ECOLOGICAL STUDIES OF THE WOLF ON ISLE ROYALE*

Annual Report

(Covering the eighteenth year in the Isle Royale studies)

1975-76

by

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NOT FOR PUBLICATION

In May 1975 Peterson moved from Purdue University to Michigan Technological University, where he joined the faculty in the Department of Biological Sciences. Following Allen's retirement in mid-1976, Peterson will direct this continuing study of wolf-moose ecology in Isle Royale National Park.

Summer field personnel were the following: Rolf and Carolyn Peterson, April 29 - September 1, September 21 - October 30; James D. Woolington, May 13 - September 1; Joseph M. Scheidler, May 13 - August 13; Durward L. Allen, September 21 - 30. The pilot for the October moose survey was John Brandrup, Bohman Airways Inc., International Falls, Minnesota.

The 1976 winter study period extended from January 26 to March 11. Peterson participated for the entire study period, and we were most fortunate to again have the services of pilot Donald E. Murray, Mountain Iron, Minnesota, who was back for his eighteenth consecutive winter study. Connection flights from Grand Marais, Minnesota, were provided by Wilderness Wings of Ely, Minnesota. National Park Service personnel from Isle Royale who assisted during the winter period were the following: Warren L. Rigby, January 26 - February 5; Superintendent John M. Morehead, February 5 - 19; Donald S. Anderson, February 19 - 25; Delbert C. Galloway, February 25 - March 6; Noel R. Poe, March 6 - 13.

Peterson reported on recent developments in the Isle Royale wolf population at a wolf workshop held during American Behavioral Society meetings in Wilmington, North Carolina, in May, 1975, and at the Midwest Wildlife Conference in Toronto in December, 1975. A National Park Service research monograph resulting from his Ph.D. research will go to press in about a month. Allen spent as much time as possible during the past year on a major book covering aspects of the entire Isle Royale study, 1958-76.

SUMMER FIELD WORK, 1975

Two hiking teams consisting of two people each were used to cover the island, making collections from moose carcasses and skeletons and gathering information on summer wolf ecology. May and June were largely spent locating and examining the wolf-killed moose discovered during the 1975 winter study, while wolf-related work occupied most of our time thereafter. Hiking distance totaled 1760 km (1100 mi), including 824 km (515 mi) off-trail.

Moose observations - summer and fall

Moose observations were tallied during summer field work. Additional information on calf occurrence in 1976 and survival of the previous year's calf crop was provided by an aerial survey after leaf-fall in October. These data are summarized in Fig. 1 and Tables 1 and 2. Calf occurrence during summer ground counts may be lower than the actual proportion in the population, but these records do provide relative data from year to year.

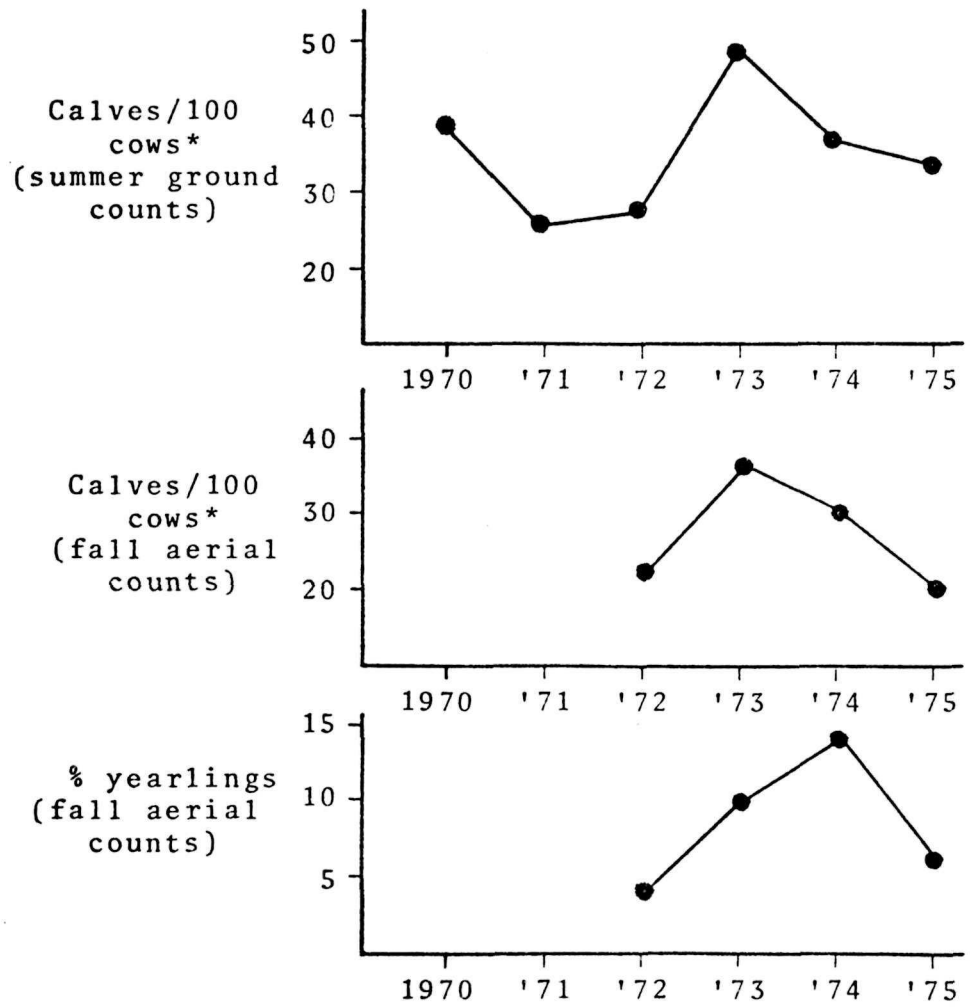

Fig. 1. Productivity and survival data for Isle Royale moose, 1970-75.

