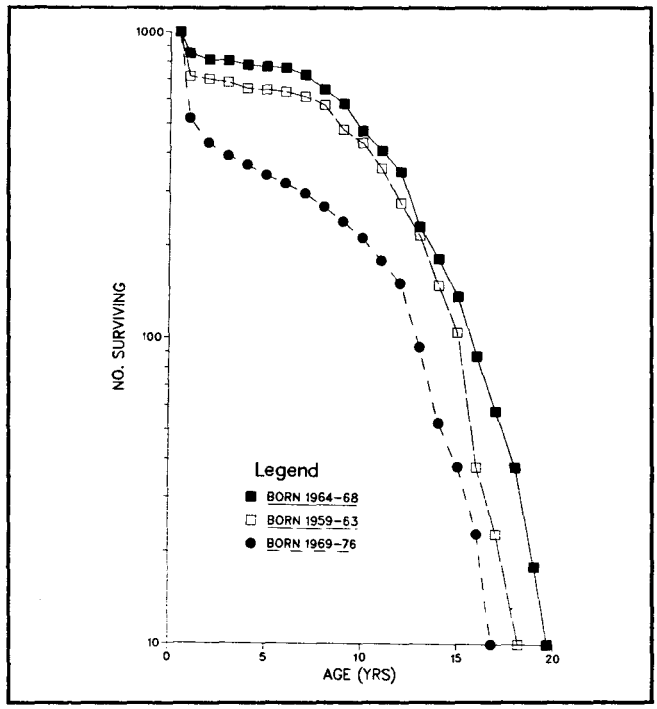
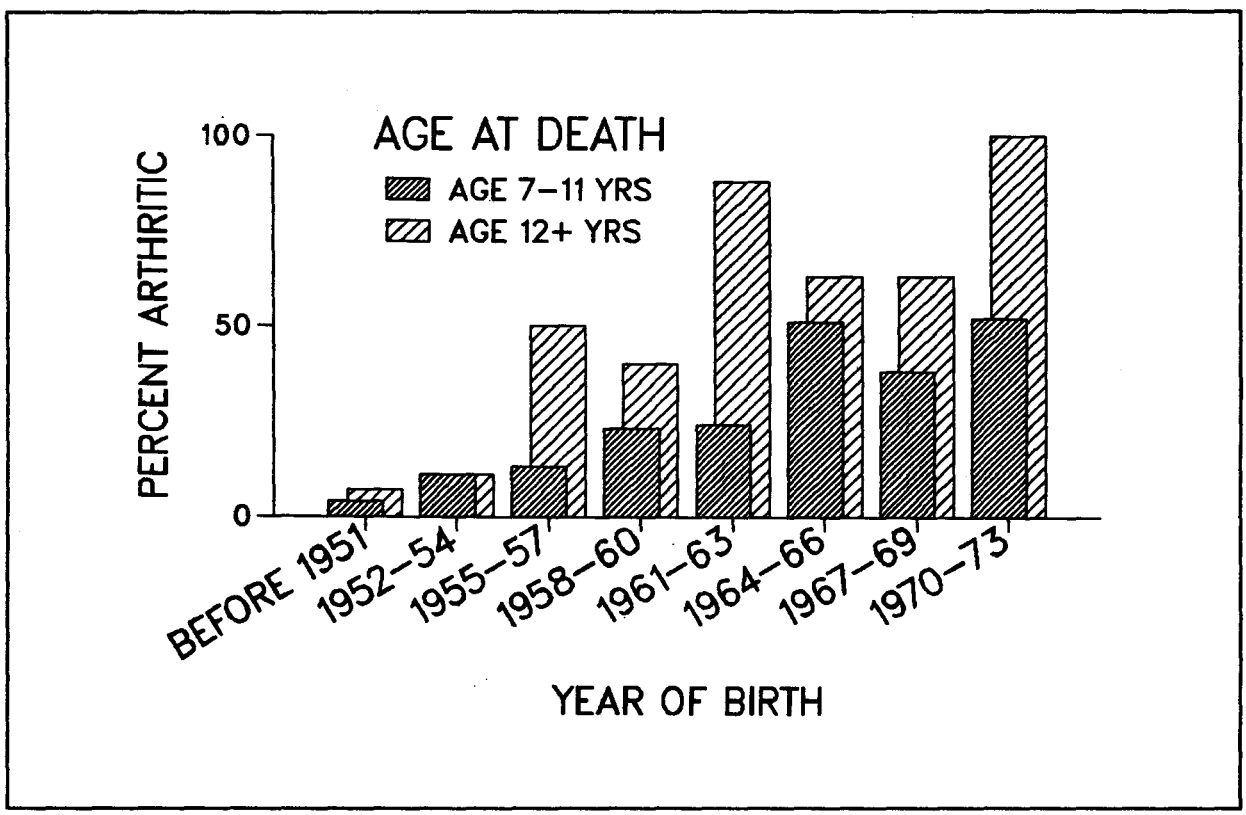


Figure 6. Frequency of arthritis among Isle Royale moose according to year of birth, determined from skeletal collections during 1958-85.



The Wolf Population, 1985-86

Wolf numbers at Isle Royale have closely followed trends in food supply, or moose vulnerability. The wolf population stabilized at a level near the long-term average after the population crash of 1980-82. The age structure of the moose population (Fig. 3) suggests that food supply for wolves will remain static and relatively low until the late 1980's, when abundant moose cohorts born since 1981 will begin to reach a vulnerable age.

In 1986 the wolf population declined slightly as the Harvey Lake Pack (HLP) lost its territory and its identity. For several years the HLP existed on a marginal food base between the East Pack II (EPII) and the West Pack II (WPII). It has been attacked by both neighboring packs in previous years. In 1986 the EPII finally took over the HLP territory, killing at least one wolf and apparently dispersing the few survivors.

In 1985 only the EPII and WPII reproduced; no homesites were located in HLP territory and the HLP wolves traveled widely as a group throughout their territory. Even in the other packs relatively few surviving pups were produced. In winter 1986 only 1 pup could be identified (by appearance and behavior) in the EPII, while the WPII contained 3 pups.

Survival of wolves present in 1985 was determined from the change in total wolf numbers and the number of pups present. Pup identification in this unmarked population has always been a problem, but we have considerable confidence in our recent estimates because direct observations from survey aircraft have been enhanced tremendously over the past 3 years by a gyro-stabilized 15X monocular (Fig. 7). Of the 22 wolves from last year, 16 were still present in 1986 and there was no opportunity for ingress or egress, so the survival rate was 77%.

The pack territories delineated by pack movements in 1986 clearly indicate a significant shift in the range of the EPII (Fig. 8). When we arrived in January the EPII was actively scent-marking the former HLP territory, where they remained for 3 weeks. Actual identification of the EPII itself was only possible after we were able to observe their behavior in their old territory and compare travel routes used to traditional HLP and EPII routes.

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

	West Pack II 1986	East Pack II 1986	All packs, 1971-85 average (sample size)
Pack size	11	5	7.9 (38 packs, 15 years)
Travel rate (km/day)	11.8	6.9	9.6 (10,477 km/1,089 pack-days)
Kill interval (days)	4.4	8.7	5.5 (1,598 pack-days/290 kills)
Travel between kills (km)	55.8	59.8	41.6 (9,736 km/234 kills)

Figure 7. Group greeting is initiated as the West Pack II begins to travel at sunset. Alpha male is in right center, with tail curled, while alpha female is behind him with tail straight back. Other wolves with raised tails are high-ranking subordinates.

