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ECOLOGICAL STUDIES OF WOLVES ON ISLE ROYALE

ANNUAL REPORT

1978-79

ECOLOGICAL STUDIES OF WOLVES ON ISLE ROYALE*

Annual Report - 1978-79

(Covering the twenty-first year of research)

by

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INTRODUCTION

Now in its 21st year, wolf-moose research on Isle Royale continues to center on a basic study of wolf ecology, with special emphasis on the predator-prey relationship of wolves and moose. For the past five years, Isle Royale has supported the densest wolf population known to exist anywhere. In spite of a high wolf-moose ratio (1 wolf per 20 moose) and habitat completely comprised of mature forests, the moose population has proved to be remarkably durable. In 1979 this 544 km^2 (210 mi^2) island supported 43 wolves and about 800 moose.

Joseph M. Scheidler directed the summer field work in 1978, and in May 1979 will complete his master's thesis, entitled "Population trends and mortality in Isle Royale moose". Rolf O. Peterson again spent most of the past year on a wolf-moose research project at Kenai, Alaska, but returned for the winter study on Isle Royale in early 1979. Summer field assistants were Lee J. Scheidler, John W. Brooks and Philip W. Stephens, with field work running from June 9 to August 30, 1978. The Scheidlers were again present from October 15 to 21 for an aerial moose composition count.

The 1979 winter study ran from January 24 to March 11, with the field team consisting of Peterson, a study pilot, and National Park Service personnel from Isle Royale National Park and Grand Portage National Monument. NPS personnel were the following: Thomas J. Hodges and Julia A. Kuncl, Jan. 24 - Jan. 31; John M. Morehead, Jan. 31 - Feb. 12; Robert A. Huggins and Norman D. Hellmers (GPNM), Feb. 24 - Mar. 5; Stuart L. Croll, Mar. 5 - Mar. 11. Also among winter study participants were J. Robert Stottlemyer (NPS scientist assigned to Michigan Tech), Jan. 31 - Feb. 12, and Robert A. Janke (Michigan Tech Biology faculty member), Feb. 12 - Feb. 24.

Don Murray, Mt. Iron, Minnesota, again piloted the winter study aircraft for his 21st consecutive winter study, Feb. 3 - Mar. 11. Don Glaser (Wings North, Grand Rapids, Minnesota) flew the autumn aerial moose survey on Oct. 17 and 18, 1978, and also helped out during the winter study from Jan. 24 to Feb. 5. Supply flights were handled by Stephen Gheen, Carlo Palombe and Doug Bohman of the Ely Aviation Unit, Superior National Forest, USFS.

Publications which appeared in the past year include Peterson's monograph entitled "Wolf ecology and prey relationships on Isle Royale" and a note entitled "Social rejection following mating of a subordinate wolf" in the Journal of Mammalogy. Those interested in receiving these publications may use the request form on the back page of this report. Durward Allen's book on 18 years of wolf-moose research on Isle Royale, entitled "Wolves of Minong" (Houghton Mifflin) is expected to be available by mid-May, 1979.

SUMMER FIELD WORK, 1978

During the summer all the carcasses located during the previous winter study were ground-checked and aspects of summer wolf ecology (food habits, location of rendezvous sites, and whether pups were produced in each pack) were studied. Hiking mileage was 555 miles (893 km), including 135 mi (218 km) off-trail.

Moose surveys - summer and fall, 1978

Moose population composition and productivity were estimated by summer ground surveys and an aerial survey after leaf-fall in October. The ground counts (Table 1) provide relative indications of density and calf production, while the aerial survey (Table 2) provides data on calf abundance, adult sex ratio and overwinter survival of calves born the previous year (Fig. 1).

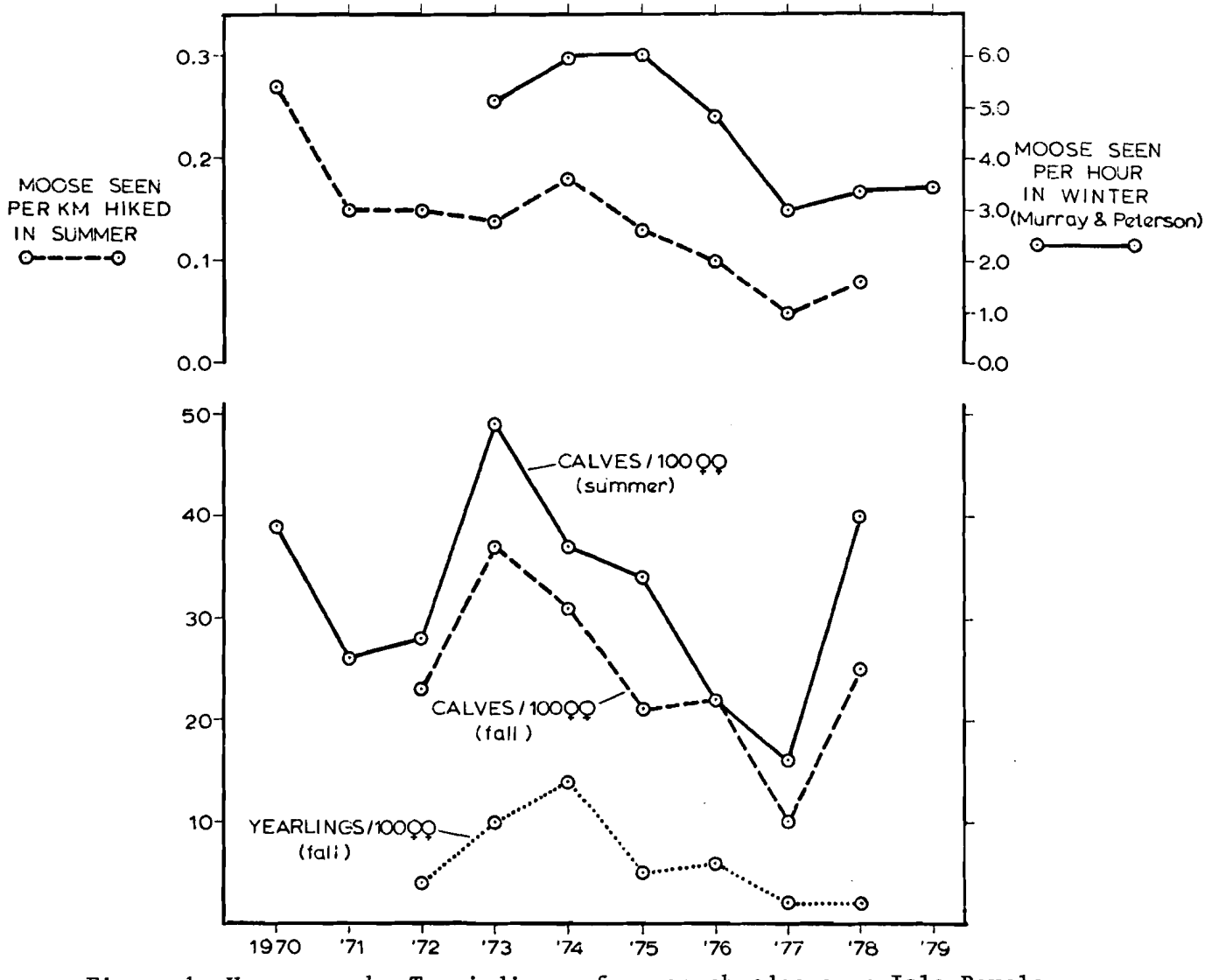

Figure 1. Upper graph: Two indices of moose abundance on Isle Royale.
Lower graph: Trends in calf production and survival, 1970-78.