Table 1. Moose population composition and productivity, based on ground observations.

	June 9-Sept. 4, 1970	May 18-Sept. 7, 1971	May 9-Sept. 25, 1972	May 4-Sept. 30, 1973	May 6-Aug. 13, 1974	Apr. 29-Oct. 21, 1975
Total seen	192	142	231	244	118	240
Males	64	47	106	92	36	97
Females	91	64	92	102	57	101
Calves	35	19	23	38	21	34
Unknown	2	12	10	12	4	7
Calves per 100 adult females[1/] (after June 1)	39	26	28	49	37	34
No. sets twins	5	1	2	4	4	2

1/ Includes yearling females, which at times cannot be distinguished from older cows.

Table 2. Fall aerial classification counts of Isle Royale moose.

	Oct. 17-19 1972	Oct. 23-25 1973	Oct. 22-25 1974	Oct. 21-22 1975
Total seen	114	192	117	157
Adult bulls	47	73	43	61
Yearling bulls[1/]	2	8	7	4
Cows	53	81	51	76
Calves	12	30	16	16
Bulls/100 cows	93	100	98	86
Percent yearlings[2/]	4	10	14	6
Calves/100 cows[3/]	23	37	31	21

1/ Bulls with spikes or small forked antlers were considered yearlings.

2/ % yearlings = yearling bulls/(adult bulls + yearling bulls).

3/ Yearling females probably are unproductive but cannot be reliably separated from older cows; they are included in the total number of cows observed.

The 1975 calf crop was low, which has been the case almost every year since 1970. Twin occurrence (2 of 32 cows with calves had twins) also indicated a low calf crop. The fall aerial count indicated only 21 calves per 100 cows (including yearling cows), the lowest calf survival in the last four years. This count also showed low recruitment of 1974 calves into the yearling age class.

Low calf crops and poor survival have been recently observed in this moose population each year except 1973. This cohort was born after an exceptionally mild winter and was the greatest calf crop in the last six years. Bone measurements indicated larger physical size at birth that year, also. The 1973 calves survived well through the summer and following winter, and recruitment of yearlings was good the following year. This cohort probably comprises a rather large share of the young adult segment of the population.

The two likely causes of poor calf survival are wolf predation and poor physical condition resulting from fetal malnutrition. Even with the wolf population at an all-time high in 1975 we examined carcasses of 5 calves that died immediately after birth of non-predatory causes (U. of Mich. researcher J. Edwards found two of these on islands. Prior to the recent upsurge in the wolf population, calf survival was related directly to the severity of the previous winter.

Moose mortality, 1975

During 1975, remains of 135 moose were examined, including 55 moose killed during the previous winter by wolves (39 located in winter, 16 in summer). Of the 55 wolf-kills, only 13 (24%) were calves-- Usual calf occurrence in wolf-kills from winter is 30-35%. The adult moose examined have not yet been aged accurately, but in Table 3 they are separated into rough age classes according to tooth wear. While wolves killed considerable numbers of young adults (1-5 years old) in the early 1970s, in 1974 and 1975 predation was again concentrated on the oldest age classes. We interpret this to mean that the young adults that were vulnerable to wolves have been culled from the population, and wolves are relying once again on old adults. The high vulnerability of young adults in the early 1970s was correlated with reduced physical size in these cohorts at birth and subsequently retarded physical development.

Wolf predation continues to be the principal cause of adult mortality, almost all of which occurs during winter. With the wolf:moose ratio at an all-time high, predation pressure is maximal and prevents significant loss directly to malnutrition. In the early 1970s, the wolf population on Isle Royale was not high enough to remove moose affected by winter malnutrition. Wolves were "surplus-killing", yet additional animals were dying of malnutrition, especially in 1972. The number of winter malnutrition deaths recorded (with approximately the same searching intensity) were: 1971 - 6; 1972 - 13; 1973 - 0; 1974 - 9; 1975 - 3.

During summer field work metatarsi were collected from all calves killed the previous winter. Calf size appears to be largely dependent on the severity of the previous winter (Fig. 2), although there is also a trend toward increasing calf size through the first half of the 1970s.

Table 3. Age distribution of wolf-killed moose, winter 1974 and 1975.[1/]

1974

Age	Calf	1+	2+	3+	4+	5+	6+	7+	8+	9+	10+	11+	12+	13+	14+	15+	16+	17+	18+	19+	Total
No.	20	1	-	-	1	1	-	1	-	2	-	1	-	-	-	1	1	-	-	-	

Wear Ave.	Class age (yrs)	I 2.3	II 2.6	III 3.6	IV 5.1	V 7.3	VI 9.2	VII 10.6	VIII 11.9	IX 11.9	Adults of unk. age	
No.		-	-	-	-	-	5	2	2	1	2	41

1975

Wear Ave.	Class age (yrs)	I 2.3	II 2.6	III 3.6	IV 5.1	V 7.3	VI 9.2	VII 10.6	VIII 11.9	IX 11.9	Adults not wear-classed	
No.		2	1	4	4	5	6	5	4	2	9	
No. of calves in the kill: 13												55

1/ At a later date age will be determined for all adults shown in table by the more accurate cementum annulation method.