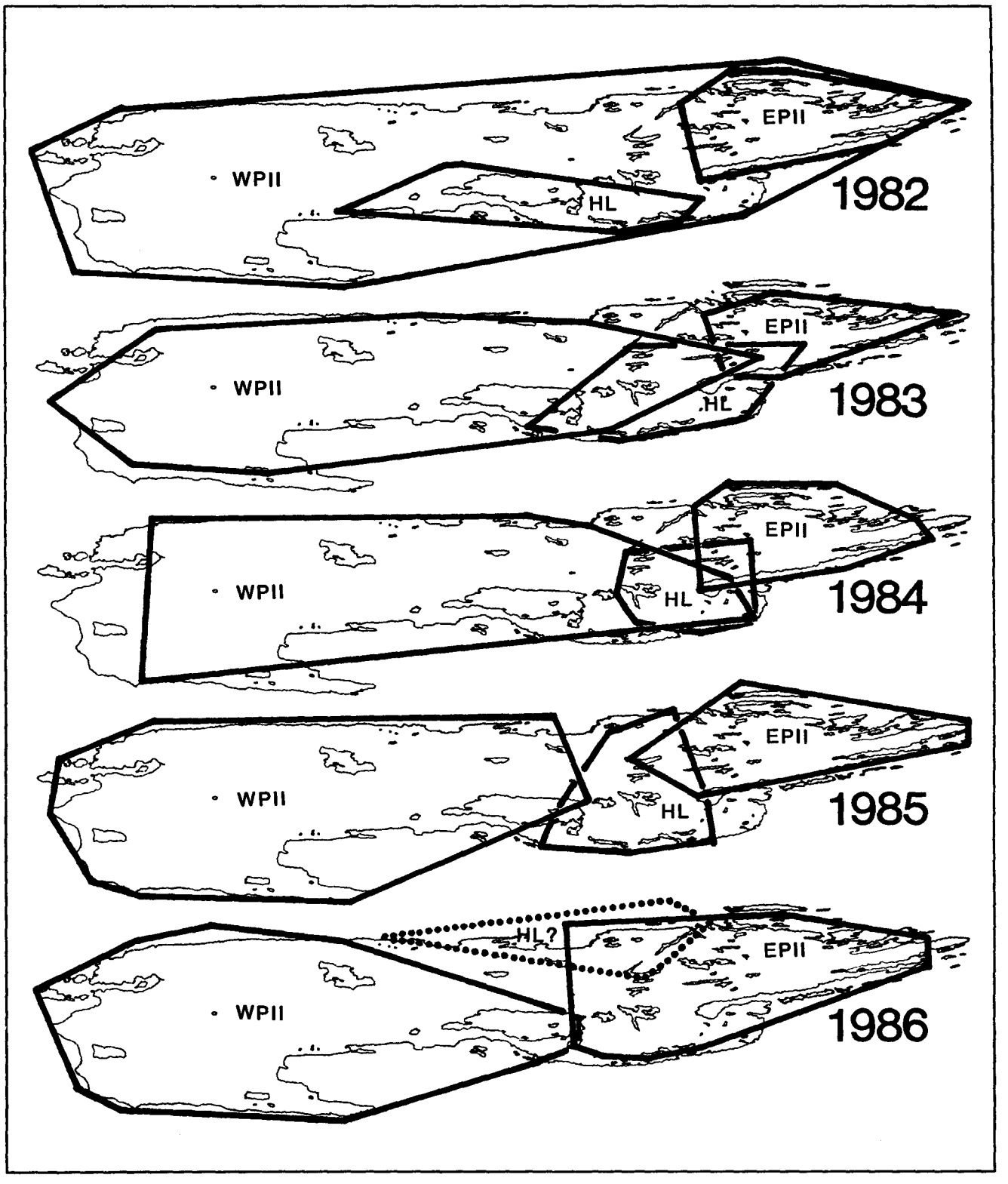
Both WPII and EPII scent-marked heavily at the eastern end of Siskiwit Lake, the largest interior lake on the island, effectively dividing the length of the island in half. The EPII also established very prominent scent-posts in the middle of the north shore of the island. The WPII confined most of its movements to the southern shoreline of the island, but its traditional territory abuts the EPII completely through the middle of the island.

In late January at least 3 single wolves moved into old HLP territory from the SW, and we surmised that these were HLP wolves returning to their former place of residence after being routed by the EPII before our arrival. On 28 January the EPII killed a wolf traveling alone near Chickenbone Lake, and remained near the carcass of the dead wolf all day. We recovered the almost intact remains of this wolf, a middle-aged adult female (#1828) exhibiting no evidence of past reproduction (unpigmented, small teats, no active ovulation, and no scars in the portion of the uterus that ravens allowed us to recover).

The duo remaining on the north shore of the island in February traveled together and killed 2 moose. Only 1 scent-mark was observed on the ground at these 2 kills, suggesting that the duo was not actively territorial. In fact, they were chased off one of their kills by the EPII and several days later they sought refuge on pack ice when the same pack chased them a second time. It is highly likely that at least one of these 2 wolves was a member of the old HLP pack, as the duo made a major effort to revisit the Chickenbone site where the EPII killed the single wolf. We believe that this pair has little chance of reproducing, and their survival depends on successfully skirting the 2 packs that currently claim the entire island.

The kill rate for wolf packs in 1986 approximated the long-term average (Table 1). Kill rates in 1986 were only one-third to one-half those of a decade ago; currently it often takes several nights of hunting before packs are able to make a kill. Travel between kills was consistently high for both packs, as snow was deep (more than 75 cm) and soft in the interior of the island and wolves traveled most extensively on shoreline ice.

Figure 8. Isle Royale wolf pack territories indicated by pack movements, 1982-86.

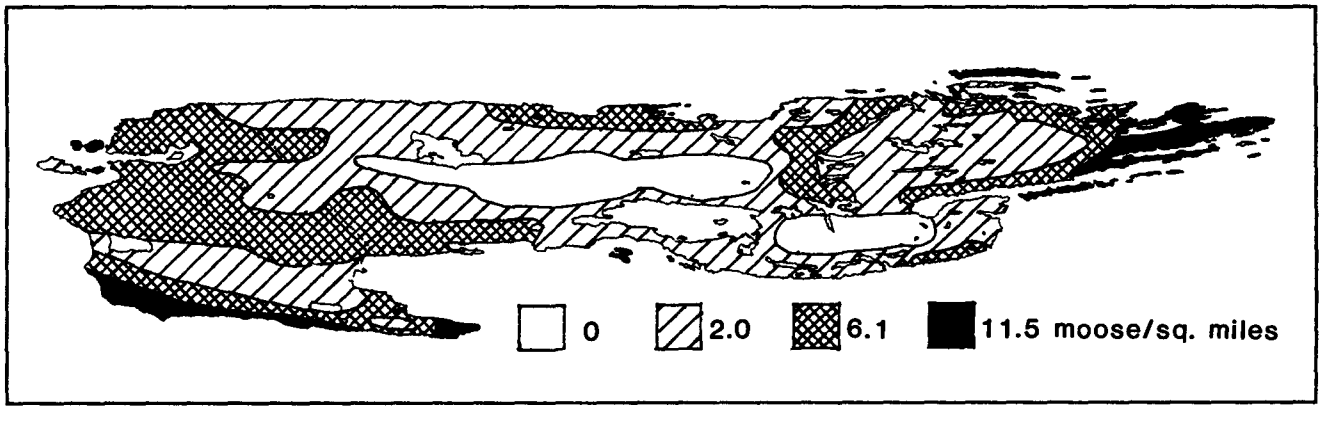


Adult moose killed by wolves in 1985 were among the oldest ever examined at Isle Royale (Fig. 3). The bulk of the moose population is still less than 5 years of age, and virtually untouched by wolves except as calves. These large cohorts of moose will not begin to reach a vulnerable age until the late 1980's. In the meantime, we expect wolves to have difficulty finding vulnerable moose; this should ultimately be reflected in stable wolf numbers at the present level.

