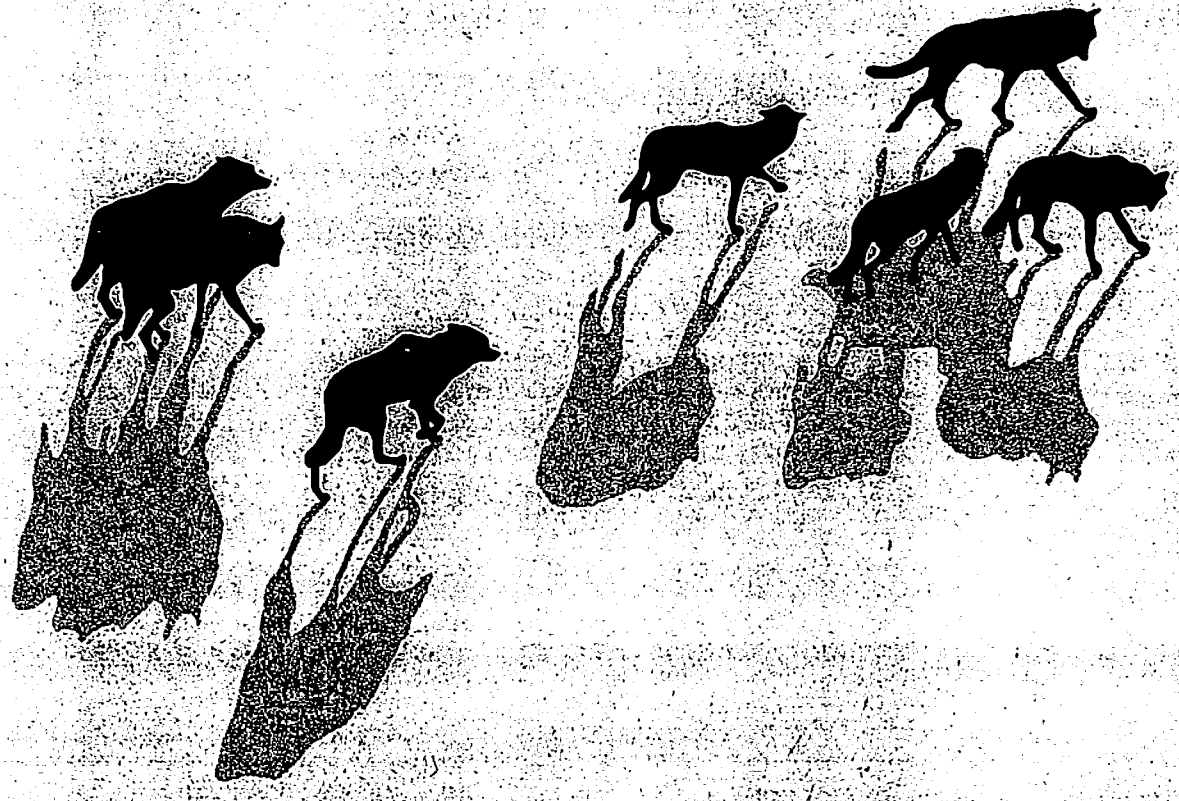
ECOLOGICAL STUDIES OF WOLVES ON ISLE ROYALE

ANNUAL REPORT

1983-84



ECOLOGICAL STUDIES OF WOLVES ON ISLE ROYALE*

Annual Report - 1983-84

(Covering the twenty-sixth year of research)

by

Rolf O. Peterson
Department of Biological Sciences
Michigan Technological University
Houghton, MI 49931

(with the assistance of graduate
students Kenneth L. Risenhoover,
Richard E. Page, and Jacqueline Wilcox)

15 May 1984

NOT FOR PUBLICATION
(Please do not cite without author's permission)

*During the past year this research was supported by major funding from the U.S. National Park Service, National Geographic Society, Boone and Crockett Club and National Rifle Association, with additional donations from R. A. Absolon, Mr. and Mrs. P. M. Carter, Mr. and Mrs. K. Mason, Quaker Oats Foundation, and Rohm and Haas Company.

Photographs by R. O. Peterson, courtesy of National Geographic Society.

Cover page drawing by Fred Montague, RFD #5, Monticello, Indiana 47960

SUMMARY

In 1983-84 the Isle Royale wolf population remained at about the same level as last year, in spite of considerable turnover and changes in all 3 wolf packs. The moose population appears to have declined slightly to less than 800 animals, although the long-term trend for moose is expected to remain upward (Fig. 1). Our current ideas on wolf-moose dynamics at Isle Royale lead to the prediction that the wolf population should stabilize at the current level while the moose population continues to increase.

The wolf population continues to be partitioned into 3 packs, with all packs reproducing in 1983. Overall numbers were maintained as the West Pack II increased and the Harvey Lake Pack and East Pack II both declined. The 1984 population included 10-11 pups, implying 39-43% mortality among animals present in 1983. Territorial overlap and conflicts continued in 1984; the Harvey Lake alpha female was killed by the West Pack II during the winter study.

After 2 years with substantial recruitment, Isle Royale mooose apparently declined slightly in 1983-84. A reduced cohort of 1983 calves appears to be the most reasonable explanation. It remains to be seen if lower recruitment resulted primarily from loss to wolves or if it is partially attributable to the very young age structure of the population. Midwinter mortality to wolves continues to be low, with wolves relying largely on old adult moose exhibiting a very high incidence of arthritis. The 1983 calves continued to exhibit the low vulnerability to wolves in winter that has been characteristic of recent cohorts. We expect continued growth of the moose population in spite of a lower rate of increase caused by wolf predation.