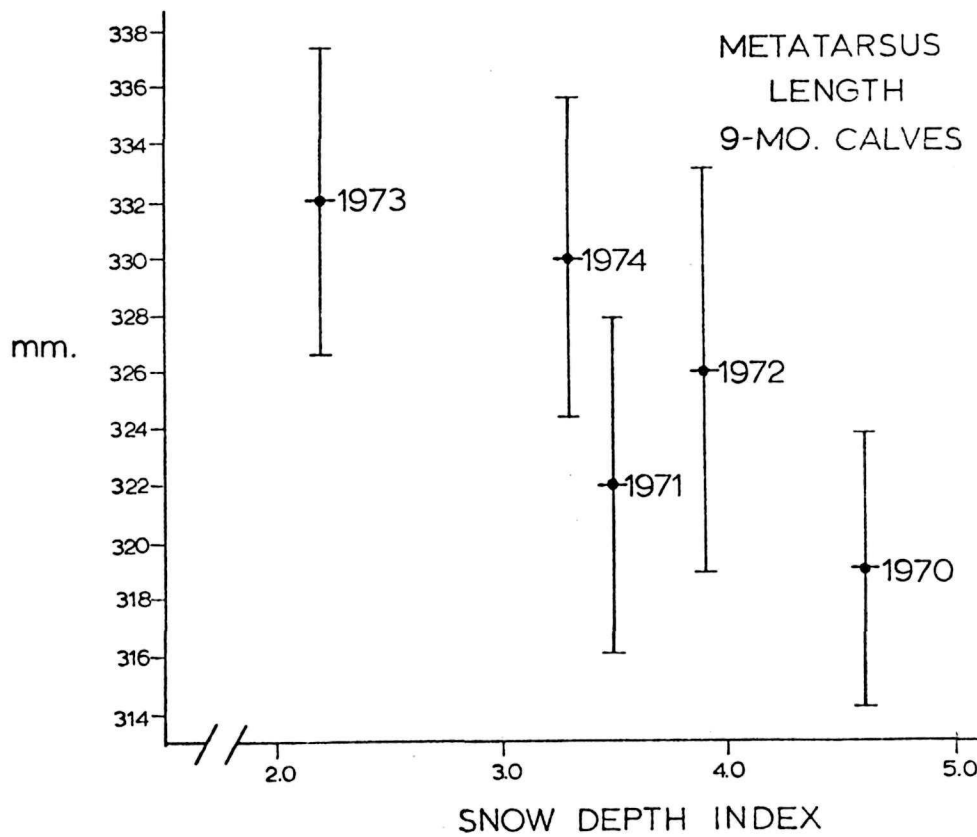

Fig. 2. Relationship between calf size and severity of previous winter (snow depth index derived from Grand Marais, MN, weather records).

Summer wolf data, 1975

At least one litter of pups was born in both the East and West packs, and at least 4-5 pups survived to late summer in both litters, judging from howling. An additional 2 pups were reported in the middle of the island, but it could not be established if these were in the Middle Pack. Thus a minimum of 10-12 pups were alive in August.

The major movements of the East and West packs were followed from the whelping den through a succession of rendezvous sites occupied, in both cases, until the end of August. Homesite locations continued to be in remote areas. Since the population increased by only 3 wolves, pup survival may have been low; the alternative explanation, that adult mortality was high, seems less likely.

Scats were examined on park trails, game trails, and wolf rendezvous sites to determine current reliance on beaver and moose. A total of 2023 scats dating from October, 1974, through October, 1975, were examined. These data are summarized in Table 4 and Fig. 3. During the open water season moose and beaver each accounted for about half of the prey occurrences identified, except for a period in late summer when wolves ate surprisingly large amounts of fruit, primarily sarsaparilla (Aralia nudicaulis). Plant material accounted for 27.7% of the food items identified during this period, with the breakdown as follows: sarsaparilla - 14.8%; raspberry (Rubus idaeus) and thimbleberry (Rubus parviflorus) - 10.2%; and blueberry (Vaccinium spp.)- 2.7%. At one East Pack rendezvous site 19% of the scats contained nothing but sarsaparilla fruit.

Table 4. Contents of wolf scats examined on Isle Royale, 1975.

Period	No. scats examined	No. of food occurrences	Percent occurrence			
			Moose	Beaver	Fruit	Other
Mid-Oct. to Dec. 1974	568	568	58.3	41.7	--	--
Apr. to mid-July 1975	727	736	52.2	46.2	1.1	0.3
Mid-July to mid-Sept. 1975	377	440	45.9	26.4	27.7	--
Mid-Sept. to mid-Oct. 1975	351	378	53.4	39.2	7.4	--