There were probably only 2 reproducing female wolves on Isle Royale in 1986, the alpha females in the WPII and the EPII. A high-ranking but subordinate female in the WPII left the pack and tracked single wolves of unknown origin for 1-2 days in late February, possibly searching for the requisite mate and vacant territory to start a new pack. She found neither, and was "punished" repeatedly by the alpha female upon returning to the pack (physically forced into passive submission 12 times in a half hour-see Fig. 19). This female, considered a "beta" female, led the pack temporarily when the alpha pair disappeared at the height of the breeding season. When the alpha pair reappeared the beta female departed again, but she returned to the pack in early March.

We've often been impressed by the extent to which wolves walk on thin ice around the periphery of Isle Royale, ice that may be only a few hours old. In 1986, for the first time, we watched a lone wolf float away one afternoon on a large ice floe toward the Canadian mainland. The wolf, with a full stomach, fell asleep on the pack ice about 200 yards offshore. The wolf was awakened by our aircraft a few times as it floated toward Ontario on the strength of a strong south wind, but each time fell back to sleep after a contented glance at its surroundings (after all, there was no way it could be harassed by a territorial pack!). Its peaceful ride presumably ended about 24 hours later when the wind switched to northwest and all the ice floes blew back to Isle Royale.

Figure 9. Moose distribution during 1986 census.



The Moose Population, 1985-86

The moose population has been growing steadily since 1981, when calf survival increased as wolves died off. The bulk of the population is at the southwest end of Isle Royale, within the range of the WPII. Moose increase at the northeastern end may have been retarded by the presence of 2 wolf packs (HLP and EPII) in a relatively small area.

Moose Population Size

In 1986 ample flying time (160 hrs) allowed us to complete an unusually thorough moose survey in January and February. The island was first stratified into 4 zones of relative moose density on the basis of relative track abundance (Fig. 9). We then counted moose from aircraft on 106 small plots each measuring about 0.5 square miles in area, together comprising almost 25% of the island area. Each plot was covered by a series of overlapping circles for an average of 15 minutes. Most plots were counted soon after sunrise, when most moose are feeding and thus easier to see. Total moose seen was 257 on all plots.

The resulting estimate and 95% confidence interval was 1025 plus-or-minus 108, similar to last year's estimate of 1062 plus-or-minus 187.

We again determined moose "sightability" (moose present on plots that are actually counted) using test plots established around radio-collared

moose. In 1985 we observed 95% of the marked moose (N = 19), but in 1986 only 75% (N = 44) were seen. The difference is attributed to an earlier movement of moose into conifer cover in 1986 (see below). A correction was introduced into the final estimate for 1986 to account for moose missed during the plot counts.

Recruitment Surveys

Since 1972 we have conducted an autumn aerial survey of moose population composition to determine adult sex ratio and relative abundance of yearlings and calves. Calf abundance is a key statistic that determines population rate of growth. The 1985 survey in October after leaf-fall indicated 40 calves/100 cows, an above-average level. However, one-quarter of the entire population was observed during the 1986 winter census and only 22 calves/100 cows were present. The latter figure is probably more reliable, and it does suggest that growth of the population over the past year was unlikely.

Winter Distribution

It has long been known that moose tend to move into conifer cover as winter progresses (Fig. 10). This is accompanied by a reduction in activity which persists until late March or April at Isle Royale. Of course, it is much more difficult to observe moose inhabiting conifer habitats. The rate at which this "conifer shift" occurs varies between years, producing highly variable results in midwinter surveys unless moose sightability can be determined annually (Fig. 11).

Figure 10. Moose move into conifer cover, usually cedar lowlands, as winter progresses. They continue to feed along the edge of such areas, as shown in this photo of radio-collared cow 981 and her calf.

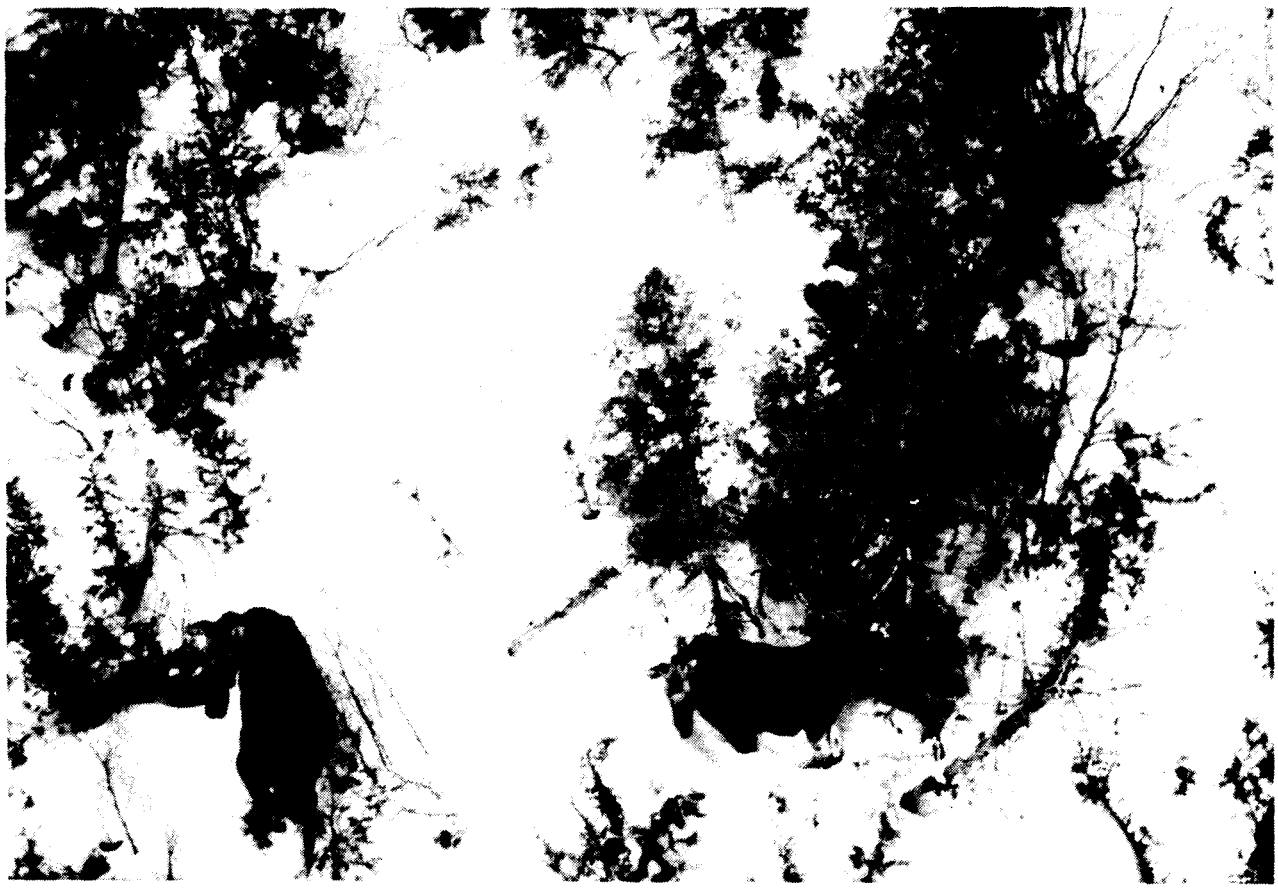


Figure 11. Moose observations during routine survey flights declined during winter as moose enter conifer cover. The shift to conifers occurred later in 1985 than 1986, producing superior "sightability" during the 1985 moose census.