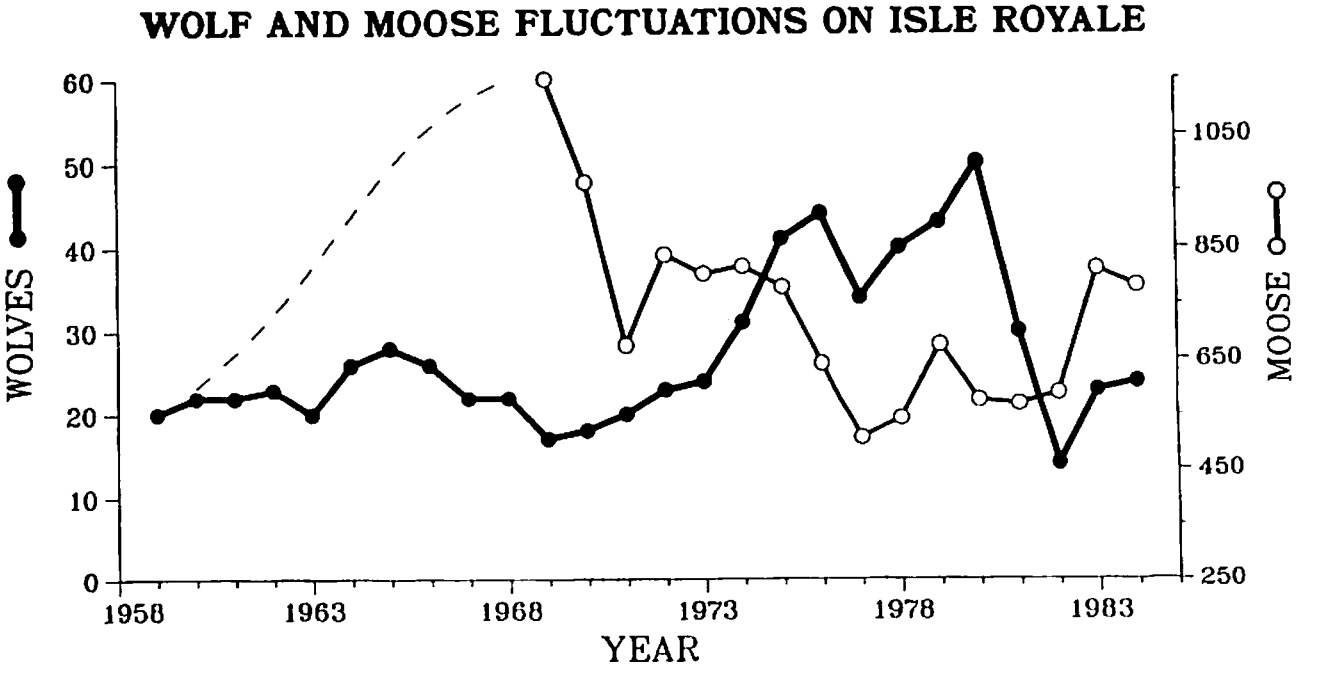


Figure 1. Isle Royale wolf and moose population levels, 1959-84.

PERSONNEL, SCHEDULES, AND PUBLICATIONS

Field work during the past year followed the usual pattern, with intensive work during June-August 1983 and in midwinter 1984. Field personnel in summer 1983 were the following:

June 1 - August 24: Timothy G. Laske and Edith N. Greene
June 12 - August 10: Kenneth L. Risenhoover
June 1 - August 31: Rolf and Carolyn Peterson et al.

An aerial survey of moose population composition was flown during October 25-30 after a 1-week delay caused by late leaf-fall. Pilot Fred Stroble flew the survey with Rolf Peterson as observer.

The 1984 winter study was conducted between Jan. 17 and Mar. 7. Pilot Donald E. Glaser once again piloted the survey aircraft, and he and Peterson were present the entire period. Richard E. Page participated during Jan. 17 - Feb. 7. National Park Service personnel assisting during this time were Craig C. Axtell (Jan. 17 - 26), Stuart L. Croll (Jan. 26 - Feb. 7), Jay F. Wells (Feb. 7 - 21), Donald E. Brown (Feb. 21 _ 28), and Bruce W. Reed (Feb. 28 - Mar. 7). Supply flights were flown by the Ely Aviation Unit, Superior National Forest, U.S. Forest Service.

The following publications appeared during the past year (reprints available upon request):

Peterson, R. O. and R. E. Page. 1983. Wolf and moose population fluctuations in Isle Royale National Park, U.S.A. Acta Zoologica Fennica 174:251-253.

Peterson, R. O., C. C. Schwartz and W. Ballard. 1983. Eruption patterns of selected teeth in three North American moose populations. Journal of Wildlife Management 47(3):884-888.

Peterson, R. O., J. D. Woolington, and T. N. Bailey. 1983. Wolf management and harvest patterns on the Kenai National Wildlife Refuge, Alaska. Pages 96-99 in L. Carbyn (ed.). Wolves in Canada and Alaska. Canadian Wildlife Service Rep. Ser. No. 45. Ottawa.

Shelton, P. C. and R. O. Peterson. 1983. Beaver, wolf and moose interactions in Isle Royale National Park, USA. Acta Zoological Fennica 174:265-266.

THE WOLF POPULATION, 1983-84

In spite of the seemingly precarious position of the Harvey Lake Pack (it has little exclusive territory and was attacked by both neighboring packs last year), all 3 wolf packs from 1983 persisted into 1984 and all packs successfully reproduced. The West Pack II increased and both Harvey Lake Pack and East Pack II declined. The total population numbered 24 wolves, virtually unchanged from the 23 present in 1983 (Fig. 2). A total of 10-11 pups were present in this year's population, implying that 39-43% of the animals present in 1983 had died (mortality the previous year was 29%, more typical of a protected wolf population). Such high mortality may reflect the fate of many of the pups present in 1983 (comprising 56% of the population). Only 1 dead wolf was recovered during the past year, the alpha female from the Harvey Lake Pack killed during the 1984 winter study.

Distinguishing different packs and interpreting behavior requires recognition of individuals. In the past we have had only limited success in this effort unless individuals were strikingly different in appearance (Fig. 2). Furthermore, observations with binoculars from circling aircraft were only marginally useful because of vibration. In 1984 we were pleased to make use of a gyro-stabilized monocular viewing device (Model XM-21, Fraser-Volpe Corporation, 1025 Thomas Drive, Warminster, PA 18974). Virtually all vibrations were removed by the stabilized monocular, which increased the usefulness of our aerial observations by an order of magnitude.