Table 1. Summer ground observations of moose on Isle Royale, 1970-78.

	Jun 9-Sep 4, 1970	May 18-Sep 7, 1971	May 9-Sep 25, 1972	May 4-Sep 30, 1973	May 6-Aug 13, 1974	Apr 29-Oct 21, 1975	May 26-Oct 29, 1976	May 31-Aug 17, 1977	Jun 9-Aug 30, 1978
Total observed	192	142	231	244	118	240	134	44	67
Males	64	47	106	92	36	97	51	14	23
Females	91	64	92	102	57	101	64	25	30
Calves	35	19	23	38	21	34	14	4	12
Unk. sex (adults)	2	12	10	12	4	7	5	1	2
Sex ratio (males/100 females)	70	73	115	90	63	96	80	56	77
Calves per 100 females 1/ (after June 1)	39	26	28	49	37	34	22	16	40
No. sets of twins	5	1	2	4	4	2	0	0	2

1/ Includes yearling females, most of which are probably unproductive but which cannot be reliably distinguished from older cows.

Table 2. Autumn aerial composition surveys of Isle Royale moose, 1972-78.

	Oct. 17-19, 1972	Oct. 23-25, 1973	Oct. 22-25, 1974	Oct. 21-22, 1975	Oct. 18-20, 1976	Oct. 18-20, 1977	Oct. 17-18, 1978
Total observed	114	192	117	157	120	75	118
Adult bulls	47	73	43	61	50	29	53
Yearling bulls 1/	2	8	7	4	3	1	1
Cows	53	81	51	76	55	41	51
Calves	12	30	16	16	12	4	11
Bulls/100 cows	93	100	98	86	96	73	106
% Yearlings 2/	4	10	14	6	6	3	2
% Calves	11	16	14	10	10	5	9
Calves/100 cows 3/	23	37	31	21	22	10	25
Yearlings/100cows 3/ observed	4	10	14	5	6	2	2

1/ Bulls with spikes or small forked antlers were considered antlers.
2/ % Yearlings = yearling bulls/(adult bulls + yearling bulls).
3/ Yearling females are included in the total number of cows observed

Moose calf production was up dramatically from the previous year, judging from both ground surveys in summer and the fall aerial survey. Twin calves were observed by research personnel for the first time since 1975. The exceptionally high windfall frequency during the previous winter, coupled with winter conditions that did not severely hamper moose, seem to explain the upswing in calf production. Windfall frequency (determined by Tom Hodges, NPS trail crew) was more than twice the normal level, and caused a significant change in moose distribution during the 1978 winter study. Moose fed heavily on windfall tops and apparently the overall nutritional status of the moose population improved as a result, leading to higher calf survival.

Two indices of moose observation frequency (moose seen per km hiked during summer and moose seen per hour by the same pilot and observer in winter) show similar trends over the past six years, and both showed a slight increase in 1978. This suggests that the moose population may have reached a relatively stable level after apparent decline during five years of high wolf density, and we expect that subsequent fluctuations in population level will be influenced heavily by winter severity. The winter of 1977-78 could be characterized as of "average" severity, and during the following summer only 3 moose were discovered that died of malnutrition.

Due to a very low proportion of moose calves during the winter of 1977-78, we had difficulty obtaining an adequate sample of bones to measure from 1977 calves. However, the small sample available does fit the general pattern determined over the past 8 years, which links physical size of calves closely to the severity of the winter prior to birth (Fig. 2).

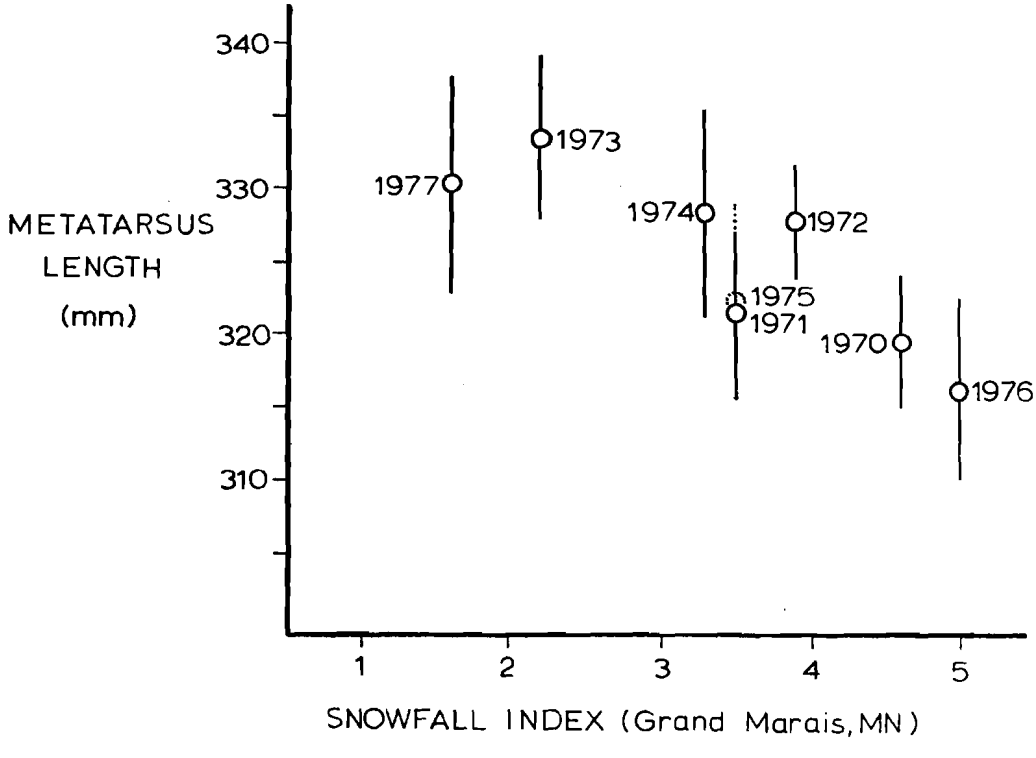

Figure 2. Relationship between size of nine-month-old moose calves and severity of the winter prior to their birth (while in utero). Indicated on the graph are mean metatarsal length and its 95% confidence interval.

Summer wolf activity, 1978

The presence of at least four litters of wolf pups was established in 1978, one in each of the principal pack territories. No dens were located, and four of the five rendezvous sites examined were in non-traditional areas. Beavers continued to be a very important prey species for wolves during the open-water season, comprising about half of the food items identified in wolf scats (Table 4). In this regard the 1978 census of beaver colonies by Philip C. Shelton is very interesting (see p. 19), indicating a drop of about 50% in the number of active beaver colonies in the last 4 years.