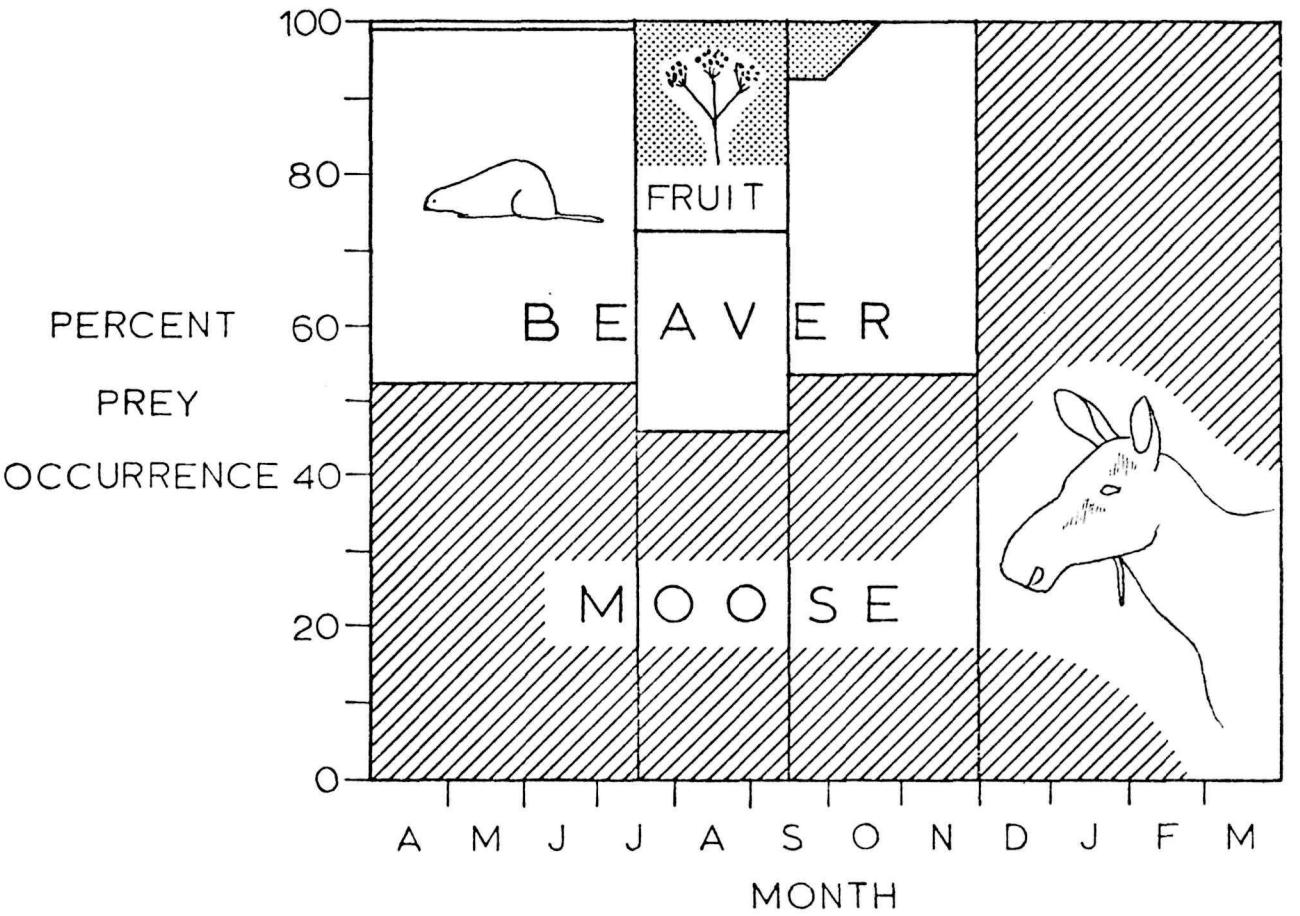

Fig. 3. Diagrammatic representation of wolf food habits on Isle Royale, Oct. '75 through Oct. '76.

Scat incidence on 86 km (54 mi) of park trails was monitored before and after the start of the visitor influx in late May. Trails were covered frequently enough so that trampling of scats by hikers was eliminated as a cause of variation; results indicated that wolf travel on trails dropped by 37% after hikers began appearing. In view of the fact that wolves make heavy use of park trails before the visitor season and again after human use drops off in October, the 37% reduction is attributed entirely to purposeful avoidance of humans. Detailed analysis of these data can be found in the Isle Royale park files. Avoidance of humans in summer and subsequent alteration of travel routes (with possible changes in distribution of predation effect) is the only known human-caused disturbance on Isle Royale having a bearing on wolf ecology.

WINTER FIELD WORK, 1976

As in 1975, during the 1976 winter study we experienced above-average temperatures and had very little shore ice around the island. A solid ice bridge never formed between the island and the mainland. Average daily minimum and maximum temperatures were -12.2°C and -1.7°C. Extreme temperatures were 12.2°C (Feb. 25) and -25.5°C (Feb. 2). The temperature rose above the freezing mark on 17 out of 20 days between Feb. 8 and 27.

Snow depths averaged 72 cm in open areas at Windigo during the seven-week study, and ranged from 55 cm to 98 cm. Maximum snow depth was recorded during the last day of the study. A total of 141 cm of snow (water equivalent 9.1 cm) fell during the study period.

Flying conditions were quite variable, but we had enough good flying days interspersed with storms so that we were not severely hampered. Flying time totaled 78 hours.

Wolf population, 1976

The wolf population was maintained at a peak level in 1976, with 44 wolves the maximum number recorded during the winter study (current density: 1 wolf/12.4 km^2). As shown in Fig. 4, the population is now almost twice as high as its midwinter average over the last 18 years. The reasons for the increased wolf population (summarized in last year's annual report) include an increased beaver population and high vulnerability in the moose population (resulting from combined effects of severe winters and forest successional change).