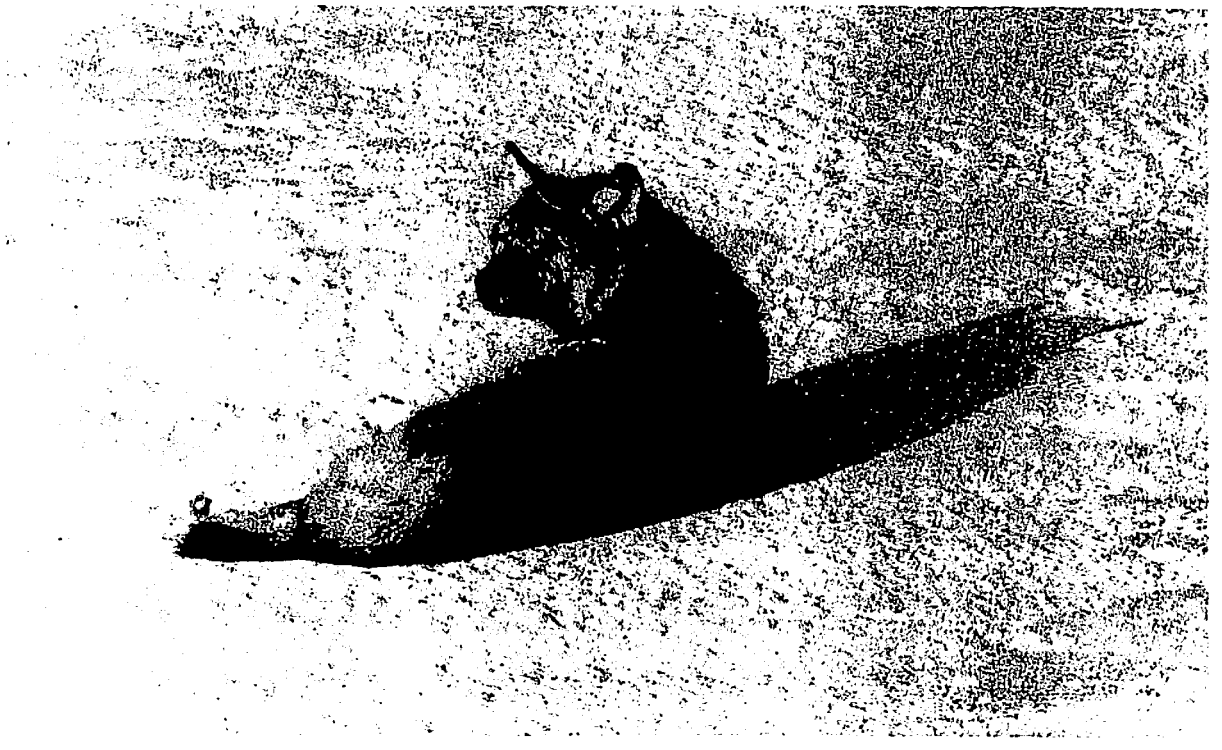


Figure 2. East Pack II alpha male resting on the ice-- graying muzzle and sides suggest an old wolf.

Summer, 1983

Pups were produced in all 3 packs in 1983, but total number was determined only for the Harvey Lake Pack (HLP). HLP used a traditional den site and 2 pups were heard howling several times through the summer. The East Pack II den was located and pup tracks seen, but no howling was heard all summer. From this we surmised that relatively few pups were probably present. Several pups were heard howling in the West Pack II at a rendezvous site located in August. Notable in 1983 was the almost total lack of success in stimulating howling responses-- 1 response in over 100 attempts. We speculate that the lack of howling responses may be linked to the rapid change in territorial relationships over the past 2 years and the aggressive nature of the West Pack II (i.e., perhaps it pays not to "advertise").

Scat examinations indicated that wolves again relied heavily on moose calves in summer (Fig. 3). The ratio of moose to beaver in scats was almost 3 to 1, and moose calves accounted for 94% of all moose remains. The high occurrence of calves in summer wolf scats over the past 3 years probably reflects high calf vulnerability.

Subsequent winter observations are consistent with the idea that initial pup production was low in the HLP and EPII, but survival of the pups that were produced was high. Winter observations also indicated that pups were about normal size (some had appeared growth-retarded in 1983).

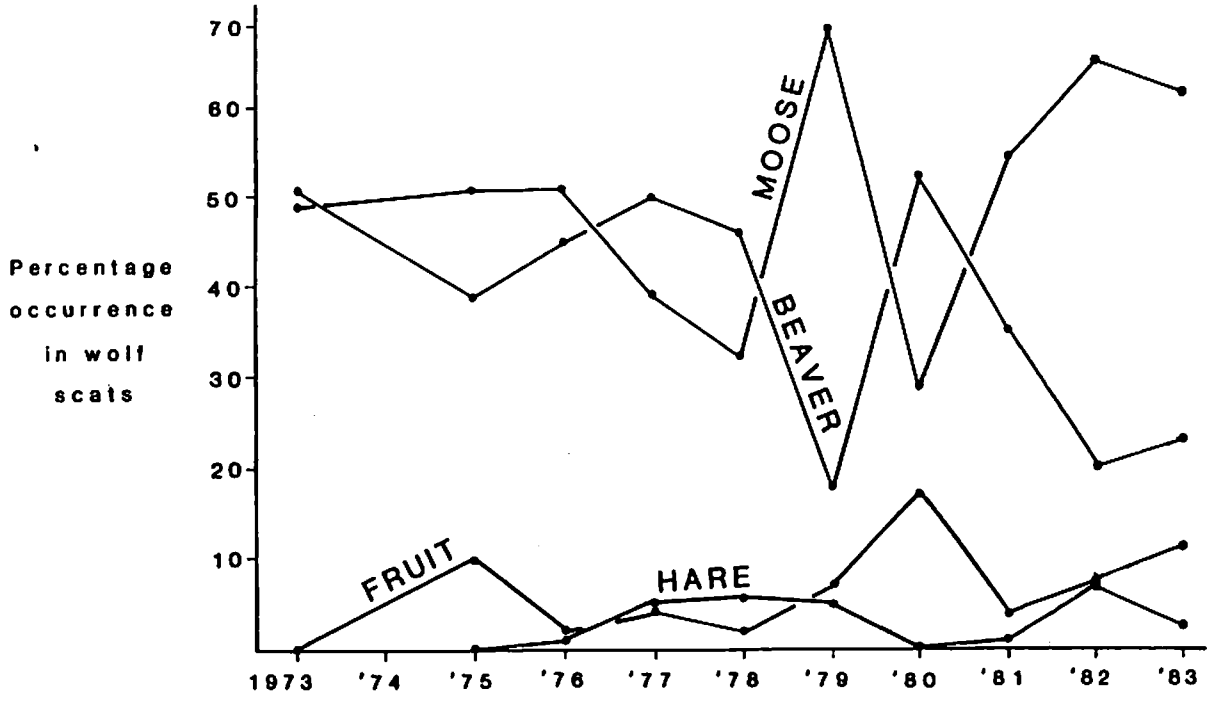


Figure 3. Summer diet of Isle Royale wolves, as indicated by percentage occurrence among food items in wolf scats.

Winter, 1984

The winter population consisted of 21 wolves in 3 packs plus 3 single wolves. The East Pack II consisted of an adult pair plus 3 pups, the Harvey Lake Pack contained 2 adult males, 2 adult females, and 2 pups; both these packs declined in number from 1983. The dominant West Pack II continues to flourish, with 5-6 pups present in this pack of 10 wolves.

The spatial organization of the wolf population remained very similar to that of the previous year (Fig. 3). The Harvey Lake Pack had very little exclusive territory, although the alpha pair actively scent-marked throughout their travels. HLP was completely overlapped by the West Pack II and the East Pack II. (1984 pack territories are shown in Fig. 6).

Courtship behavior was observed between the West Pack II alpha male and female on Feb. 16, and estrous bleeding and/or courtship behavior was noted in the East Pack II alpha pair during Feb. 20-24. Following the death of the Harvey Lake Pack alpha female during Feb. 10-12, the sole remaining female became dominant and exhibited courship behavior on Feb. 15 & 18. In 1984 we once again expect 3 litters of wolf pups, providing the Harvey Lake Pack persists.