Table 4. Contents of Isle Royale wolf scats, 1975-78.

Period	No. scats examined	No. food occurrences	Proportion of occurrence (%)				
			Moose	Beaver	Fruit	Other	Unknown
Spring-mid Oct. 1975	1455	1552	51	39	10	--	--
Spring-mid Aug. 1976	641	675	51	45	2	1	2
Spring-mid Aug. 1977	191	205	39	50	4	5	1
Spring-Sept. 1978	206	222	32	46	2	6	14

TRENDS IN MOOSE MORTALITY

During the past 20 years, over 600 wolf-killed moose have been ground-checked on Isle Royale; most of these kills were made during the annual winter study period from late January to early March. The most striking variation in the general pattern of wolf predation occurred in the early 1970s, when a high moose population was suddenly faced with a series of severe winters in a habitat that had been declining due to forest succession over the previous decade.

In our previous analyses we had separated calves from adult moose when examining age distributions of kills, assuming that the age distribution of adult kills was independent of the proportion of calves in the kill. This assumption has proven incorrect, as there is actually an inverse relationship between predation on calves and predation on older moose. This probably indicates a shifting in predation pressure to older moose whenever calves are not abundant or available to wolves (Figure 3).

Figure 3. Annual proportion of calves and 6-18 year-old moose among wolf-kills.

Our former analyses indicated a tremendous increase in predation on 1 to 5 year-old moose in the early 1970s, but these analyses were confounded by the unusually high level of predation on calves and relatively little killing of old adult moose. While there was some increase in predation on young adult moose (Fig. 4) during this period, the overall level of predation on this age group has not changed greatly over the past 15 years.

Based on our earlier analyses, we had also predicted that by the late 1970s there would likely be a dearth of moose in the middle-age group (age 7-10 yrs) which Isle Royale wolves have always relied heavily upon. However, it is evident that wolves did not have a great deal of difficulty finding moose in this age group (Table 3) in 1978, which indicates that the heavy predation on calves and, to a lesser extent, young adult moose in the early 1970s did not deplete these cohorts to the extent that we had believed. This ties in well with the 1979 aerial moose census, which revealed more moose than we had expected (page 15).

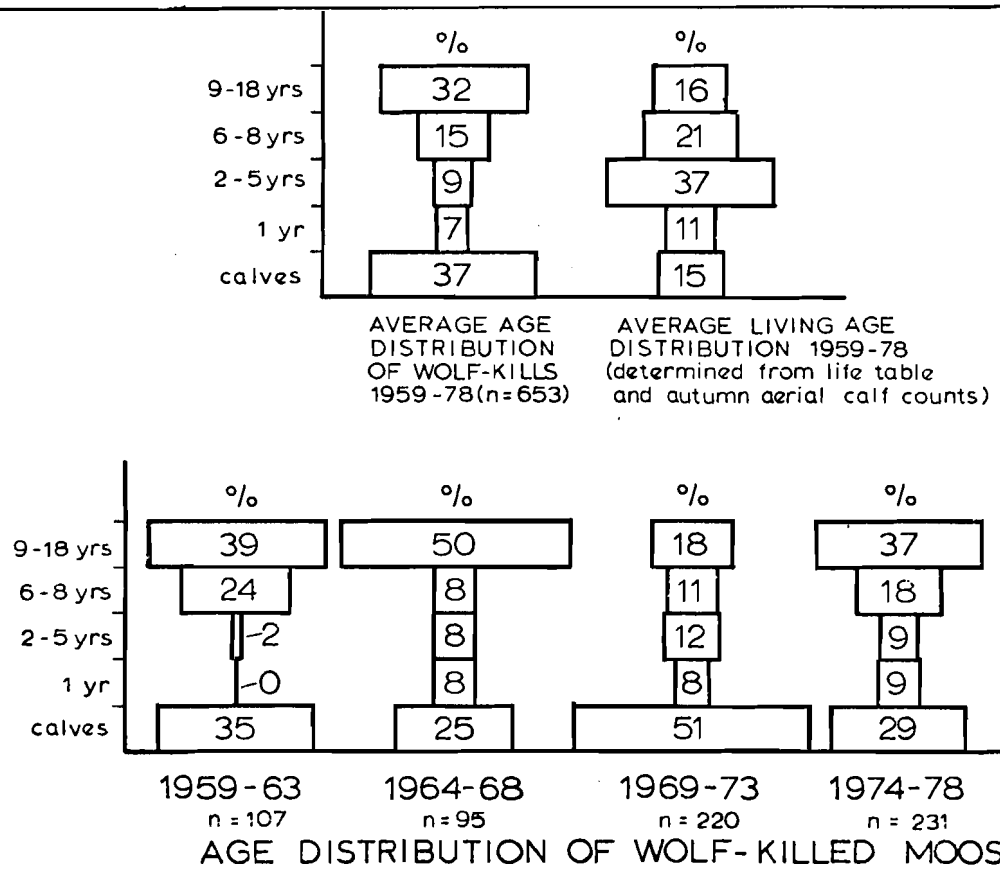

Figure 4. Upper graph: Long-term average age distribution of wolf-killed moose compared to living age distribution.
Lower graph: Age distribution of wolf-killed moose sorted by five-year intervals.

Table 3. Age distribution of wolf-killed moose, winter 1978.

Age	Calf	1+	2+	3+	4+	5+	6+	7+	8+	9+	10+	11+	12+	13+	14+	15+	Total
No.	2	3	-	-	1	4	2	3	6	3	1	2	2	-	-	1	31 (including one adult of unknown age)

WINTER FIELD WORK, 1979

Weather was quite prominent during the 1979 winter study, during which we experienced both record-low temperatures and record-high snowfall. The first four weeks of the study period were generally clear and cold, with the temperature falling below zero on all but four nights during the first three weeks in February. On Feb. 17, we recorded -30 deg.F at the Windigo weather station and -41 deg.F at the USGS gaging station on Washington Creek. The final three weeks of the study were relatively warm, and we received about two feet of additional snow at this time. Average daily minimum and maximum temperatures for the entire study period were -0.3 deg.F and +18.6 deg.F, respectively. Flying conditions were good, especially early in the study period; we flew on 31 out of 43 days for a total of 135 hours.

Very cold temperatures prior to winter study produced an exceptionally smooth and solid ice bridge between Isle Royale and Ontario which lasted the entire study period. It probably formed by early January and was still observed during a NPS patrol flight on May 1. The Coast Guard reported that all the Great Lakes, including Lake Superior, were completely frozen over for the first time since records have been kept. Needless to say, we had good landing conditions around the edge of the island, but slush prevented landings on most interior lakes.

Wolf population, 1979

The wolf population numbered 43 during the past winter study, near its all-time high level (Fig. 5). We found only three large packs that occupied a definite territory, while in the previous two winters there had been four packs.