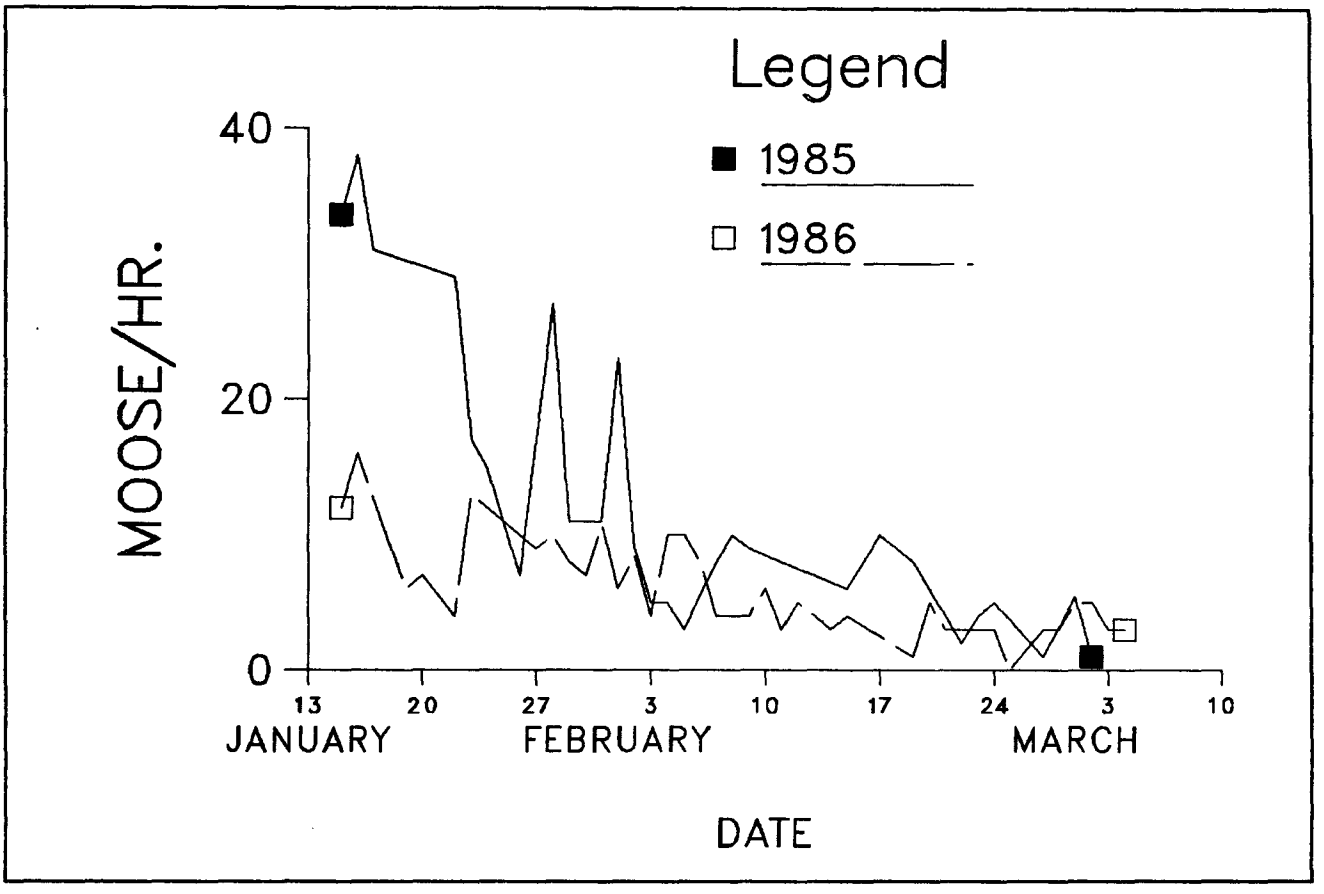
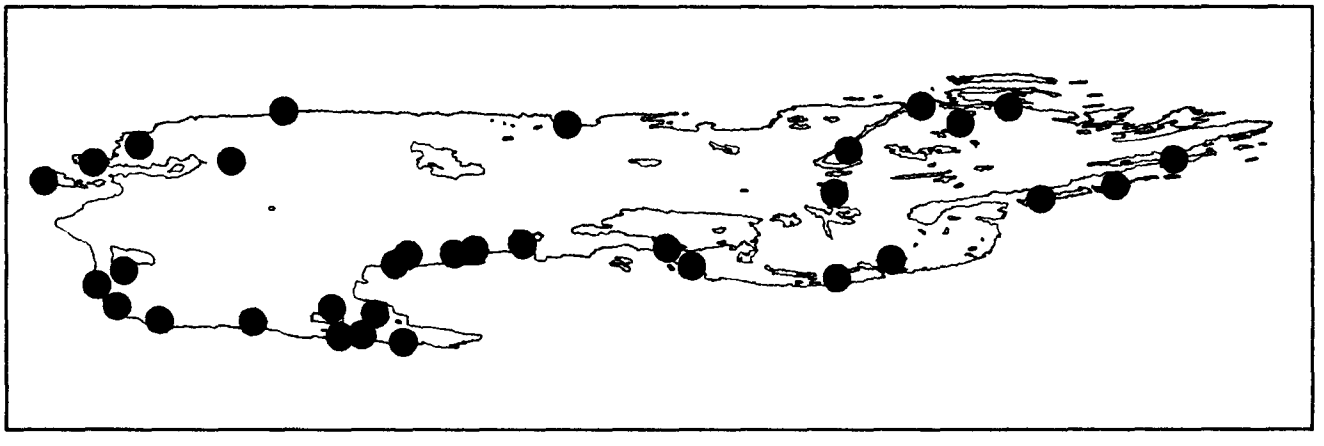


Figure 12. Distribution of moose carcasses located during the 1986 winter study.



We hope to quantify this in the future using routinely-gathered "moose/hour" data from normal flights throughout the winter study. As long as radio-collared moose continue to transmit, we will be conducting sightability trials in an effort to determine the relationship between this variable and moose/hour observed in routine flights.

Mortality in 1986

We enjoyed excellent tracking conditions for the entire winter study in 1986, and were able to back-track wolf movements and kills to 29 December, the last significant snowfall before our arrival.

Total moose mortality was thus determined for 66 consecutive days (Fig. 12). The 28 moose dying during this period succumbed to wolf predation (86%), malnutrition (11%), and accidents (4%). Total loss amounted to 0.42 moose per day, about the same level as the previous 5 years (Fig. 13).

The proportion of calves among wolf-kills was only slightly above average, at 38% (calves are highly preferred prey in winter and often occur twice as often among wolf-kills than in the the population itself).

Carcasses of 20 yearling-and-older moose were examined on the ground during the winter study (Fig. 14). Half of these moose were arthritic (Fig. 15) and 6 additional moose exhibited periodontal infections along their toothrows, so 80% exhibited obvious skeletal pathology. This high rate of maladies reflects the extreme age of adults currently serving as wolf prey.

Figure 13. Moose mortality in midwinter on Isle Royale has stabilized at a relatively low level since 1980.