Twice during the 1984 winter study the West Pack II moved into the area utilized by the Harvey Lake Pack. The first contact between the packs occurred during Feb. 10-12, when we were grounded by rain and fog (fortunately, all movements of packs during this period were preserved in frozen slush the thaw). Tracks suggested extensive chases covering several kilometers, in the midst of which we recovered the remains of the alpha female (Fig. 7) from the Harvey Lake Pack. The remaining observations of this pack, on Feb. 15 and 18, revealed that the alpha female position was quickly filled, but mate preferences had not yet been worked out. The new alpha female actively courted the subordinate male in the pack, very likely a potential suitor from the past. Whenever he exhibited the slightest courtship behavior, however, the subordinate male was completely subdued by the alpha male. Meanwhile, the alpha male and the new alpha female seemed uninterested in each other (twice during this period the pack revisited the carcass of the dead alpha female). After this time tracking conditions deteriorated completely and we did not determine the final outcome of this "triangle" relationship. We expect that the new alpha female eventually did breed, but with whom?

It is well-established that scent-marking plays an important role in territorial boundary marking, and also reflects dominant status and breeding condition. During courtship an alpha pair will customarily "double-mark" the same sites. After assuming the position of dominant female in the HLP, this new alpha exhibited a high rate of scent-marking (7/hr), but these were all solo marks without the participation of the alpha male. The overall scent-marking rate of Isle Royale wolves in 1984 seems elevated over the pre-1982 period, but considerably lower than in 1982, when the population was completely reorganized (Fig. 4).

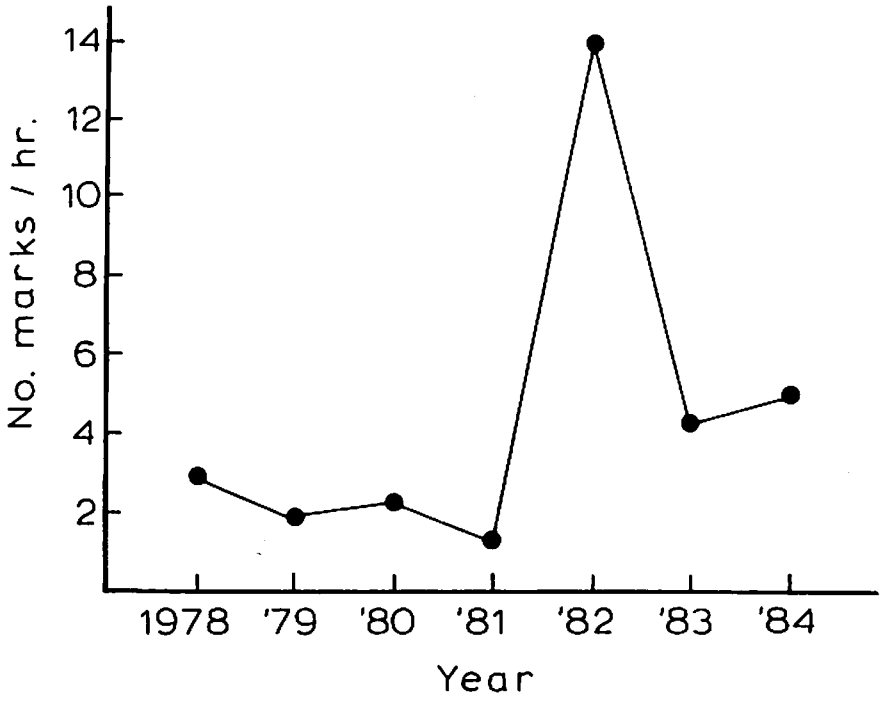


Figure 4. Scent-marking frequency for traveling wolf packs on Isle Royale (excluding observations during intensive hunting).

Figure 5. Under the watchful eye of the rest of the pack, a pup in the East Pack II slides down a steep hillside.

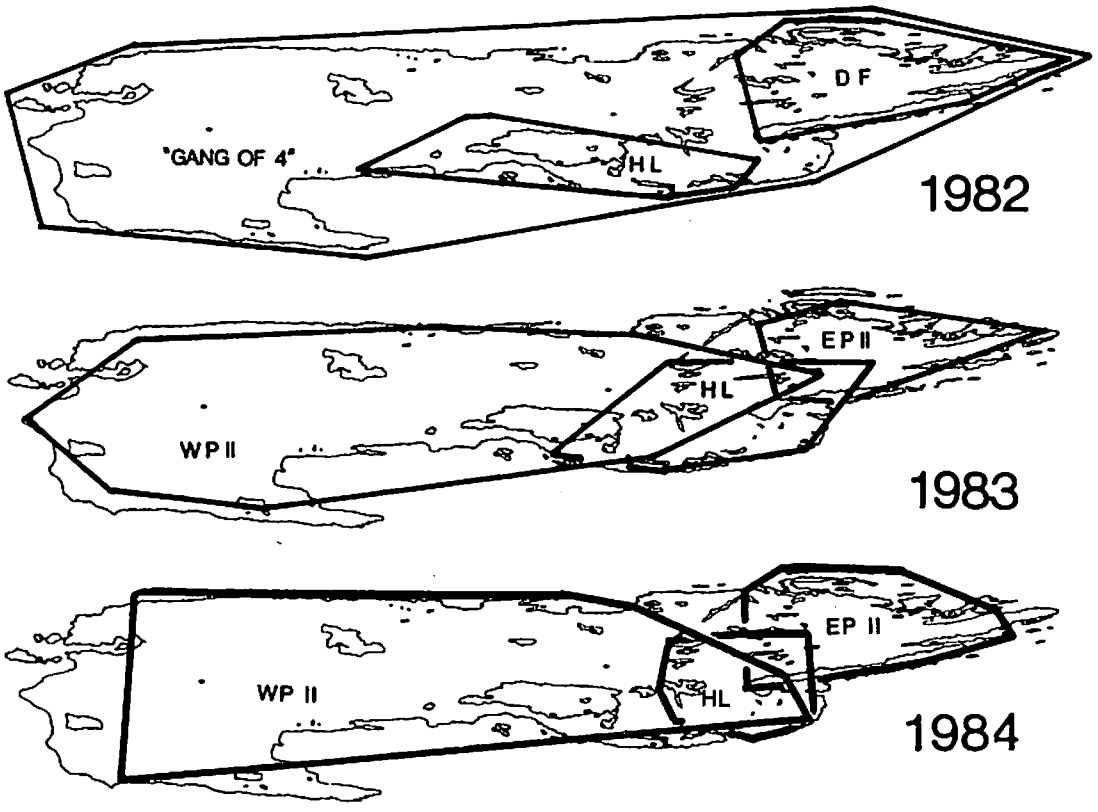


Figure 6. Pack territories as indicated by movements, 1982-84.