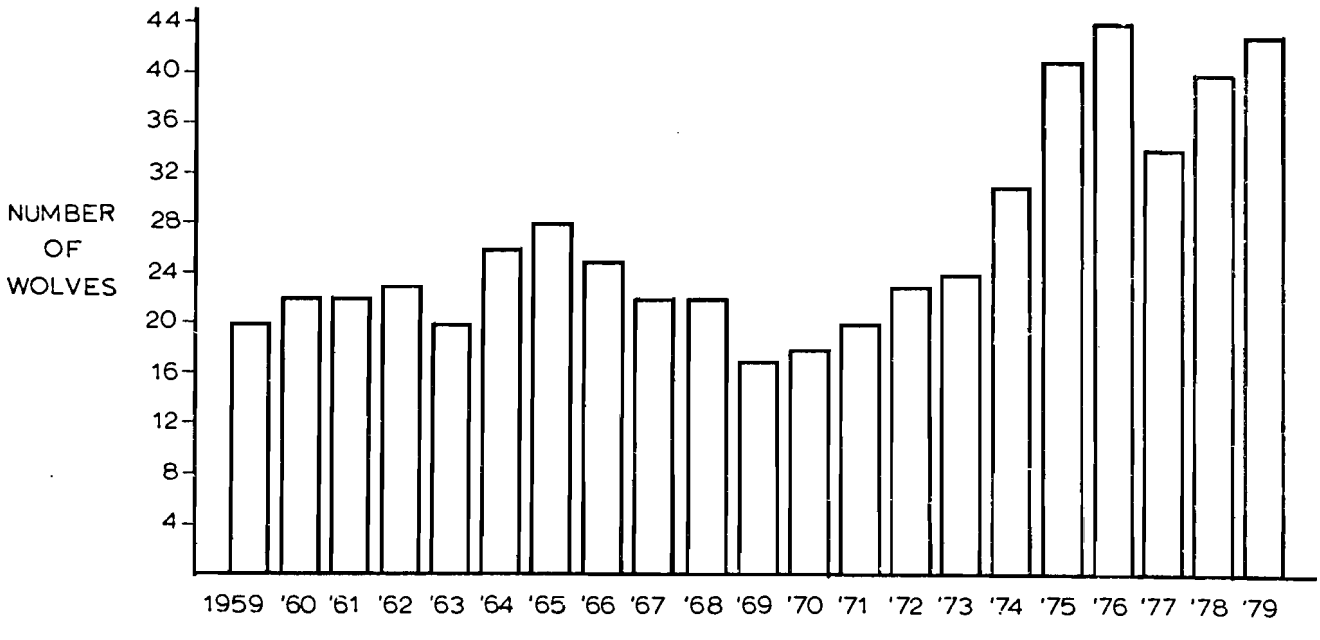

Figure 5. Isle Royale wolf population levels in midwinter, 1959-79.

The Southwest, Middle and East packs all occupied their traditional territories, with pack sizes similar to last year (Table 5, Fig. 6). We found no wolves at all in the space occupied by the West Pack last year; however, elsewhere on the island there were 7 non-territorial wolves that seemed loosely affiliated with each other. We initially found these wolves on a kill on Amygdaloid Island in groups of 5 and 2. For most of the winter study they were split into groups of 3 (Locke Pt. trio), 2 (Todd duo), and 2 singles that were usually found in Rock Harbor. The trio and duo were usually at the northeastern end of the island, and avoided areas heavily used by the East Pack. The East Pack appropriated two of the four kills made by these wolves during the winter study, and was observed chasing a single wolf within its territory. On another occasion, a group of four wolves from this "foreign" pack ran away from the island after finding the East Pack near a kill. We followed them northward toward Ontario for about 2½ miles before leaving to refuel. We don't know how far these wolves went, but five days later they were again observed on the island, where they remained for the rest of the study period.

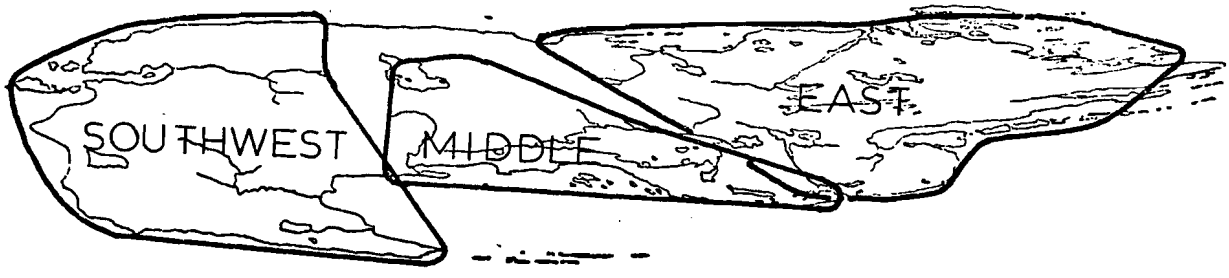

Figure 6. Spatial organization of Isle Royale wolf packs, 1979

Table 5. Composition of the Isle Royale wolf population, midwinter 1979.

East Pack	11	
Middle Pack	14	
SW Pack	9	
Locke Pt. trio	3	comprise the seven wolves initially seen at Amygdaloid Is.
Todd duo	2	
Rock H. loners	2	
additional loners	2	
	43, minimum number present and best estimate	

About three weeks later the Locke Pt. trio left a kill during the middle of the night (the East Pack was on a kill about five miles straight down Rock Harbor, and during the night had been very active on the harbor) and crossed to the north side of the island, where they picked up the tracks of the Todd duo and began following them. All five wolves (still separated into two groups) then traveled directly to the other end of the island, in the process going out onto the ice as far as five miles toward Ontario. The duo remained at the SW end of the island for the remaining two weeks of the study and eventually made a kill in the vacant West Pack territory. The trio rested overnight, and the next morning struck out for the northeast end of the island. We were able to track the trio during the entire odyssey, and found that they traveled 100 miles in less than 48 hours.

It is quite likely that the West Pack from 1978 abandoned their territory and split up, thus explaining the unusual number of foreign wolves along the edge of the East Pack territory. The space occupied by the West Pack has shifted very noticeably over the past several years (Fig. 7), and in 1978 this pack occupied a territory with fewer moose than the other three packs. The former territory of the West Pack has now been largely taken over by the Southwest Pack. It is noteworthy that the West Pack can be traced directly back to the original "Big Pack" observed during the late 1960s.

An alternate explanation for the 1979 observations would be that the West Pack simply left the island and that the seven wolves seen originally on Amygdaloid Island had likewise left Ontario and settled on Isle Royale. All of these events, however, would have had to occur in the month just prior to the winter study, and it seems unlikely that two large packs would simultaneously travel to and from Isle Royale.

For the past eight years the East Pack has consistently provided excellent data on predation rates, travel rates, and has been the largest and most cohesive pack on Isle Royale. During its entire existence (since 1971) it has been led by one alpha female wolf, and for the past five years by the same alpha male. The alpha female is now at least 10 years old, and this year, for the first time, we found that another female may be assuming some of the alpha's leadership roles. Both females scent-marked, both led the pack at different times, and the alpha male was observed mating with the younger female on Feb. 25 (the only mating observed in 1979). Relations between the two females seemed amicable, although we observed little interaction. The alpha male was most active in his courtship of the younger female, yet remained friendly with his older mate. We don't know if the old alpha female mated, and it was clear that her role within the pack had changed.