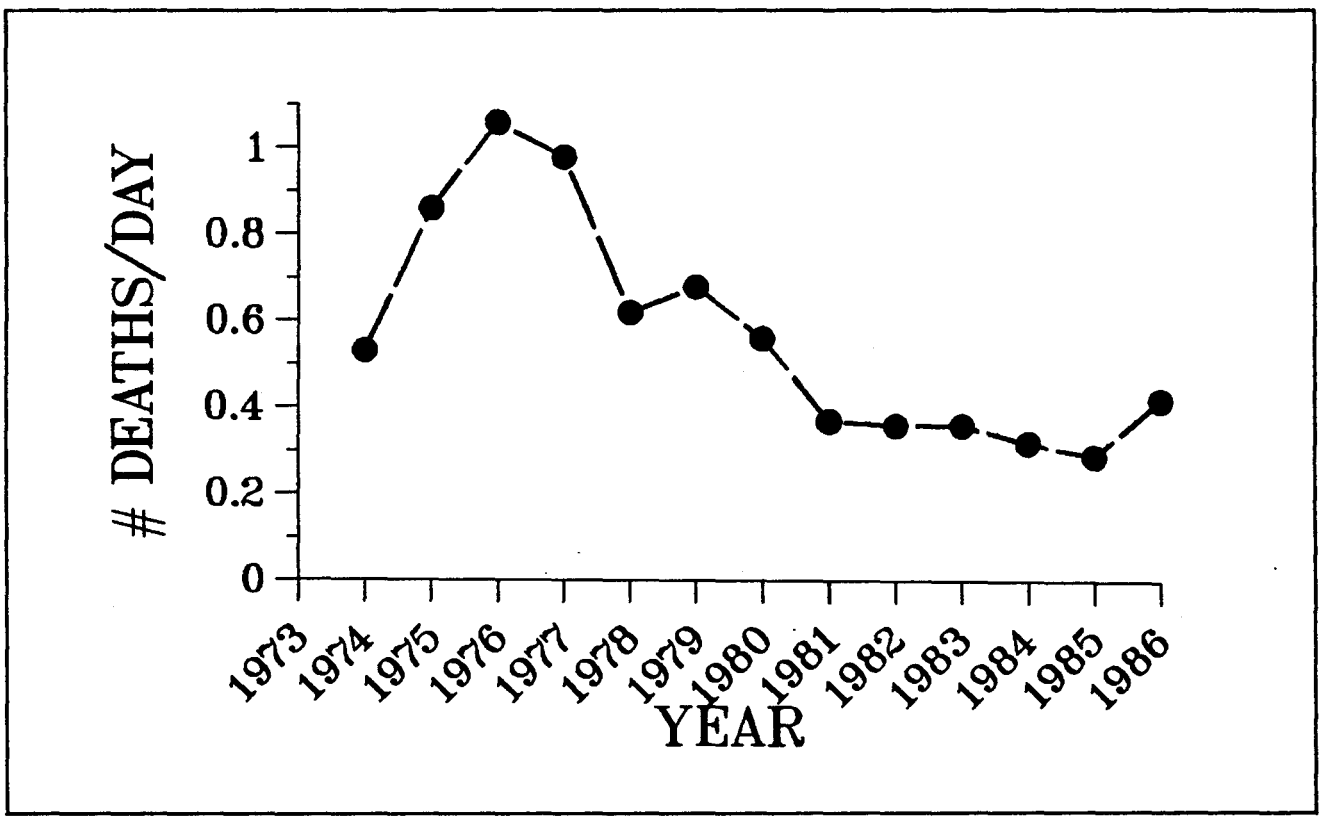
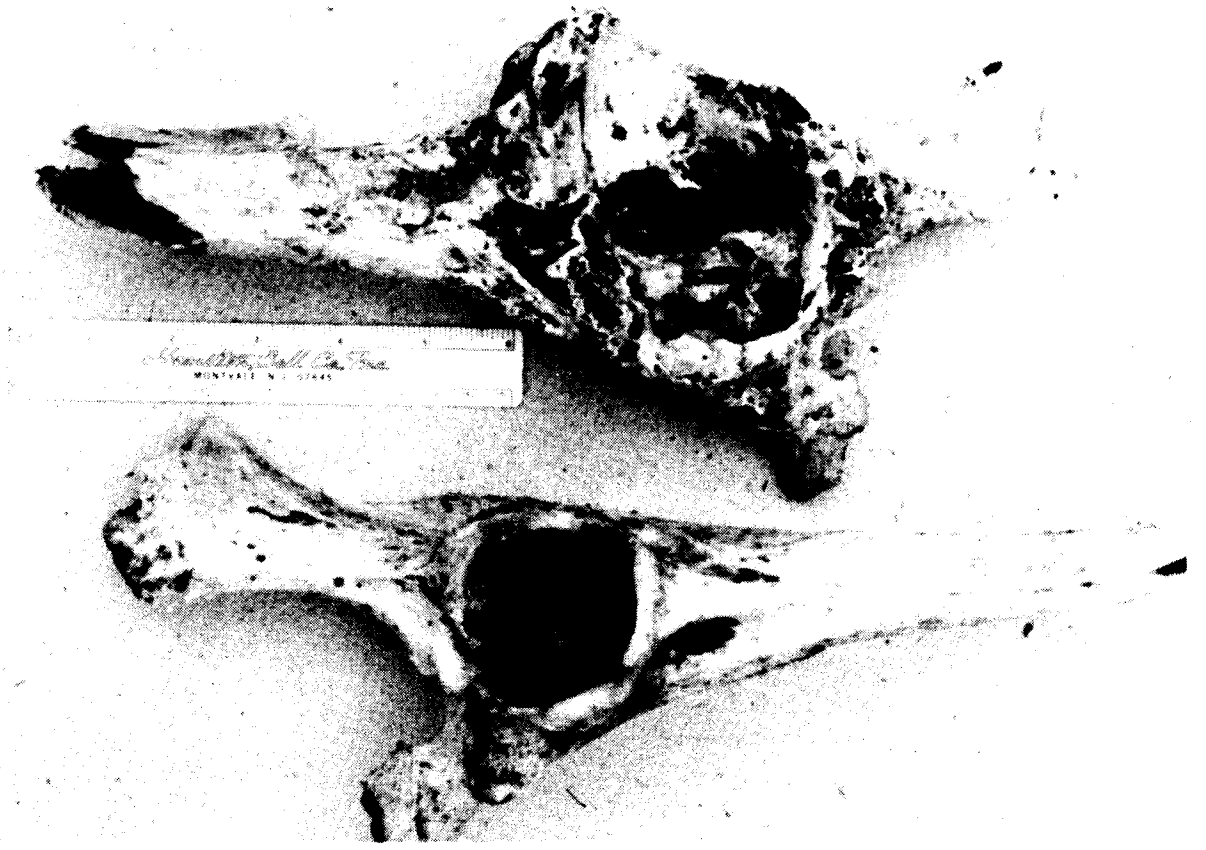


Figure 14. Adult bull moose (#1836) that died 6 days after being wounded by 5 wolves in EPII. Wolves remained close for 5 days, preventing the moose from moving or lying down. This 14.5-year-old moose, with only a few lacerations on one rear leg, died without any significant external injuries 24 hours after the wolves departed (top). Wolves returned and cleaned up most of the frozen carcass in one feeding (bottom), then waited for a thaw to eat the remainder.

Figure 15. Arthritic vs. normal hip joint from moose #1836 (Fig. 14), showing acetabula of pelvis.