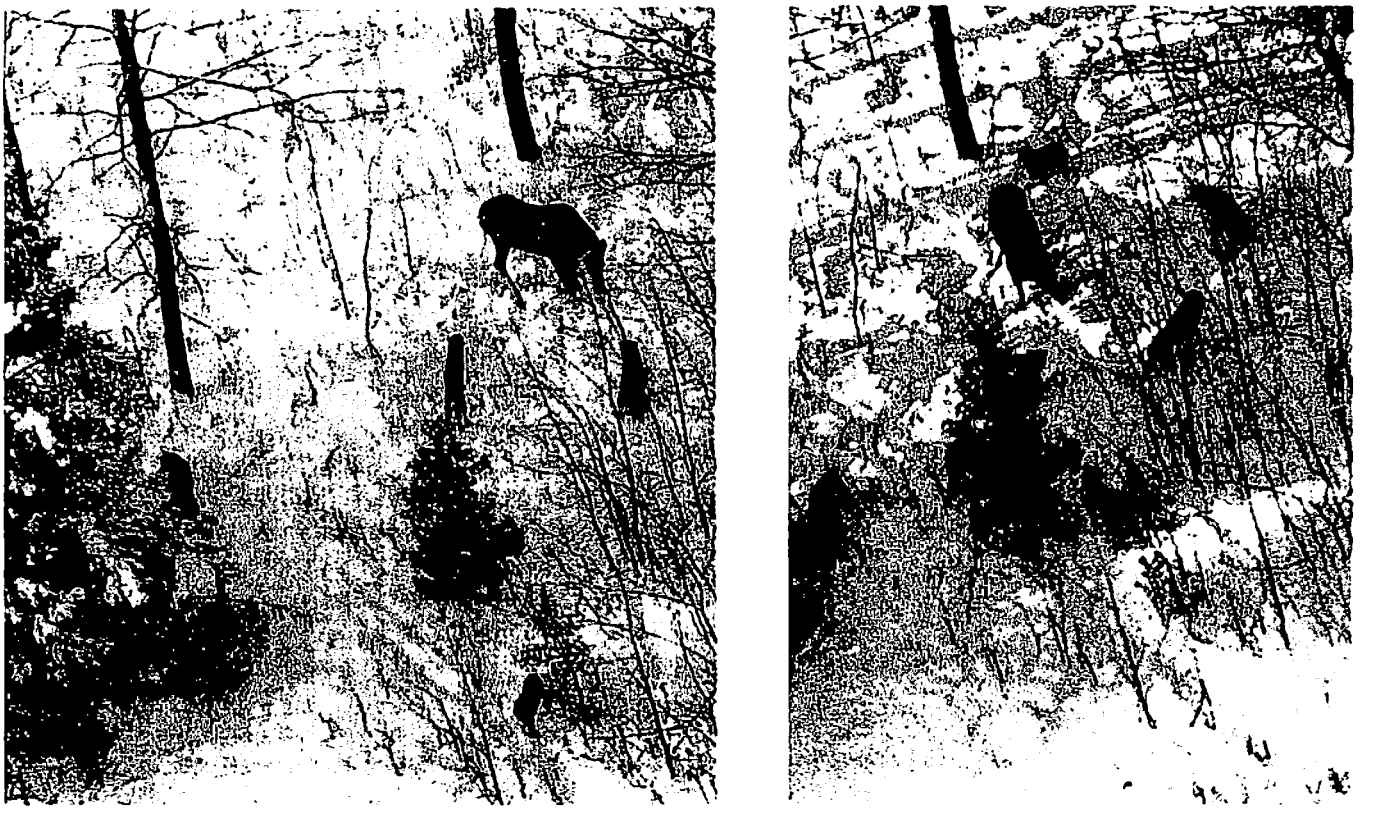
Figure 7. Remains of the HLP alpha female (killed by WPII) had been mostly consumed by foxes prior to recovery.

Predation rate by Isle Royale wolves in winter continued at the low level of 1 kill/3.1 days for the entire population, or 1 kill/pack/9.3 days. This represents the lowest kill rate for over a decade. As expected, utilization of carcasses was virtually complete. Food availability averaged 4.9 kg/wolf/day and varied little among packs. Travel rates (Table 1) for all packs in 1984 were low, reflecting a lack of extensive shoreline ice and very slow travel conditions in the island's interior due to snow conditions. Hunting wolves were observed in 1984 for 6.7 hrs, during which time they tested 14 moose without making a kill (but see below).

One kill by wolves was witnessed in 1984, although the wolves were already attacking the moose when we arrived on the scene. The West Pack II containing all 10 wolves was involved, with the victim an old bull moose that they had wounded previously. This is only the fourth kill witnessed by Peterson on Isle Royale in the last 14 years (Fig. 8).

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

	West Pack II 1984	Harvey Lake Pack 1984	East Pack II 1983	All packs, 1971-83 average (sample size)
Pack size	10	6	5	8.8 (32 packs, 13 years)
Travel rate (km/day)	5.5	3.2	4.3	10.3 (9,420 km/915 pack-days)
Kill interval (days)	5.6	10.0	12.3	5.3 (1,394 pack-days/265 kills)
Travel between kills (km)	30.8	32.0	52.9	40.6 (8,566 km/211 kills)



(a) (b)

Figure 8. West Pack attacks bull moose, destined to become #1768 in our autopsy series. The moose had been wounded 2 weeks previous to the final attack and also exhibited periodontitis, a severely arthritic hip, and fat-depleted bone marrow. The moose's crippled rear leg hung useless (a) but it managed to stay upright for at least 30 minutes while the wolves attempted to bring it down. Though it is difficult to see in the photo (b), one wolf climbed onto the rear and back of the moose in an unsuccessful attempt to force the moose down.

THE MOOSE POPULATION, 1984

Both the midwinter moose census and a winter aerial index to moose observations suggested a slight drop in moose numbers from 1983 to 1984. In 1983 the census indicated 900 $\pm$ 195 moose (95% confidence interval), and our combined "best estimate" (derived from the census plus a winter and a summer index) was 811 animals. In 1984 the census estimate was 781 $\pm$ 187 moose and the winter index declined 23% to 5.0 moose/hr. A drop in the % calves compared to the past 2 winters suggests that the decline

is real and may be attributed to lower calf recruitment. It remains to be seen if moose will level off at present numbers or continue to increase, albeit at a slower rate of growth. We have predicted that Isle Royale moose should increase almost 3-fold over a 15-20 year period. A moose population growing unimpeded could produce such an increase in less than half that time.

1984 census

A stratification survey was completed shortly after we arrived on the island and continued favorable flying conditions allowed us to count all plots before the end of January. No pronounced shift in distribution (Fig. 9) was noted after our arrival, although use of conifer cover on a micro-scale increased greatly after a strong surface snow crust formed in mid-February. The census estimate and 95% confidence interval of 781 $\pm$ 187 includes 40 moose counted during complete coverage of small islands. Ten moose were counted on both Washington Island and Amygdaloid Island. Calf percentage was 15% for 143 moose on plots on the main island and 28% for 40 moose on offshore islands (refuge from wolves).

Recruitment surveys

An autumn survey of moose population composition was hampered by sun and very warm temperatures, even after a 1-week postponement to the last week of October. Only 87 moose were classified. A great excess of bulls indicated a systematic bias. Young males were apparently more easily detected than other moose, as 44% of all bulls possessed antlers with 3 or fewer tines per antler. If only moose with 2 tines or fewer are considered yearlings, the resulting percentage is still 27%. In both cases the yearling proportion was greater than the calf proportion last winter.