Although Isle Royale wolf packs are usually large, they occupy small territories. Yet we have very little evidence of direct encounters between packs. The packs obviously know that they have neighbors, and we've speculated that they must occasionally see adjacent packs, especially in the winter when traveling over vast expanses of snow-covered ice. This year, on Jan. 29, we saw such an encounter on Siskiwit Bay, between the Southwest Pack of 8 wolves and the Middle Pack of 11 wolves. The Middle Pack had traveled along the north shore of Siskiwit Bay the the SW edge of their territory, and we first observed them running rapidly back along their own tracks, frequently looking out over Siskiwit Bay. About 1½ miles straight out from the Middle Pack stood the Southwest Pack,

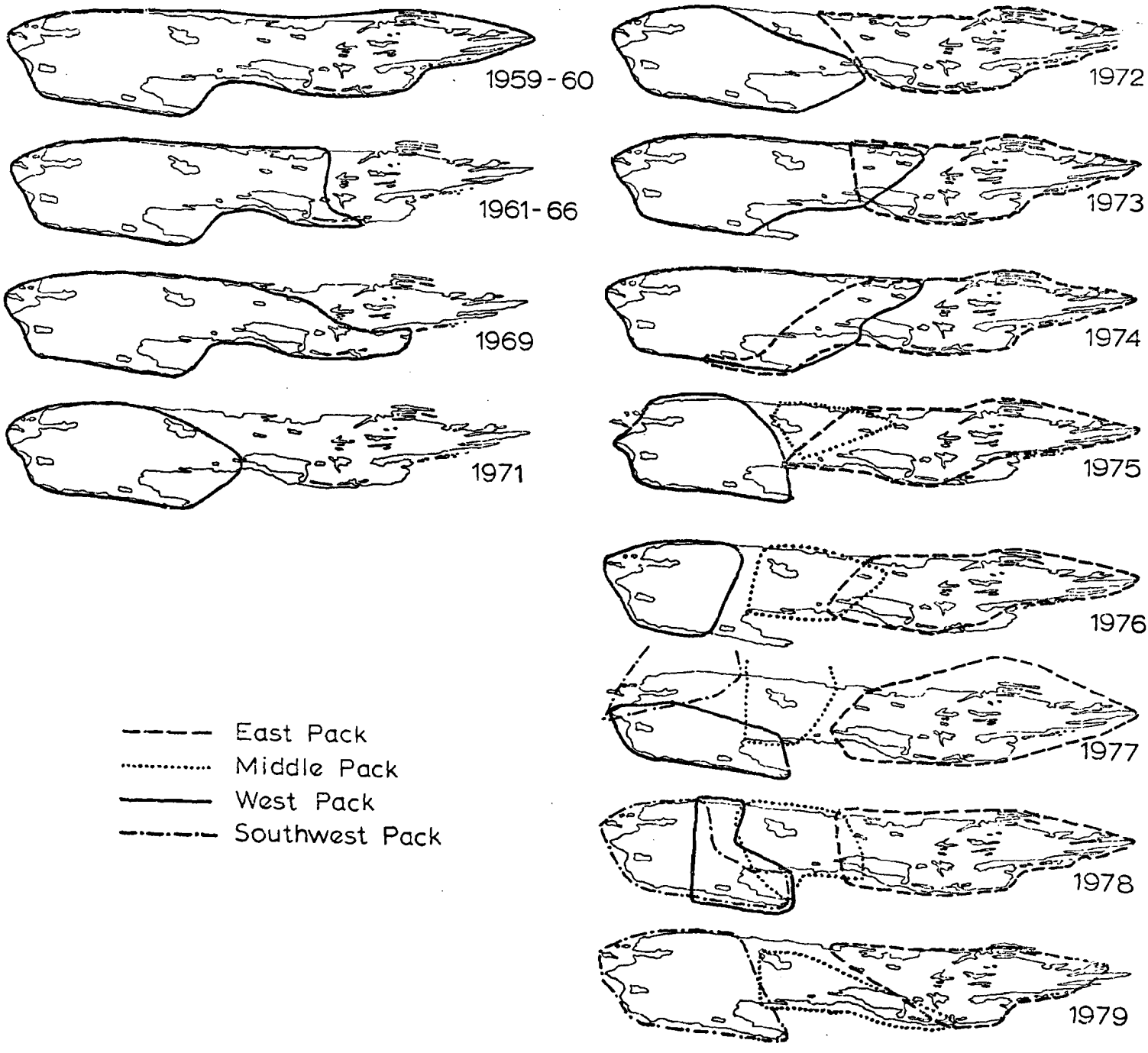

Figure 7. Spatial organization of Isle Royale wolf packs, 1959-79.

motionless and alert, staring at the Middle Pack. The Middle Pack ran rapidly out of sight by crossing a narrow peninsula into Hay Bay, and then continued into the middle of their territory.

Wolf-moose relations, 1978-79

During the 1978 winter study we noted that wolves seemed to have difficulty finding and killing moose, as evidenced by a low kill rate and the great attention paid to moose that were wounded (one pack wounded a moose and stayed by it for a full week before they were able to kill the moose). We inferred that their difficulty arose from the general declining nature of the moose population. After examining all the 1978 kills, however, we found that calves made up only 6.5% of the total kill by wolves (Table 3), whereas the 20-yr average for calf proportion is about 37% (Figure 4). During the previous aerial survey in autumn, the proportion of calves seen was only 5% of the total sample, the lowest level observed on Isle Royale in 20 years of study. It has been clear over the years that moose calves were highly preferred prey of wolves during winter, and the record of last year indicates how heavily wolves depend on the annual calf crop. In 1978, even with a smaller pack, the East Pack traveled 60% farther between kills and the interval between their kills was 29% longer (compared to the previous six years); this now appears to have resulted from the lack of calves. While the East Pack was able to maintain a kill rate comparable to previous years, predation by the other three packs dropped to an all-time low (Fig. 8).