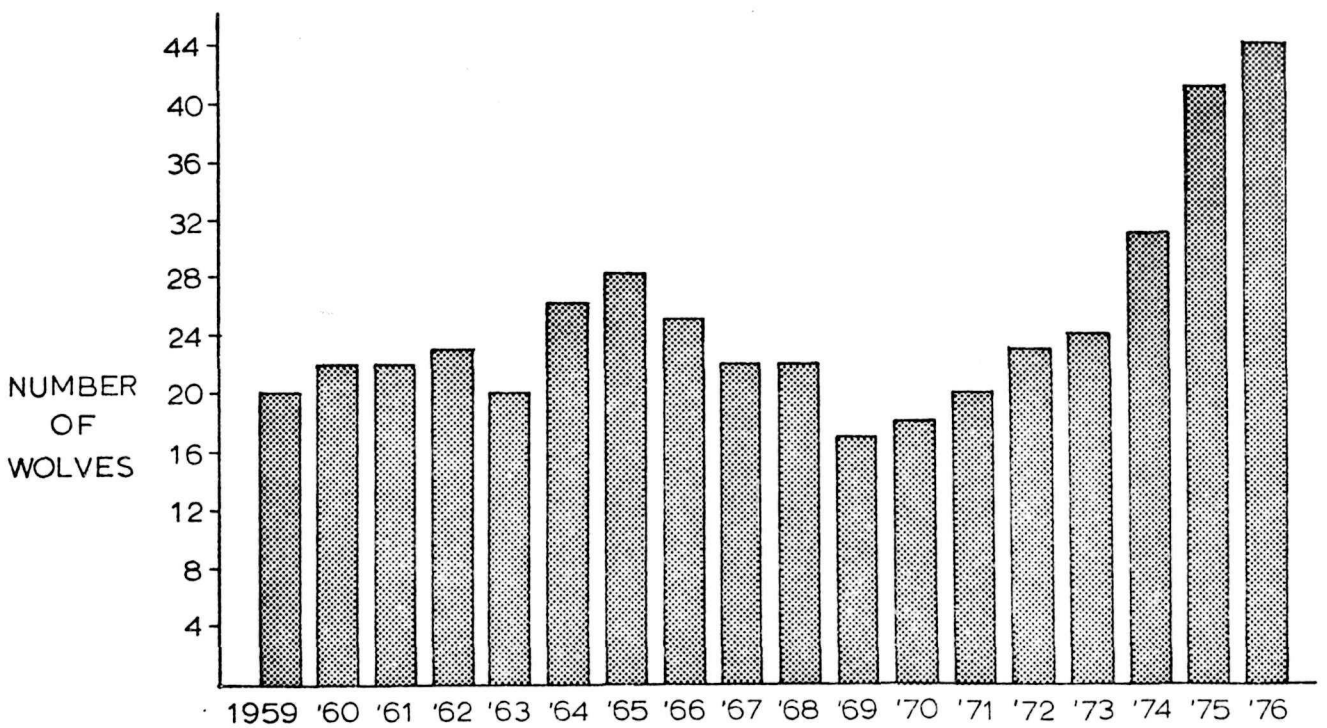

Fig. 4. Isle Royale wolf population levels in midwinter, 1959 to 1976.

The composition of the wolf population and spatial relationships of the principal packs are shown in Fig. 5. In addition to the three basic packs recognizable in 1975, there were a number of small packs present in 1976 which we were able to distinguish from one another. Most of these small groups and loners confined their activities to the sou hwest end of the island, within traditional West Pack territory. Except for one incident described below, the groups stayed clear of one another and did not unite or engage in conflict. The Siskiwit Bay trio contained a reddish wolf that appeared to be the alpha female from the Middle Pack of 1975 (which then contained 7 wolves). This trio occupied space adjacent to the Middle Pack, and tracks late in the study (when the trio could not be located) suggested overlap with the Middle Pack. It is quite possible that the Middle Pack was fragmented into two groups for the entire study period in 1976. Fortunately, the East Pack was quite cohesive and we were able to maintain a complete travel and kill record for this pack.

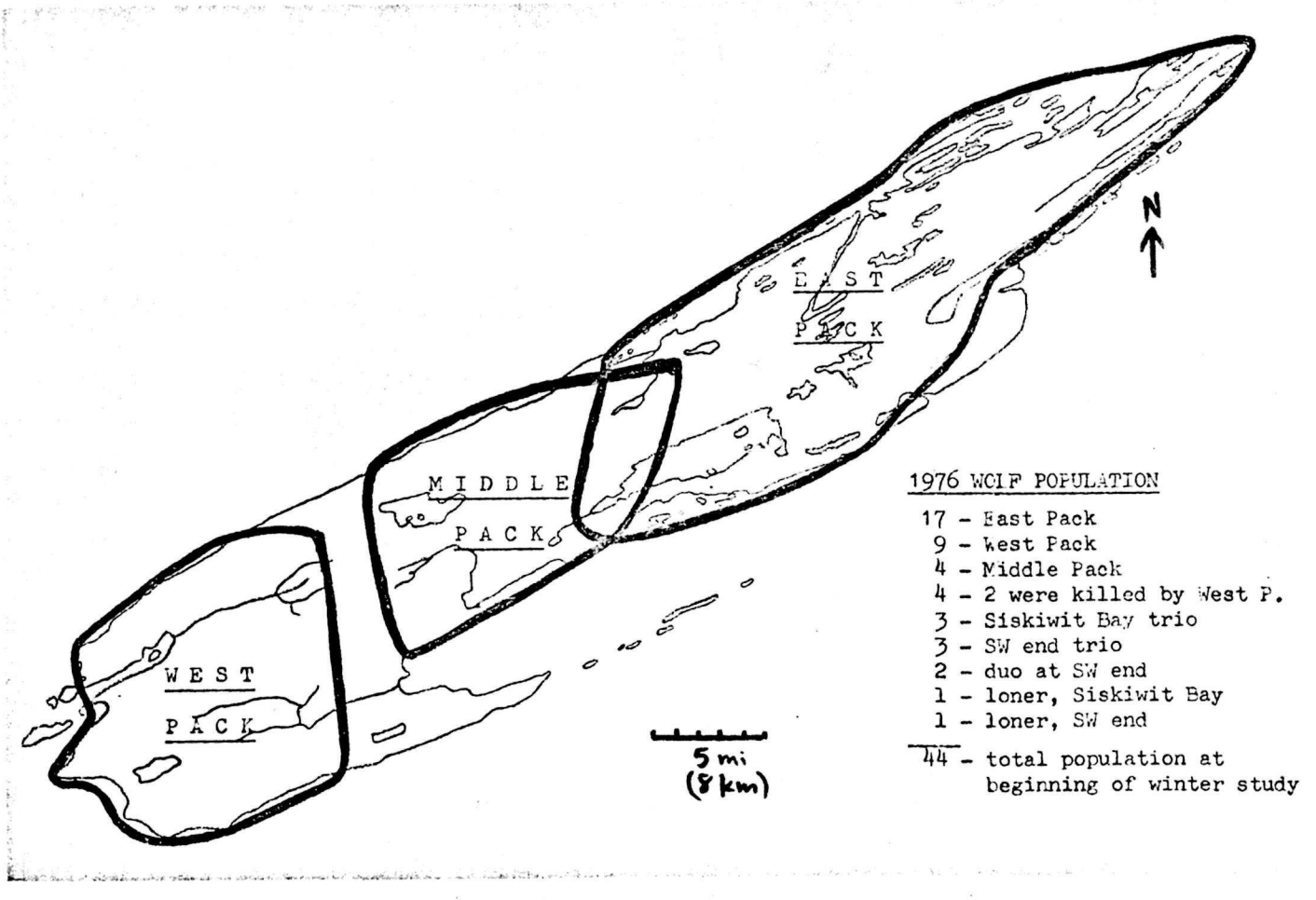

Fig. 5. Summary of 1976 wolf population and spatial relationships between principal packs.