Yearling bias notwithstanding, it appears that recruitment from the 1983 cohort was above the average of the past decade, but probably lower than in 1981 and 1982 (Fig. 10). Given the stable trend in adult mortality, variation in total moose numbers probably reflects recruitment variation. Similar to the past 2 years, 6 sets of twin calves were located in the 1984 winter study.

Moose mortality and pathology

Carcasses of 17 moose were located during winter, 1984. Only 3 of these were calf moose, suggesting low vulnerability in this age group. Of the 14 adults, 12 exhibited either arthritis or periodontitis and 10 had arthritis. The distribution of all kills in shown in Fig. 11.

For several years Isle Royale wolves have relied primarily on old adult moose in winter and have killed relatively few calves. Since 1980 calf proportion in winter has averaged 20% in the population but only 10% among wolf-killed moose ($\bar{N}$ = 95). Previously calves were at least twice as numerous among wolf-kills than in the living herd.

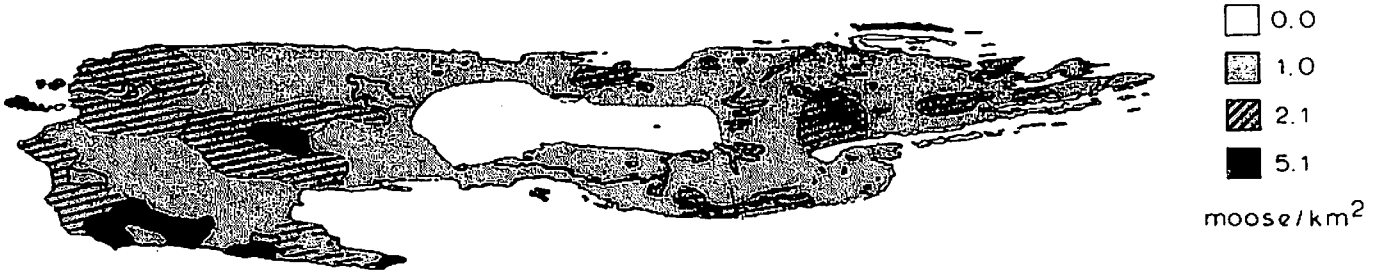


Figure 9. Midwinter moose distribution on Isle Royale, January 1984.

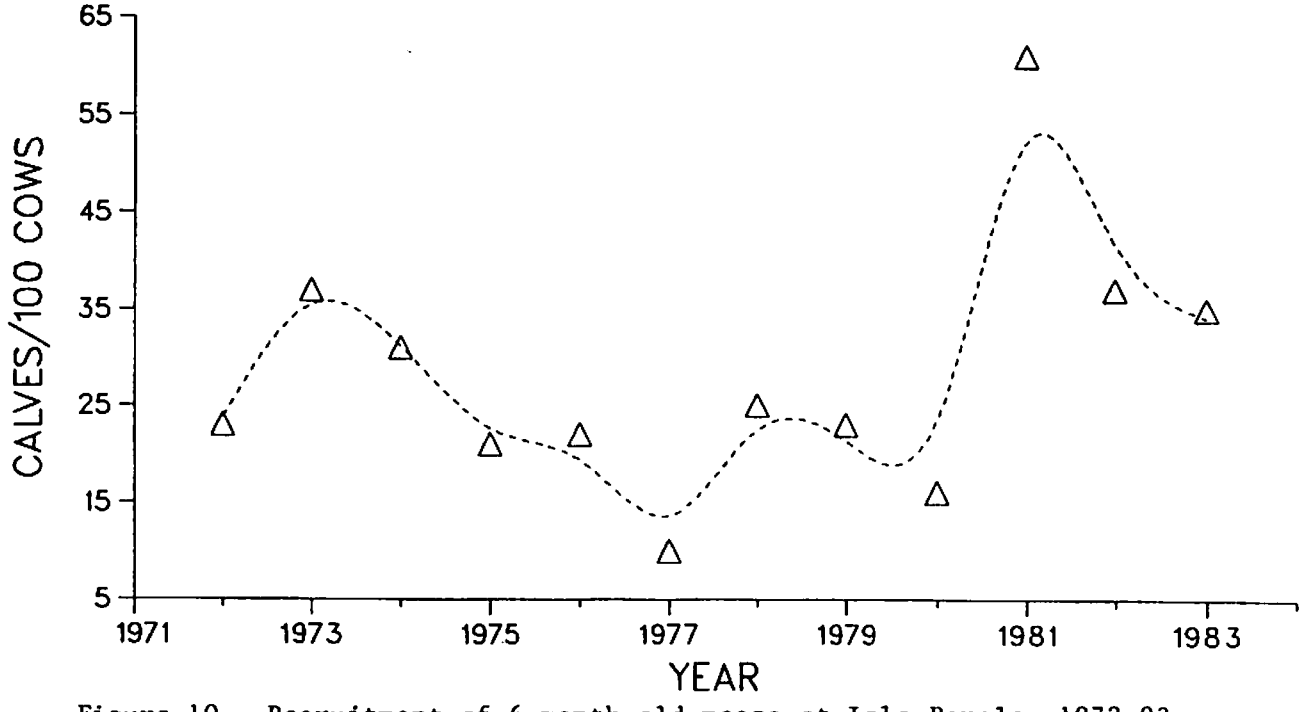


Figure 10. Recruitment of 6-month-old moose at Isle Royale, 1972-83.

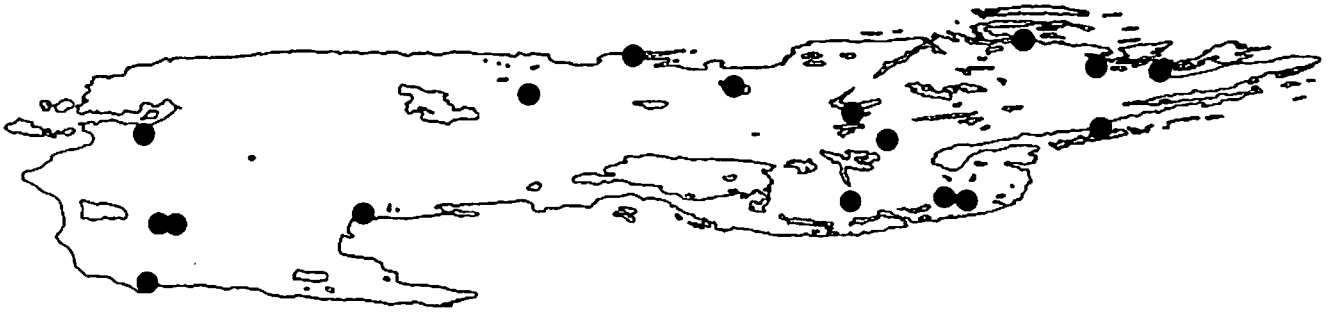


Figure 11. Distribution of dead moose located during 1984 winter study. All dead moose located were killed by wolves.