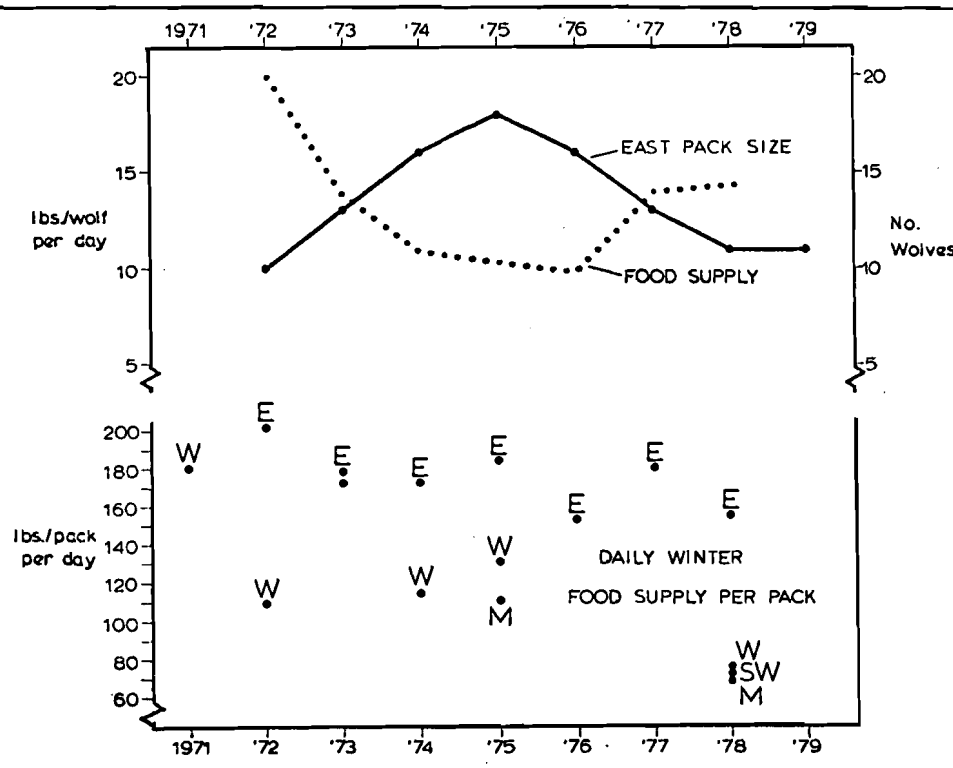

Figure 8. Upper graph: East Pack size and food availability per wolf, 1972-79. Lower graph: Predation rate as indicated by food availability per pack. E=East Pack, W=West Pack, M=Middle Pack, SW=Southwest Pack.

During each winter study we try to maintain a complete record of the travels and kills of the principal packs on the island, and these data enable us to determine levels of food supply and general prey vulnerability. In 1979 we were able to put together travel and kill records for the three principal packs for a five-week period. Averaging data for all packs observed over the past nine years produces composite figures such as those in Table 6, with an average pack of 11 wolves making a kill every 3.8 days in winter, and traveling 22 miles between kills. Of the 199 kills recorded in this compilation, 35% were calves.

Table 6. Composite Isle Royale wolf pack, summarized from data on 19 wolf packs studied during 1971-79.*

	All packs, 1971-79	Sample size
Average pack size	10.8 wolves	19 packs over 9 years
Average travel in midwinter	6.6 mi/day	3994 mi in 604 pack-days
Average kill rates (moose)	1 kill/3.8 days	199 kills in 765 pack-days
Average amount of travel between kills	22.3 mi	164 kills/3463 mi
Average proportion of calves among wolf-killed moose	35%	199 kills

*These data were compiled during January, February and March, and can be safely applied only for the winter period. They are probably realistic data for the period November-April. Wolf-caused mortality rates for adult moose on Isle Royale are about 12 times higher in winter than in summer, based on antler development in all skeletons examined (Peterson 1977).

We have generally regarded food availability per wolf as an indicator of kill rate for a given pack, but an examination of the records for the East Pack since 1972 (Figure 8) reveals that food availability figures seem to depend primarily on pack size-- as a pack gets larger, food availability per wolf drops, and vice versa. The kill rate of this pack has not varied greatly over the years, even though pack size has varied from 10 to 18 wolves. The implication, then, is that larger wolf packs do not mean greater predation rates, at least within the range of pack sizes exhibited by the East Pack.

Kill rates observed in 1979 appeared to be near average for Isle Royale packs, although the data will not be complete until all kills are examined on the ground this spring. Distribution of wolf kills (Fig. 9) reflects the shoreline movements of wolves in 1979, caused by deep, soft snow in the interior of the island.

The island-wide kill rate in 1979 was slightly higher than in 1978, but still considerably lower than in 1976 and 1977, when wolves were killing moose at the rate of about one/day over the whole island (Table 7). The drop in predation has resulted from relatively low kill rates for the established packs, loss of a full-functional West Pack, and disappearance of several small groups of 2-4 wolves that were observed on the island in the mid-1970s.

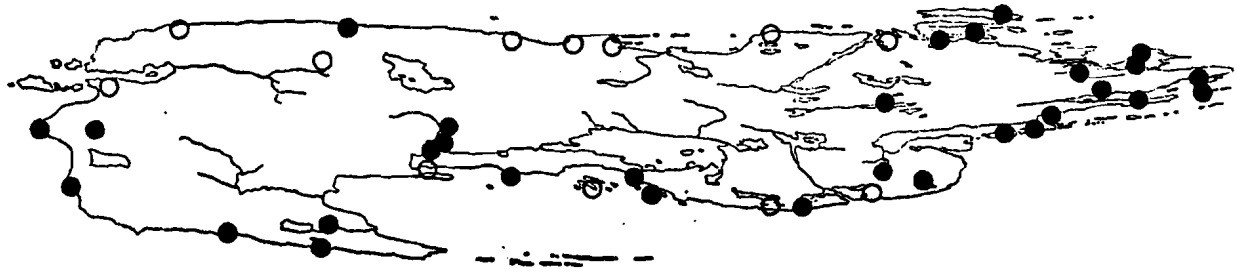

Figure 9. Distribution of moose carcasses located by aerial search in 1979. Closed circles denote kills made by wolves during winter study.

Table 7. Island-wide predation rate in midwinter, 1976-79.

Year	No. kills	No. days coverage	No. kills per day
1976	51	48	1.1
1977	39	40	1.0
1978	26	42	0.6
1979	30	44	0.7

One wolf-moose encounter which occurred this winter was quite noteworthy. On the afternoon of February 24 we found a bull moose bedded on the ice of Siskiwit Bay opposite Malone Bay, about 1½ miles from shore. Since this was rather unusual, we checked the area the following morning and followed the moose's wavering and circling track back to a small island about 1 mile from shore, where we found him bedded; later in the day he was browsing along the shoreline of the same island. We landed next to the moose to have a close look and found very obvious cataracts in both eyes; during one low pass of the aircraft the moose turned directly into a rock wall, indicating total lack of vision. We followed its tracks made during 24 hours before it walked off the island, and found the moose's browsing and bedding pattern to be very similar to normal moose, except that when the moose encountered an opening he would begin making circles until he encountered vegetation.

On the afternoon of Feb. 25 the Middle Pack of 11 wolves found this blind moose while he was browsing along the side of a sheer rock wall. We arrived just after the wolves had left, but from the tracks we determined that there had been a short, but intense encounter with the moose backed up against the rock. The wolves were unable to kill or wound the moose. That night the moose wandered off the small island and the Middle Pack again confronted him, this time on the open, frozen harbor. Again the moose was able to fend off the wolves, and they again abandoned their attempts. Over the course of the next 1½ days the moose slowly made his way away from the island, ending up about 2 miles from shore. By the afternoon of Feb. 27 the moose had gone without eating for 2 days and there seemed little likelihood of his finding a way back to the island. By the time we figured out the logistics of shooting the moose and examining it (which we were reluctant to do after he had managed to do so well in the face of a large wolf pack), we were grounded by a snowstorm that deposited 15" of new snow. When we flew next on March 5 we found no trace of the moose, and presumed that he either somehow returned to the island or fell into open leads of water beyond his last location.