On Feb. 12 we found 4 wolves, not previously seen, near an old kill in the northwest corner of the West Pack's territory. The West Pack (9 wolves) was less than two miles away on Washington Harbor, but they showed little sign of activity. After several hours, we returned and found six wolves from the West Pack running back onto the harbor, and we backtracked them to the extreme northwest corner of the island. Here were signs of a fight and solid evidence that one wolf had been killed and then had slipped into the lake. Two wolves from the pack of four were bedded nearby, one of them bleeding and licking wounds. The fourth wolf was almost a mile further along the trail of the West Pack, motionless and bleeding severly from its neck;this wolf died several hours later. We deduced that the West Pack had tracked the pack of four, then chased them along the shore to the corner of the island where one was killed and another injured. The West Pack proceeded further along the shore back toward Washington Harbor and along the way attacked the wolf that later died. The original group of four had consisted of one full-tailed wolf and three thin-tailed wolves. The two surviving wolves were thin-tailed, and the full-tailed wolf which we recovered was a 28 kg adult female. The pack had either split off the East Pack (which in previous years contained all but one of the thin-tailed wolves on the island), or was a new pack consisting of a female and pups. In any case, the pack had not been present in that area in previous winters, and were in fact "trespassing" in West Pack territory. Interestingly, all subsequent sightings of the two surviving wolves were in the West Pack territory. Although one of these wolves was still bleeding five days after the fight, the two appeared to be traveling normally on March 4 and had killed and eaten at least one moose.

The East Pack alpha male in 1976 was the same individual as in 1975, and the current alpha female has held that position for five consecutive winters (the entire period of this pack's existence). In both 1975 and 1976 there were four dominant wolves in the West Pack, all of whom carried their tails high and intermingled at the front of the pack. These wolves are difficult to distinguish, and we were not able to make enough behavioral observations to determine their relationships beyond establishing that two were males and two were females. It is likely that the leadership of the West Pack was the same in 1975 and 1976.

Observations indicated that at least six females came into heat in February: two among the dominant "quartet" in the West Pack, one in the Middle Pack, one in the Siskiwit Bay trio, and two in the East Pack. The East Pack alpha male courted both the alpha female and a subordinate female who was unreceptive. While no actual matings were observed, tracks of mating wolves (which are quite distinctive in appearance) were observed on Feb. 8 (Siskiwit Bay trio), Feb. 10 (Middle Pack), Feb. 21 (Middle Pack), and at two locations on Feb. 24 (unknown identity).

During the 1976 winter study we located 63 moose carcasses by aerial search (Fig. 6):

50 fresh kills made by wolves
12 older "probable kills", exposed by Feb. thaw
1 moose dying during the study either from wounds or malnutrition