It is not yet clear if the shift in age structure of wolf-kills is due to lower intrinsic vulnerability among calves (due to greater viability or defense from cows) or simply exceptionally high vulnerability among old adult moose. Low calf vulnerability is suggested by the low overall kill rates in the face of moderate or high calf abundance. Calf metatarsal measurements have confirmed that cohorts from 1980-82 were physically larger ($P < 0.001$) than calves born a decade previously.

Bare areas were commonly observed on moose during the 1984 winter study. We suspect that moose ticks are responsible, but this could not be confirmed. No ticks were found at the sites of any wolf-killed moose.

Marrow fat values from wolf-killed moose in 1984 ranged over the entire possible range (Fig. 12). Three moose killed by wolves at varying lengths of time after being wounded by wolves provided some insight into marrow fat depletion patterns. Moose #1768 was killed after 2 weeks of very restricted movements and probably little forage intake. This moose exhibited periodontitis, a severely arthritic hip, and a partially crippled rear end (from the initial attack). Femur marrow from #1768 contained 50% fat, compared to undepleted levels of at least 80%. Moose #1773 was killed 4 weeks after being chased and probably wounded by wolves; this moose had earlier suffered a broken mandible (Fig. 13), mostly "reconstructed" by new bone growth at the time of death, plus one severely arthritic hip. Proximal leg bones contained about 27% fat, with progressive depletion toward distal bones, measuring about 68% fat. Moose #1774 was killed about 6 weeks after being wounded by wolves and during that time was ambulatory but exhibited very restricted movements. It was evidently quite weak and fell down a steep slope just before death; proximal and middle leg bones contained 16-18% "fat" (mostly cellular debris) while distal bones still contained just over 50% fat. Fat depletion occurred in all bones simultaneously, but proceeded faster in proximal bones; front and hind leg bones were very similar.

We observed an interesting demonstration of moose vulnerability on ice on March 4. Near Daisy Farm we found a cow moose (bedded) with calf (standing) on glare ice over 100 m from shore (Fig. 14). This occurred when snow was hard-crusted and moose often sought open lakes when traveling (Fig. 15). Accumulated pellet groups indicated that the cow and calf had stayed on the ice overnight. We landed for a closer look and found both moose uninjured. We slowly moved to within 3 m of the pair as the cow stood and assumed standard defensive posture over the rear of her calf. Both moose, especially the calf, seemed reluctant to move and the cow refused to leave her calf. The pair had apparently been stranded after walking across patches of packed snow the previous night, when cold temperatures provided less slippery conditions. We left the moose as we found them, thinking they had little chance to survive on such an important wolf travel route. However, it snowed that night for the first time in 3 weeks and the moose walked safely to shore.

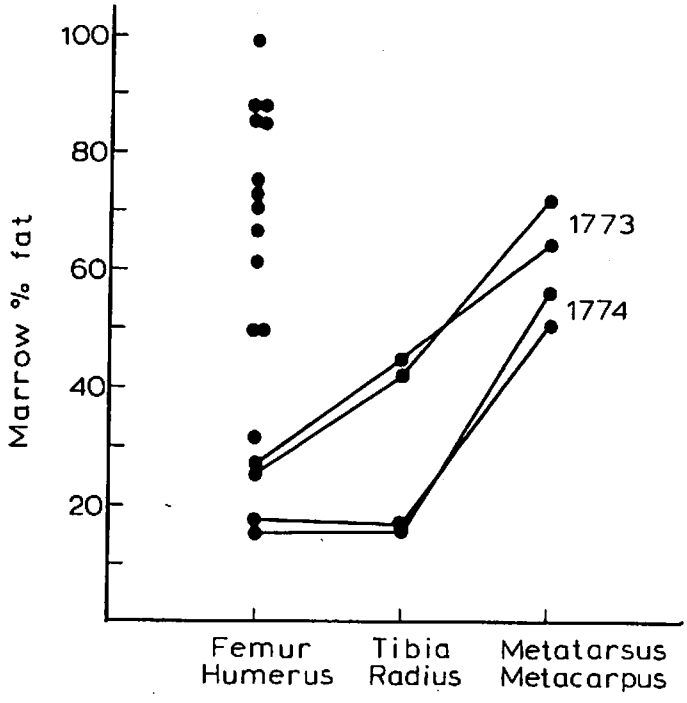


Figure 12. Marrow fat values from wolf-killed moose on Isle Royale, 1984. Connected values are from a single leg (moose autopsy number indicated).

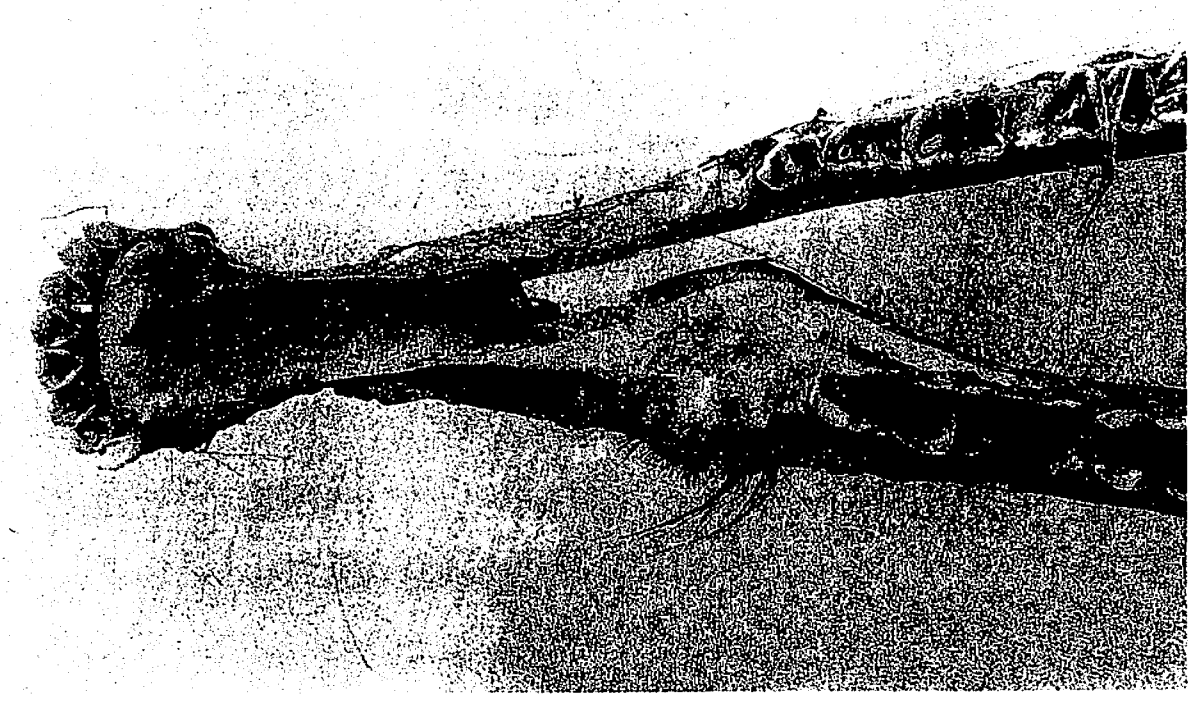


Figure 13. Partially reconstructed broken mandible of moose #1773.