Moose population, 1979

For the first time since 1974, the moose population was censused during the winter study period, this year between Jan. 26 and Feb. 19. The census involved counting moose on 70 plots averaging about 0.4 mi^2 in area, and stratification of the island into four zones of relative moose density. The plots were permanent plots that have been used for this type of census on Isle Royale since 1966. The plots occurring in each zone were used to calculate an average density for that area, and, multiplied by the area of the zone, provided an estimate of the number of moose in each zone. Stratification of the island into different zones of moose density was based solely on the relative frequency of moose tracks, judged subjectively during all flights over the island, primarily when searching for wolf tracks.

The 1979 census is summarized in Table 8. Direct counting of the plots yielded a preliminary estimate of 738 moose, which when adjusted for sightability (see below) provided a final estimate of 826 moose during early February, 1979. The 95% confidence interval for the estimate was ±16%.

Table 8. 1979 aerial moose census, Isle Royale.

Zone	Area(mi^2)	No. of plots	Proportion of zone counted	Moose counted	Flying intensity (min/mi^2)	Moose per mi^2	Estimated total from direct count	Assumed sightability	Adjusted total
0	47.5	12	11.6%	2	29.3	0.36	17	95%	18
1	88.1	26	12.7%	26	33.2	2.33	205	95%	216
2	56.7	19	13.4%	32	40.8	4.22	239	90%	266
3	18.9	13	25.9%	69	50.5	14.65	277	85%	326
Whole island	211.2	70	13.8%	129	37.3	3.50	738	89%	826

Moose density in midwinter on Isle Royale is roughly proportional to the density of conifer cover, especially balsam fir (Fig. 10). The lowest-density zone was primarily in the 1936 burn, which is almost entirely aspen and birch regrowth, while the high-density zone included primarily south-facing shorelines with a canopy dominated by spruce and fir. There were no detectable changes in moose distribution occurring while the census was underway, and regular light snow kept snow depths constant and provided fresh tracking during most of the counts.

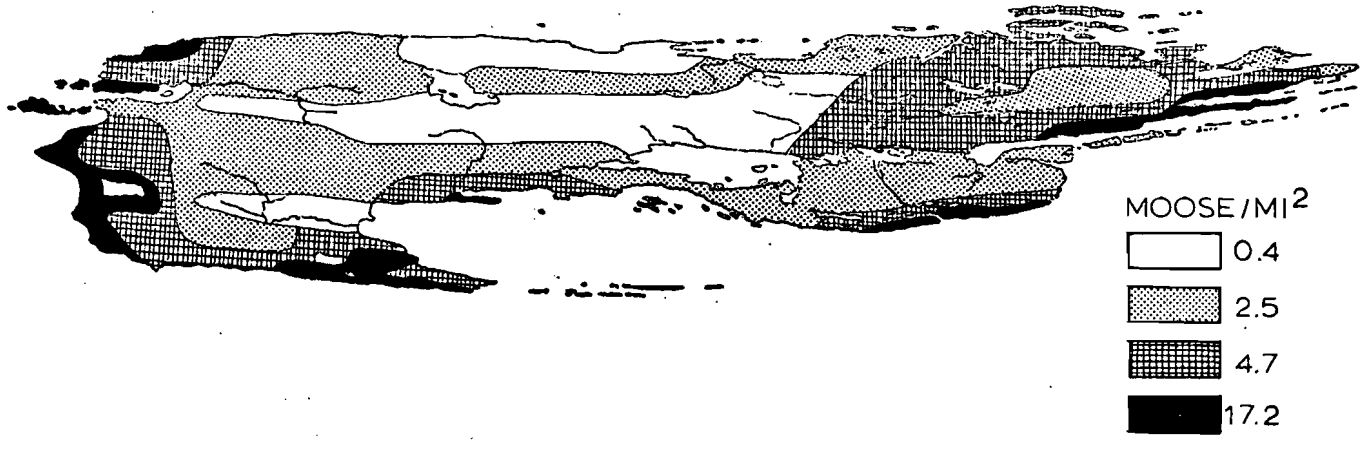

Figure 10. Moose density on Isle Royale, February, 1979. Density statistics have been adjusted by estimated sightability according to Table 8.

It is generally understood that not all moose within plots can be observed even during intensive circling at low elevations, and recent experiments by William Gasaway, Alaska Department of Fish and Game, were helpful in estimating the accuracy of the Isle Royale census. The overall sightability estimate of 89% in 1979 is quite high, but seems compatible with the criteria outlined by Gasaway for fixed-wing counts based on intensive circling. The following factors are considered important in attaining the assumed high level of accuracy:

1) Both pilot and observer had considerable current experience.
2) Plot size was relatively small, which reduced fatigue.
3) Snow conditions and flying weather were excellent. We could often confirm 100% sightability of moose within plots on the basis of tracks.
4) The amount of time circling each plot was considerable, amounting to the equivalent of 50 minutes per square mile in coniferous cover.
5) Counting was scheduled to coincide with periods of greatest moose activity (usually the first three or four hours after sunrise, as determined by about 3000 moose observations recorded in winter since 1973), and all plots were flown with good light conditions.

The 1979 census was more satisfactory than either the 1972 or 1974 counts (also done by Peterson), and probably is most comparable to the 1969 estimate by M. Wolfe of 1362 moose. Thus our best estimate for the current moose population is about 800 animals in midwinter, with a 40% decline occurring in the past 10 years.

Snow conditions, 1979

When we arrived on Isle Royale in January snow depths ranged between 40 and 60 cm (15-25"), depending on overhead canopy. Snow depths were maintained at a relatively constant depth by light snow and cold temperatures through the middle of February, then increased gradually until the end of February as temperatures warmed up and snow fell more regularly. Heavy snow fell between March 1 and March 5 and left us with record-high snow depths of up to 120 cm (47").

The initial snowpack had settled little before our arrival, due to the cold temperatures early in winter. Average snow density was about 0.18, and with no crusts within the snow profile, there was no support provided for creatures moving through the snow. Wolves moved overland only with difficulty and always single file, foxes were rarely seen and were apparently confined to snowshoe hare trails, and yet moose could move readily through the snow because of its fluffy nature.

Sleet fell briefly on February 22, producing a surface crust over the entire island. It's measured vertical strength was just under 2000 g/cm^2, occurring over 50-70 cm of low density snow. Moose did not seem to be greatly hampered by the thin crust, and wolves were not supported on it at all. Foxes could readily travel on this crust, however, and immediately became very active; the day after the sleet we followed several sets of fox tracks for more than five miles as their activities and distribution patterns were re-adjusted in response to improved mobility.

New snow which fell Mar. 1-5 was heavy and wet, with a density some three times greater than average new snow. Snow depth even under conifers reached 90 cm, and moose were absolutely paralyzed. It was not uncommon to fly for two hours tracking wolves and not see a single moose. Moose were able to move only when they left the island and walked along the frozen lake surface. Wolves continued to move with difficulty through the snow, and continued traveling primarily along shorelines. Since the new snow was quite dense, foxes were able to travel on top without sinking more than 1-2".