Two radio-collared bull moose died within the past 12 months. Male 120, the largest and most observable of the collared animals (Fig. 16) was found dead on 8 October 1985 by Dale Miquelle (Univ. of Idaho Ph.D student studying rutting behavior). A visiting veterinarian diagnosed lung troubles 2 weeks before, and we suspect the moose died of pneumonia. Based on Miquelle's observations, the last significant act of male 120 was mating with radioed female 1530 on 24 September!

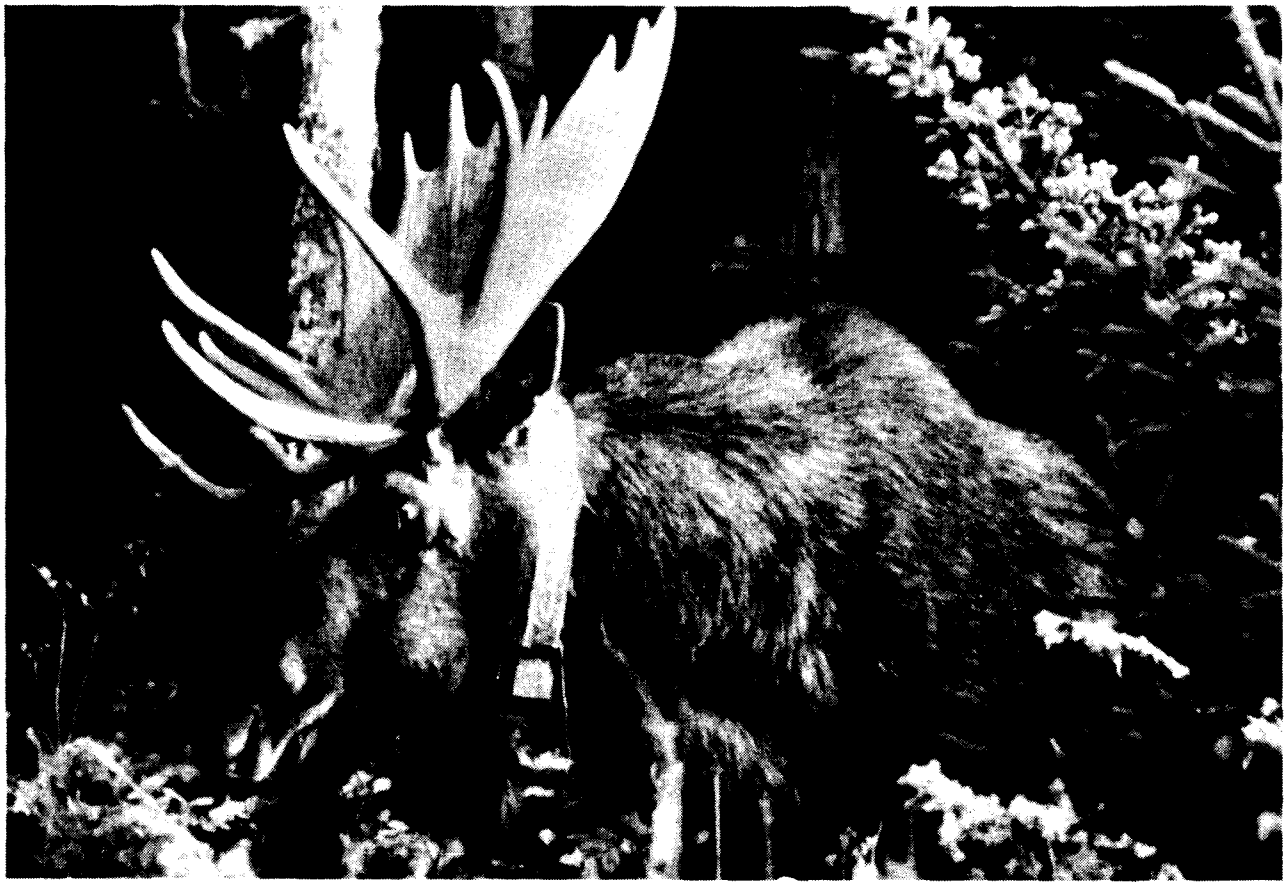
Radioed bull 1490, a migratory bull that spent the summer at the southwest end of the island, died of malnutrition in late December 1985 while enroute to his wintering area at the northeast end.

Radio-collared moose

Seventeen moose wore transmitters at the end of the 1986 winter study, after 3 additional bulls were collared in late January by ground-darting. Intensive studies of these moose will conclude in 1986, and most transmitters are expected to expire in the next year. Ken Risenhoover's comparative study of moose foraging behavior in Denali National Park in Alaska and Isle Royale will be prepared for publication during the remainder of 1986. Tim Ackerman will also conclude his study of moose activity patterns with a second summer of field work in 1986 at the southwest end of the island.

Radio-collared moose have been located by ground or aerial tracking over 2,000 times during the past 24 months. We have observed almost every conceivable type of movement in these animals, including annual migrations, year-round small home ranges, intensive use of scattered small areas, and movements that seem no more than wandering lines (Fig. 17). Generally, however, in the course of a year most individual moose intensively used a wide variety of areas spread over at least 15 square miles. Only some of the moose exhibited similar patterns of movments in different years.

Figure 16. Radio-collared male 120 in September, after shedding velvet off his 4-foot wide rack. He died just after the rutting season in October 1985, probably of pneumonia. Photo by D. Miquelle.



Significantly, none of the radio-collared females have successfully raised calves in 2 consecutive years. Two females, a current 3-year-old and a very old cow, have not produced any offspring at all. Reproduction every other year is not uncommon for ungulates on a low nutritional plane. We will closely track the radioed cows in early June 1986 in an effort to determine if calves are produced and die at an early age or if they are simply not conceived.

Other Wildlife Species

In 1985 Park resource management staff documented a significant event, the first successful reproduction in bald eagles at Isle Royale since 1963. The 2 juvenile eagles produced were observed flying around the southwest end of the island during our October moose survey. Ospreys also reproduced for the first time in many years in 1984 and 1985, an additional indication that pesticide residues in the Lake Superior region may be declining.

We assisted a statewide loon survey by William Robinson and colleagues (Northern Michigan University) in 1985 by counting all breeding pairs at Isle Royale. In 53 lakes and bays we located 39 producing pairs, yielding a total of 59 chicks. Isle Royale produced about 20% of the successfully-hatched young loons in Michigan in 1985.

The only available index to fox numbers at Isle Royale arises from our winter aerial observations (Fig. 18). Total fox numbers were up somewhat in 1986 because more moose carcasses were available for monitoring. Observations during the 1980's suggest a stable population that is probably lower than that of the early 1970's when abundant carrion from moose carcasses contributed significantly to the economy of the fox.

Figure 17. Year-long movements of radio-collared cow 1530, beginning February 1985. After June she was accompanied constantly by her calf, born on Beaver Island in Washington Harbor.