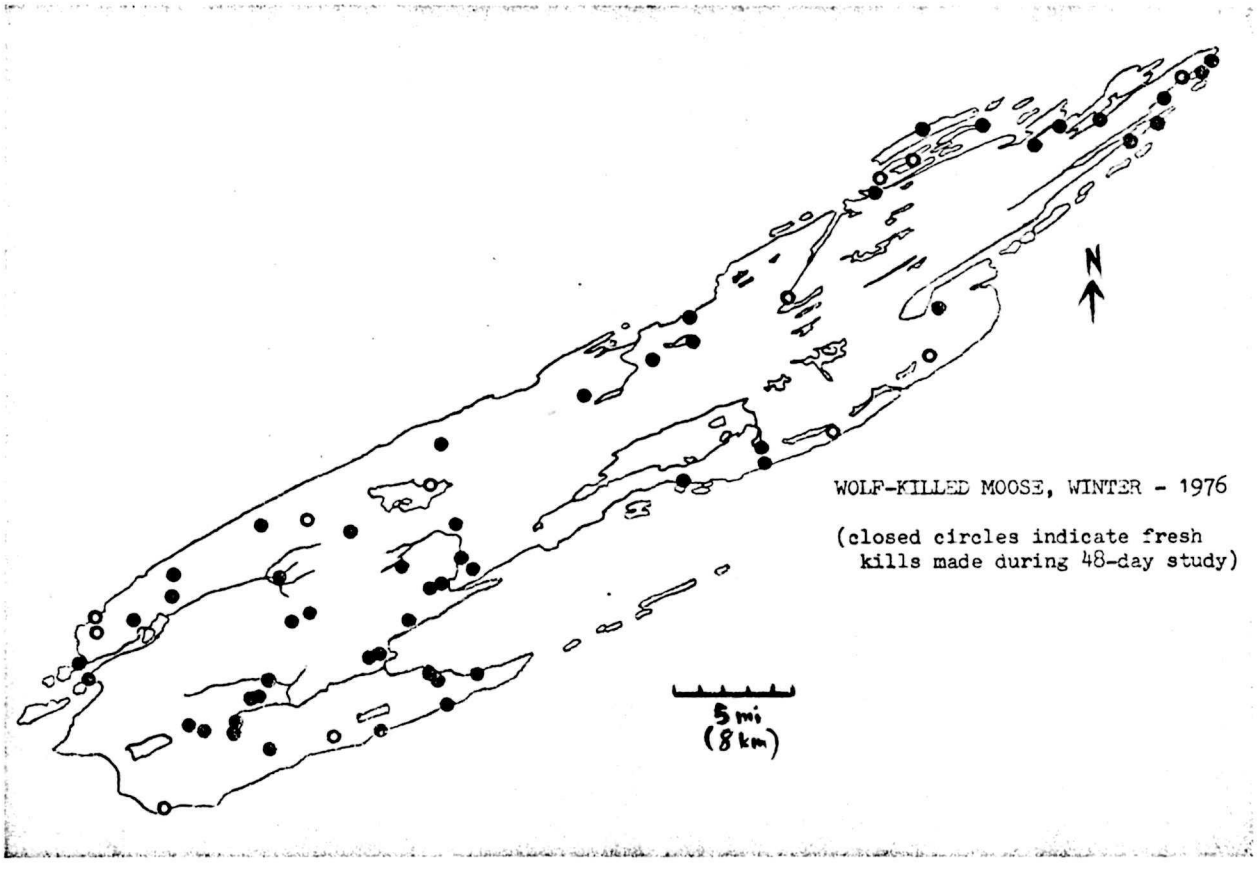

Fig. 6. Distribution of moose carcasses (all but one were wolf-kills) located during the 1976 winter study.

The 50 fresh kills were all made during 48 days of coverage, and this figure probably comes very close to the total number of kills made by wolves during that period. In other words, Isle Royale wolves were killing moose at a rate slightly greater than one/day in midwinter. This winter kill rate probably applies for no more than 120 days (late December through late April). Because of the deep snow we would expect that calves may have been highly vulnerable to wolf predation. Only 10 carcasses were examined this winter; the rest will be checked this spring.

Daily travel and kill rates for the East Pack in 1976 indicate that both were slightly higher than the 1971-76 average for all packs observed, probably because pack size was somewhat greater (see Table 5). The high overall kill rate in 1976 might be due to a high proportion of calves in the kill; in this regard it is noteworthy that 40% (51/128) of the winter wolf-kills examined in the period 1971-76 were calves, considerably higher than the 28% (58/210) calves among wolf-kills between 1959 and 1970. Estimates of winter food availability (Fig. 7) indicate a leveling-off at 4-6 kg/wolf/day by 1975, which seems to be a base level for Isle Royale wolves.

Table 5. Daily travel and kill rates for Isle Royale wolf packs.

	Number of wolves	Length of coverage	Number of kills made	Average period between kills	Daily travel
East Pack 1976	17	41 days	16	2.6 days	11.7 km (7.3 mi)
All packs, 1971-76	12 ave. size	439 days	144	3.0 days	11.2 km (7.0 mi) (based on 337 days)

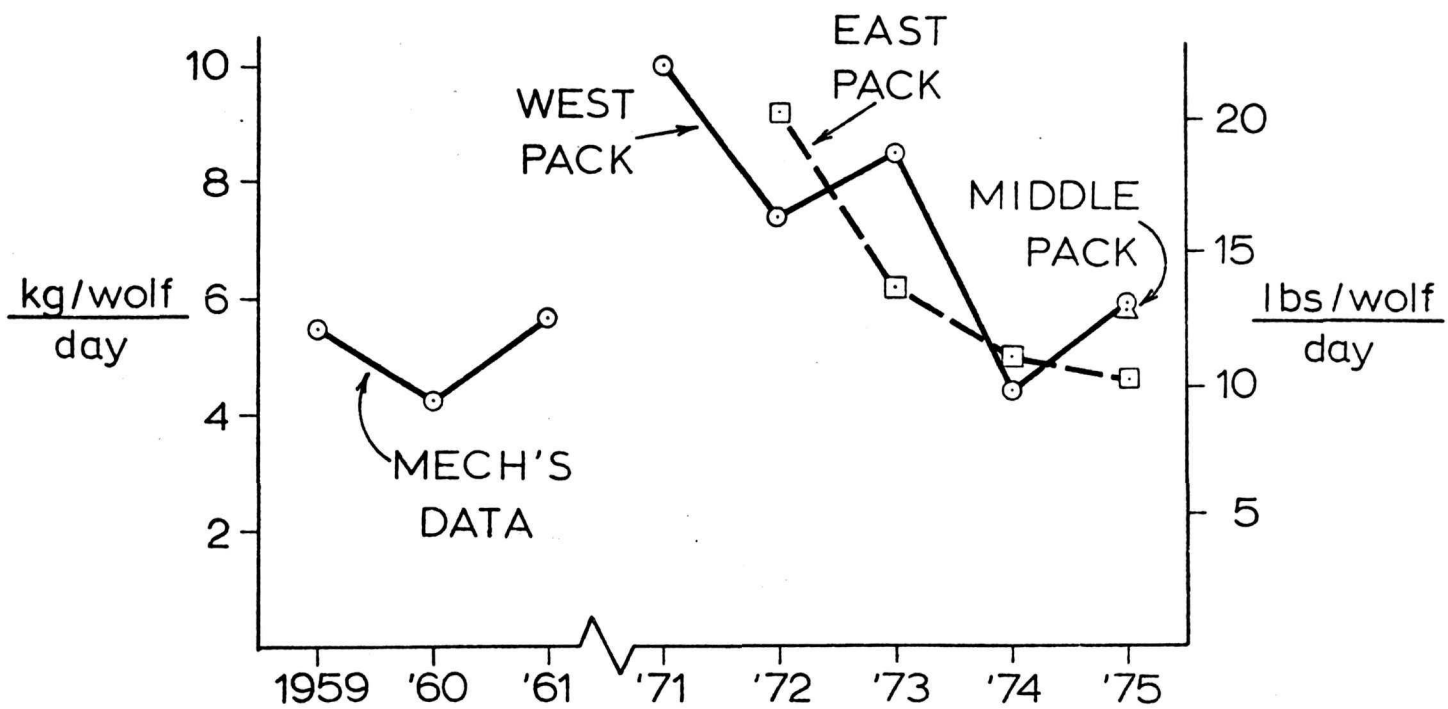

Fig. 7. Calculated food availability (not necessarily actual consumption) for Isle Royale wolves in midwinter, based on known kill rates during the annual winter study.