After we left Isle Royale there was a major thaw in the region, with the snow surface alternately freezing and thawing. This undoubtedly produced an icy surface which could probably support wolves. Late March and April were very cold, which probably maintained high snow depths through spring. We expect to find evidence of malnutrition deaths due to the severity of the late winter period, with poor survival of both the overwintering 1978 calves and the calves to be born in 1979.

OTHER WILDLIFE SPECIES

Fox observations were very infrequent in 1979 (Fig. 11). The primary reason seems to be a general lack of movement and use of moose carcasses because of the deep, soft snow during the first half of the winter study. The carcass of one wolf-killed fox was recovered from the ice of Rock Harbor, where it was caught by the East Pack near a kill along the shoreline.

Due to cold temperatures and extensive ice, beaver and otter were observed only infrequently. Otter tracks were seen only seven times, primarily in Grace Creek, Big Siskiwit River, and the drainage from Harvey L. to Chickenbone L. Beaver were active at only five sites: inland from L. Todd and Todd harbors, Houghton Point, Paul Island, and Caribou Island.

There was almost a total lack of open water around Isle Royale this winter, and only one gull and one oldsquaw were seen during the seven weeks. Common winter birds included black-capped chickadees, ravens, gray jays, redpolls and pine siskins. Ravens (and foxes) made heavy use of an unusually large crop of mountain ash fruit on the islands between Houghton Point and Menagerie Light. No eagles were seen during the winter study, and no eagle or osprey nests were observed during summer field work in 1978.

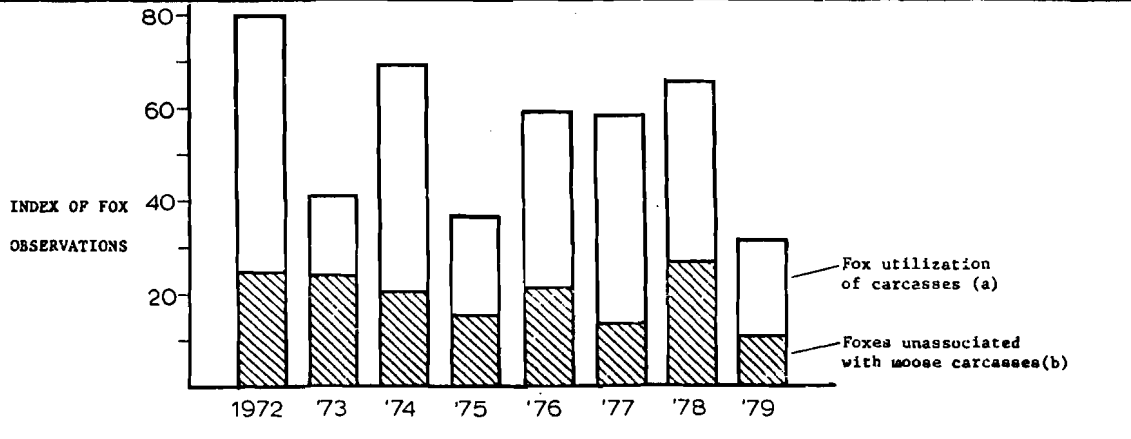

Figure 11. Midwinter fox observations, 1972-79. (a) is the sum of the maximum number of foxes seen on each moose carcass, (b) other fox observations per 100 hours of flying (more than 1 km from a moose carcass).

Beaver studies, fall, 1978 by Philip C. Shelton

During the week of 15-21 October 1978, Philip C. Shelton did an aerial survey of beaver colonies, live-travpped four colonies, and visited several colonies on the ground. The aerial count took 14 hours flying time on Oct. 16-19. Fred Stroble, of Shawano Flying Service, Shawano, Wisconsin flew the float-equipped Piper Super Cub. Funds for the aircraft were provided by the National Park Service.

Ground work included parts of three days spent inspecting colony sites on foot or by boat, and a total of 24 trap nights with Hancock live-traps at two colonies on Tobin Creek and two in Rock Harbor. Thirteen beavers were caught, including one on Tobin Creek that had been caught at the same location as a yearling in 1974.

The aerial count revealed 129 active sites determined by the presence of a food pile, and 27 additional sites had fresh cutting, or fresh mud on the house or dam, indicating the presence of at least one beaver. The count was made under good conditions, and intensive recounting of selected areas after initially covering the entire island indicated that few active sites had been missed on the first count.

This count indicates a decline of 50-55 percent from the count made in 1974, when 286 colonies with food piles and 30 with other fresh sign were tallied.

The reduction was greater for stream beavers than for harbor or inland lake dwellers, although the total number of beavers in these habitats was comparatively small. In 1974 there were 11 colonies known in harbors, and 26 on inland lakes. Comparable 1978 figures were 11 on harbors and 19 on inland lakes.

Fluctuations in beaver numbers in the past have been thought to be more drastic inland than on harbors. The decline in the 1950s was thought to be a result of tularemia, which would have been more easily spread among stream dwelling beavers than those living on larger bodies of water (Shelton, in press: Proceedings of the First Conference on Scientific Research in the National Parks).

There was no indication in 1978 that beavers suffered any physical or pathological abnormalities that could account for their decline in numbers. Twelve of the 13 beavers handled were systematically combed on the rump and hips for parasites. Beetles, tentatively identified as *Leptinillus validus* Horn, were found on six of these 12 beavers (three had one, one each had three, five, and eight beetles). Unfortunately, quantitative data were not obtained in former years. No beetles were found on the 223 beavers handled in 1961-63, but beetles were found on four of 63 beavers handled in 1974. In neither of these periods were systematic searches made for parasites. It is therefore believed that the findings in 1974 represented a real increase in incidence of the parasites. But the occurrence of parasites on half of the 1978 sample cannot be construed to indicate a further increase in parasite load since 1974.

Food supplies for beavers have been declining steadily for at least 35 years, as aspen and birch dating from fires of the last century or more have been cut back farther and farther from water at long established sites. However, there is no evidence that a food supply crisis is the direct cause of the latest decline in beavers. There remain considerable supplies of both aspen and birch within foraging distance of many ponds. Birch is seldom cut back more than a few meters from water, and at least one site was observed in 1978 where aspens had been cut close enough to fall into a pond.

With beaver feeding distances slowly increasing, and the wolf population remaining high, vulnerability of beavers to wolf predation has no doubt been high during the last four years. A region-wide drought in 1976 may have increased the vulnerability of beaver to wolf predation, and wolf scat data (Table 4) suggest that wolf reliance on beaver may have increased during the late 1970s. Since removal of either adult from an established colony may disrupt the unit and scatter surviving individuals, the effects on numbers of animals may not be as severe as is apparent from the count of colonies with visible food piles. That the number of sites observed with fresh sign, but no food pile, remained nearly the same from 1974(30) to 1978(27) may be a manifestation of such disrupted colonies, which now comprise a higher proportion of the total sites.

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