Figure 14. Cow and calf stranded temporarily on glare ice, March 1984.

Figure 15. Moose found lake ice to be very slippery after seeking refuge there from hard-crusted snow in the interior.

WINTER WEATHER AND SNOW/ICE CONDITIONS

Winter temperatures prior to our arrival had been uniformly cold without any thaws. The snow was of average depth but of unusually low density (0.14 g/cm^3) (Fig.16). These conditions prevailed through the first half of the winter study period, offering little resistance to moose movement but greatly hampering wolves. During numerous observed encounters with moose, wolves rarely even tried to give chase if a moose ran off as they approached.

A mid-February thaw with rain reduced the snow pack substantially and increased overall density to 0.31 g/cm^3. With the return of cold temperatures a 10-cm thick surface crust hardened to an average strength of 3.0 kg/cm^2 (range 0.2 - 7.0 kg/cm^2), the strongest ever measured at Isle Royale. Of course, wolves were fully supported and even left no tracks. Moose could walk and even trot on the crust most of the time, but infrequent penetration of the crust left many with bloody legs and unreliable footing. Moose tended to group together and became very difficult to observe, indicating reduced movements generally restricted to conifer areas.

Precipitation during the winter study was only 4.3cm, including 2.0cm of rain. Mean maximum and minimum temperatures were -2.8 deg.C and -11.6 deg.C, while temperature extremes were +8.9 deg.C and -29.4 deg.C.

Lake Superior was evidently very warm after the summer of 1983, and there was surprisingly little shoreline ice in winter 1984. Many ice floes blew in and froze together between Isle Royale and Ontario in early March, but it is doubtful that an ice bridge ever formed.

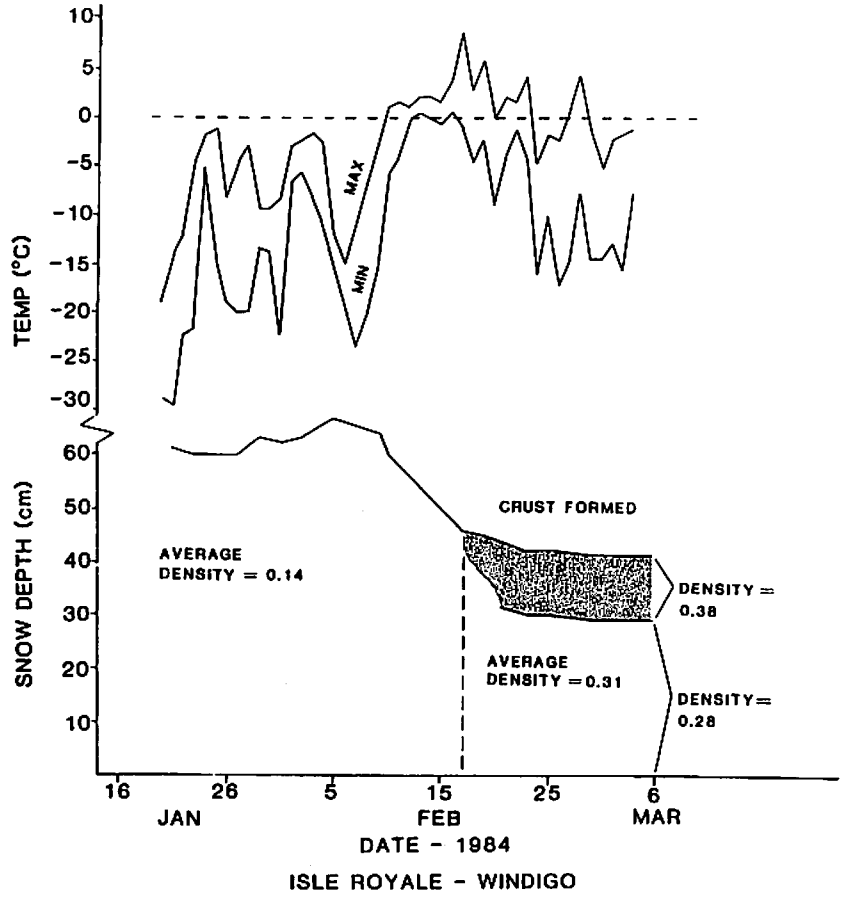


Figure 16. Temperature and snow depth (open areas) during 1984 winter study.

OTHER WILDLIFE SPECIES

The February thaw brought beavers out in numbers, prompting wolves to hunt this alternate prey in earnest. Three beaver were recorded among wolf-kills during this period. Beaver activity above the snow was recorded at 19 different sites and otter tracks were seen at 6 sites distributed throughout the island.

Fox observations continued to be rather low (Fig. 17) in 1984. Fox mobility early in the study was even more limited than that of wolves, and fewer kills coupled with little shoreline ice probably contributed to fewer fox observations.

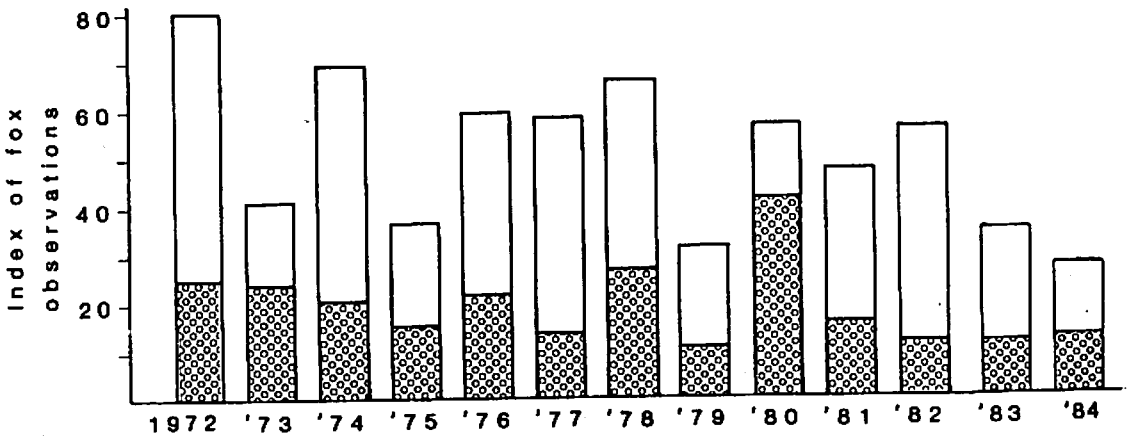


Figure 17. Midwinter fox index, 1972-84. The lower bar is the number of foxes seen more than 1 km from a moose carcass/100 hrs flying time. The upper bar is the sum of the maximum number of foxes seen on each moose carcass.

Figure 18. A researcher and a red fox dividing up a moose carcass.