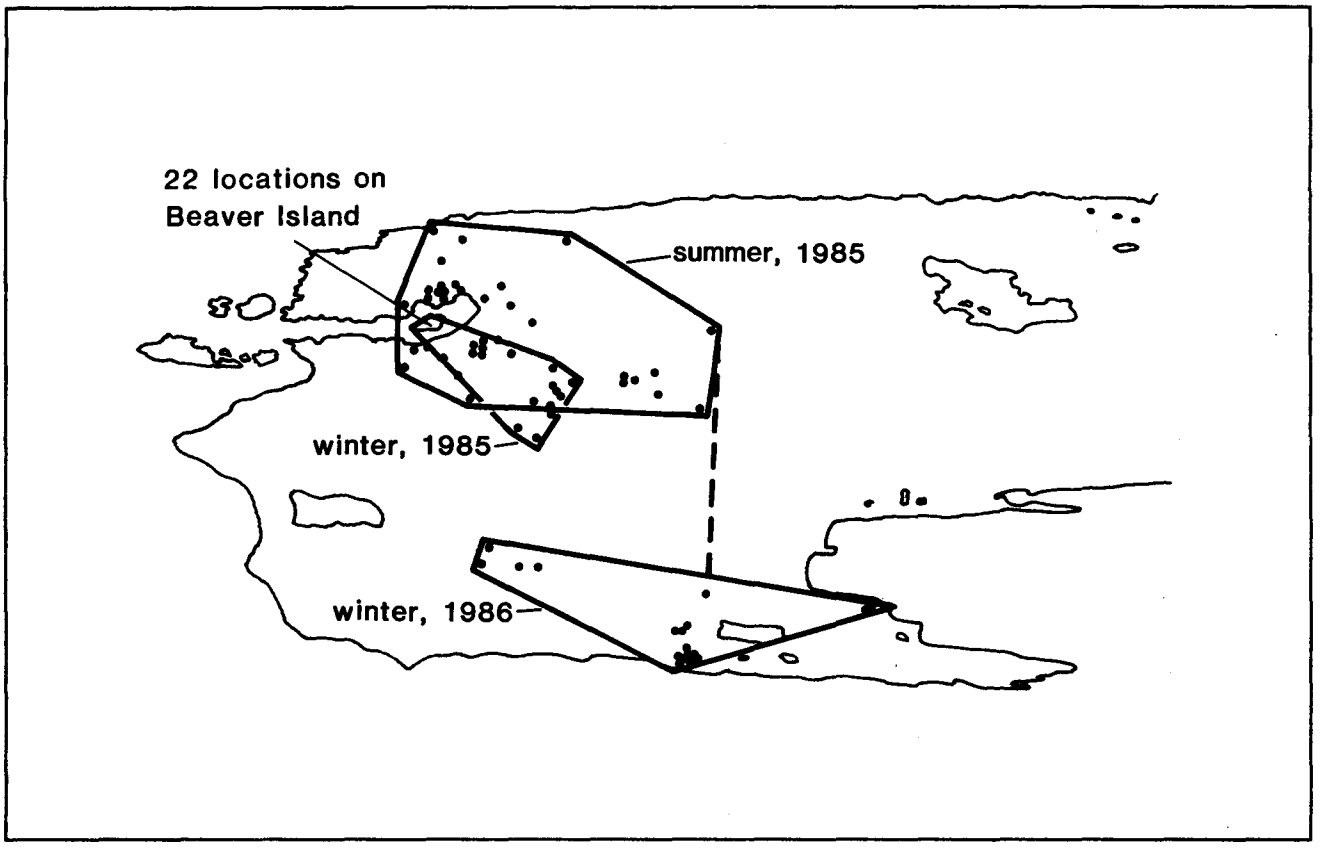


Figure 18. Index to fox observations from aircraft, 1972-86. Lower bar is the number of foxes seen away from moose carcasses/100 hours, while the upper bar is the sum of the maximum number of foxes seen at each carcass.

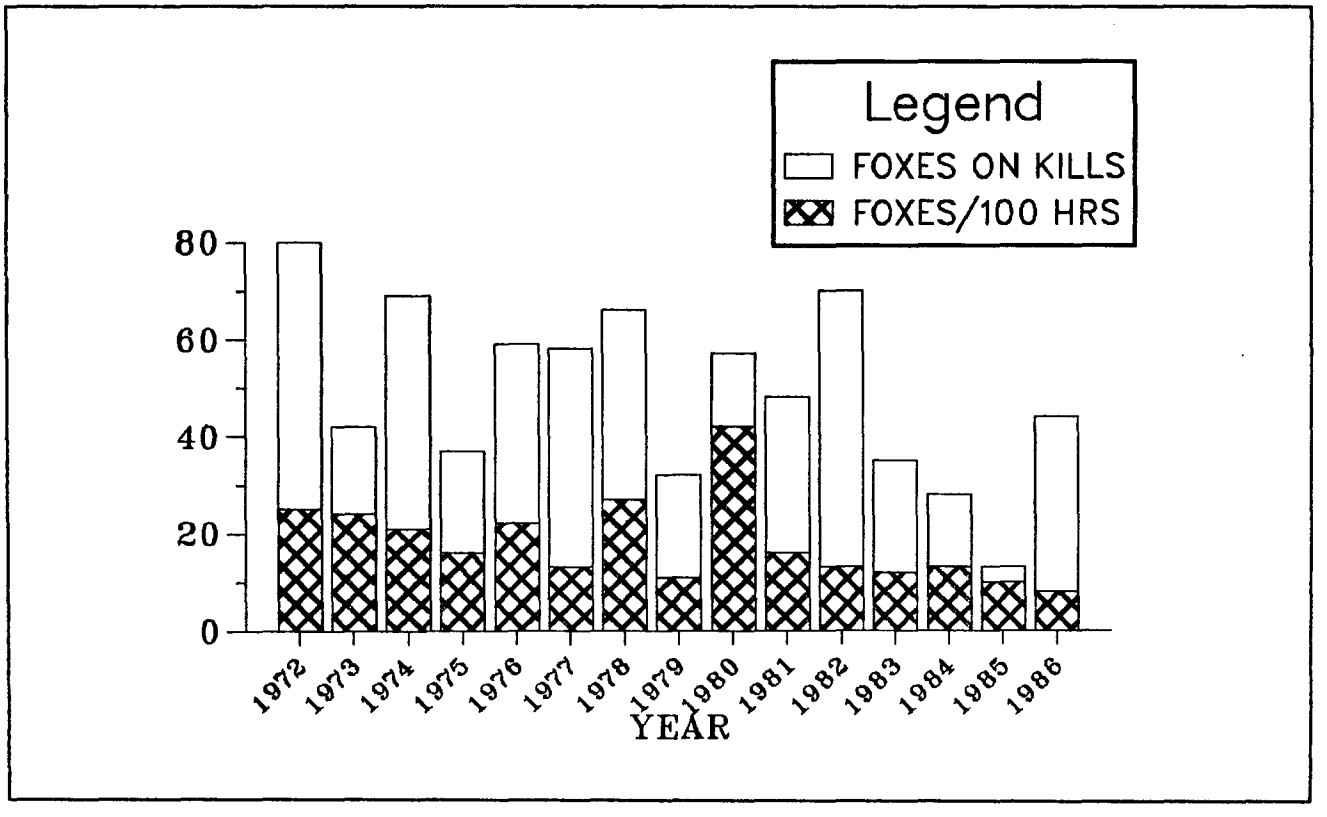


Figure 19. Alpha female (right) begins to force beta female into passive submission after the latter wolf returned to the pack from a solo journey during the breeding season.

Figure 20. Lone wolf waits on offshore pack ice after being chased from a kill by the West Pack II.

Figure 21. Pilot Glaser competes with red fox for specimens.

Figure 22. West Pack II feeds on carcass of moose that fell off an icy cliff. Alpha pair in left foreground.