Moose population, 1976

Midwinter aerial censuses of Isle Royale moose in 1972 and 1974 indicated a population of approximately 1000 animals. A similar census planned for 1976 was cancelled because deep, crusted snow caused moose to seek conifer cover. Under such conditions an accurate census is very difficult to conduct and the level of confidence in the data is further reduced.

Several trends point to a definite decline in the moose population. Since 1970 calf production has been lower than at any other time since studies began in 1958, and predation on calves has been at a peak. Winter predation rates have increased in direct proportion to the wolf population increase, and are now the highest ever observed. By applying winter predation rates through a 120-day winter period (late December through late April) we estimate that wolves may be killing 10-15% of the population each winter for the last three years, while adult recruitment (calves surviving to one year of age) has usually amounted to only 5-10% each year. Our best estimate of probable rate of decline would be about a 20% reduction over the past three winters, implying a late winter population of about 800 moose.

In 1975 and 1976 blood samples were taken from six moose in February and March (two were necropsied, four immobilized with drugs) and analyzed by Dr. U.S. Seal of the Veteran's Administration Hospital in Minneapolis, Minnesota. While larger sample sizes are needed before conclusions can be drawn, BUN (blood urea nitrogen) levels in blood serum were low in all six moose, suggesting winter food low in protein.

Snow conditions, 1976

About 8 inches of snow (20 cm) fell just prior to our arrival on Jan. 26, increasing snow depth in open areas to 70 cm. There were crusts in the snow profile only within 26 cm of the ground. Heavy snowfall in mid-February and early March brought snow depths to over 75 cm, a critical depth for calves. A mid-February thaw created a strong surface crust (especially under conifers where snow melted and fell to the ground). Thereafter travel conditions for wolves were excellent, although on the warmest days when the surface crust softened, wolves sometimes stopped traveling. Simultaneously moose confined their activity to heavy cover and we would expect that wolves were able to kill calves more readily because of snow conditions. Snow depths were at a peak when the study ended on March 13, and deep snow probably persisted until temperatures moderated near the end of March.

OTHER WILDLIFE SPECIES

Although the number of moose carcasses located and observed during the winter was very high, scavenging by foxes was relatively low, indicating that they were relying mostly on snowshoe hare. There were no obvious changes in hare densities, but snow conditions seem to be the primary factor governing fox utilization of moose carcasses. For example, foxes were observed feeding on almost every moose carcass early in the study when snow was relatively deep and uncrusted. After the mid-February thaw produced a surface crust we observed very few foxes on moose carcasses until heavy snowfall in early March once again reduced fox mobility. The number of foxes observed away from moose carcasses has been relatively constant over the last 5 winters and may be an indicator of trends in the fox population (Table 6).

Table 6. Summary of fox observations in winter.

	1972	1973	1974	1975	1976
Moose carcasses located	38	30	40	42	63
No. where foxes were observed	23 (61%)	14(47%)	26(65%)	16(38%)	30 (48%)
Foxes on utilized carcasses					
Ave. maximum number	2.4	1.3	1.9	1.3	1.2
Sum. of max. numbers	55	18	48	21	37
Other fox observations per 100 hours flying	25	24	21	16	22

In preparation for a possible reintroduction of marten (which may have been eliminated by man) on Isle Royale, red squirrels were live-trapped on a 31-acre area of spruce-fir and cedar near the Rock Harbor shoreline. Red squirrels currently experience little predation, and this situation might be altered if marten were reintroducted. Our data from 1975 indicated a density of about one squirrel per acre, only slightly lower than density determined in 1966-68 by Wendel Johnson in the same area. Most squirrels harbored ectoparasites, especially fleas. About one-third of the squirrels live-trapped were juveniles, and in this regard it may have been important that the balsam fir cone crop was excellent (cedar cones were rare and white spruce cones were uncommon). Johnson found that the proportion of juveniles in the squirrel population was correlated with the current year's cone crop.

Winter bird observations included the usual complement of blue and gray jays, ravens, chickadees,nuthatches and woodpeckers. Mergansers, goldeneyes, and herring gulls were commonly seen in the open water surrounding the island in winter. One northern shrike (a rare winter visitor) was seen. Redpolls were the only common small fringillid.

SUMMARY

In 1975 Isle Royale wolves produced at least 10-12 pups, but the midwinter population was only 3 greater than that of the previous winter. The peak population of 44 wolves recorded in 1976 is the highest ever recorded on Isle Royale and represents one of the highest wolf densities documented anywhere.

In 1976 one instance of intraspecific strife was recorded, resulting in the death of two wolves from a trespassing pack. 1976 kill rates were the highest recorded on Isle Royale over the past 18 years, with slightly more than one moose/day being killed by wolves. Detailed analysis of predation patterns in 1976 will follow examination of carcasses this spring.

The Isle Royale moose population is undoubtedly decreasing, since calculated mortality rates have exceeded adult recruitment rates for the past three years. Since 1970 calf production has been lower and predation on calves in winter higher than during the 1960s. Our best estimate of decline in the moose population over the last three winters is 20%, implying a pre-parturition total of about 800 moose.

Providing the beaver population remains at a high level, we would expect that the wolf population in winter will remain at about its current level until winter food supply (moose) becomes more limiting.