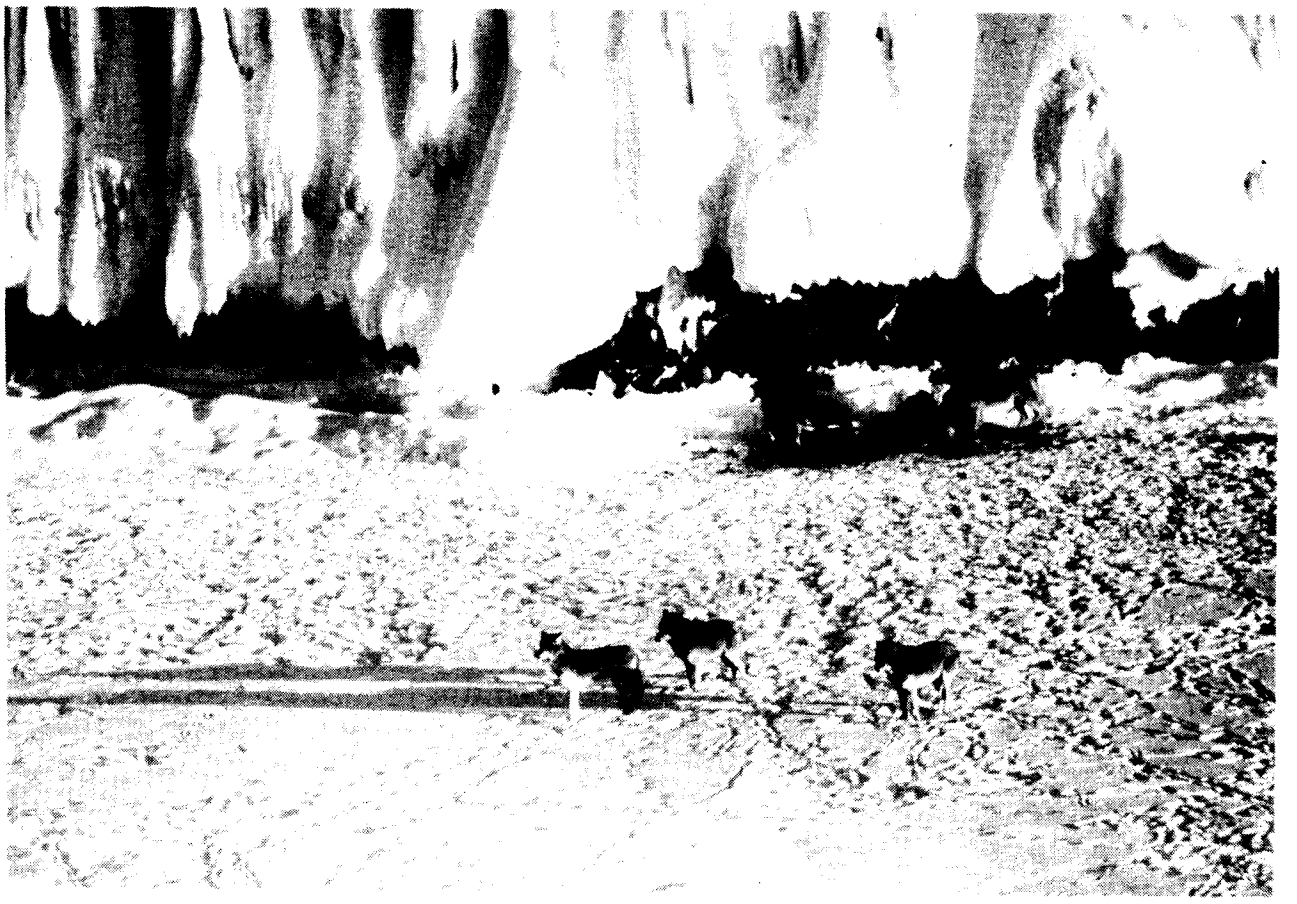


Figure 23. West Pack II wolves: alpha female in front, followed by alpha male; beta female fourth in line.

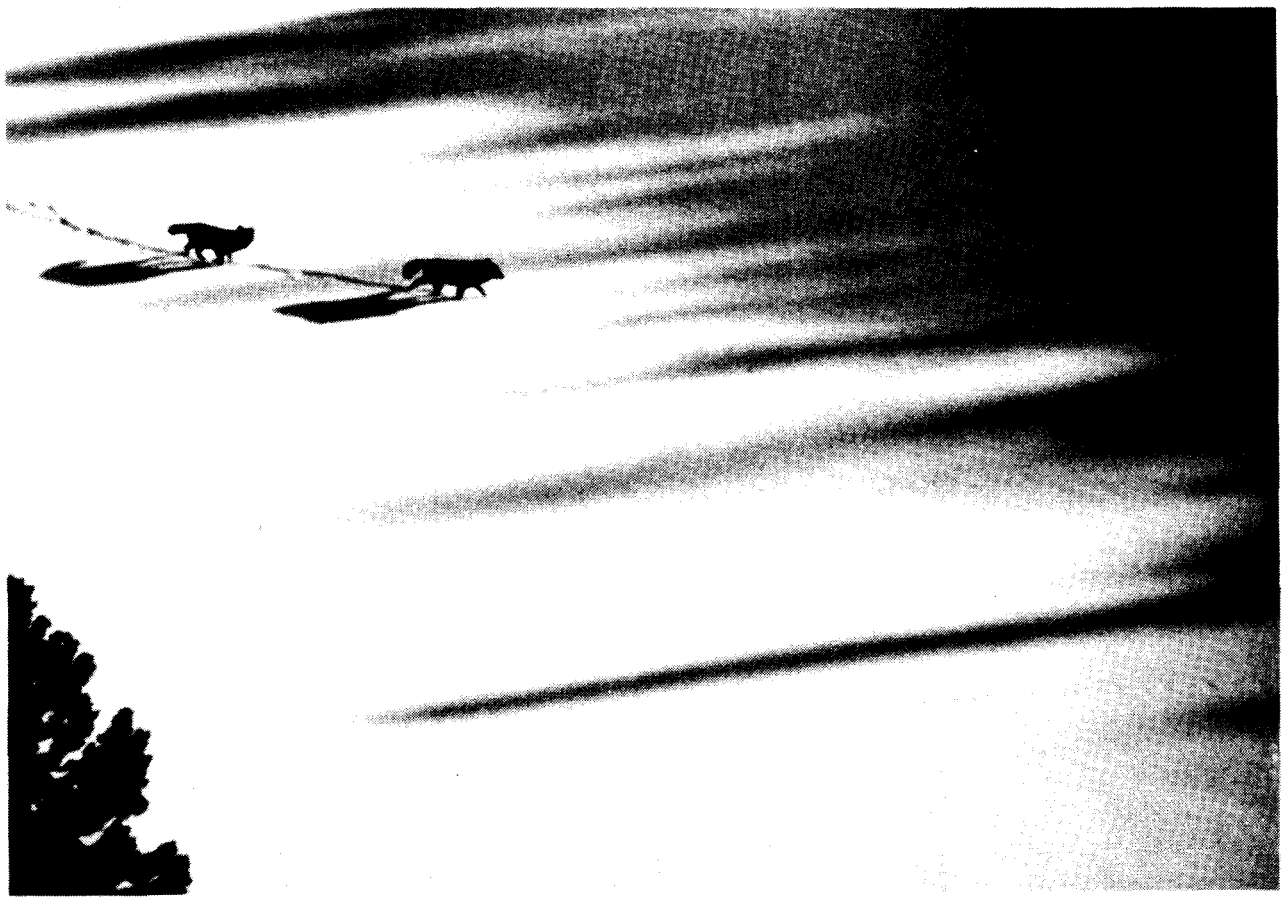



Figure 24. West Pack II alpha pair initiates travel at sunset.