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ECOLOGICAL STUDIES OF THE WOLF ON ISLE ROYALE*

Third Annual Report

(Covering the Fifteenth Year in the Isle Royale Studies)

1972-73

by

Rolf O. Peterson, Graduate Research Assistant

Durward L. Allen, Professor of Wildlife Ecology

Department of Forestry and Conservation
Purdue University
West Lafayette, Indiana 47907

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NOT FOR PUBLICATION

This report summarizes the third year of study for Rolf O. Peterson, currently working on his doctorate, with emphasis on the ecology of the wolf and moose-wolf relationship.

Summer personnel on Isle Royale during 1972 included Peterson and his wife, Carolyn (May 9 to November 1); Ronald L. Bell, a graduate student in wildlife science at Ohio State (June 13 to September 8); and Philip W. Simpson, now a senior in wildlife at Purdue (June 13 to August 18). Allen visited the island for 5 days in September with Dr. W. C. Bramble, head of Purdue's Department of Forestry and Conservation, and returned for 2 weeks of field work in October.

William J. Martila, who had flown fall moose herd composition counts and had made transportation and supply flights to the island since 1963, was killed in a tragic accident in August, 1972. Robert R. Mohr, of Crane Lake, Minnesota, was able to help us on short notice by flying the October composition counts.

Dates for the 1973 winter study were January 24 to March 16. Allen was on the island from January 24 until March 3, and Peterson was present the entire period. Fred H. Montague assisted in opening camp as in 1972 and made fox observations at Windigo until February 2. Robert E. Henshaw, environmental physiologist from Penn State University, participated from February 12 to 21.

Donald E. Murray, of Mountain Iron, Minnesota, was our pilot and observer for the fifteenth winter. Wilderness Wings (Ely, Minnesota) handled the supply flights and personnel exchanges. National Park Service personnel who gave valuable assistance during winter study were the following: William E. Dohrn, 24 Jan. - 2 Feb.; Fred H. Young (Pictured Rocks National Lakeshore), 2-12 Feb.; Alan D. Eliason, 12-21 Feb.; Richard E. Hoffman, 21 Feb. - 3 Mar.; Irving L. Dunton, 3-16 Mar.

In March, 1973, Peterson participated in an International Symposium on Moose Ecology in Quebec City, Canada, and delivered a paper by Peterson and Allen entitled "Snow conditions as a parameter in moose-wolf relationships." The paper will appear in Le Naturaliste Canadien later in 1973.

Summer Observations, 1972

Coverage of the island during the summer season was greatly increased by the use of two hiking teams-- Peterson and his wife as one, and Bell and Simpson as the other. Hiking mileage totaled more than 900, including 408 miles of off-the-trail work. Remains of all dead moose encountered were examined, with appropriate specimens collected. The moose observations yielded data on herd composition and calf production. By stimulating howling responses from the wolves, we gained some knowledge of their summer activities.

Summer wolf activity

As described in last year's report, Isle Royale now has two recognizeable wolf packs, referred to as West and East, respectively, since each ranges over about half of the island. The packs were distinguishable during the summer by their group howls. All summer locations of the two packs were within their respective winter ranges. Both packs had pups in 1972 that survived into winter, although the summer work provided no firm evidence of the presence of pups.

A transistorized megaphone (bull-horn) was used during our summer hiking to amplify human imitations of wolf howling. A total of 512 "howls" were broadcast from 178 locations, and 23 responses were heard from 12 locations, including successive responses after contact was initially established. Most of our howling was done while off the park trails and away from campgrounds and other concentrations of park visitors.

Howling success with the West Pack was limited to late May, when we estimate there were at least 4 to 5 wolves present in the pack (last winter this pack had 7-8 wolves). On one occasion these wolves were howling back and forth with a pair of wolves about two miles away. Howling locations of this pack during four days in late May ranged from Lily Lake to the Big Siskiwit River. The black lead male and the lead female were seen at Lily Lake on May 26, with the rest of the pack less than a mile away. The lead female, who had consistently limped during the previous winter, still favored her left front leg. This suggests a chronic impairment, perhaps arthritis.

The West Pack was not located again until September 1, when the pilot of the plane chartered by National Park Concessions saw five wolves on Coyote Ridge, including the lead male and apparently the lead female from the West Pack. On September 13, we found that this pack had recently revisited a summer-killed cow moose at the base of Coyote Ridge and had just finished cleaning up a freshly-killed calf nearby.

Contact was first established with the East Pack on July 22, near Link-later Lake, with at least five wolves present. This pack was heard every night from August 11 to 15 from the vicinity of Lake Richie. In addition to a minimum of five wolves in the pack, a single wolf howled from a position near the pack on two nights, and one night a group of three wolves responded in addition to the pack. The pack (at least five wolves) responded again by Wallace Lake on August 17. The pack might have had a kill in the area, although none was found.

On September 24, the East Pack (7-8 wolves) responded to howls in the burn east of Lake Richie. The Petersons continued to howl as they approached the animals, and soon they encountered a wolf traveling toward them. It turned and ran back toward the pack. The dark coloration and markings of this wolf suggested the lead male, which was distinguishable last winter. It appeared that this animal was investigating the source of the unfamiliar howls. The pack immediately left the area.

It was readily apparent this year that wolves in all sectors of the island were restricted in their use of hiking trails after park visitation increased in late May and early June. Wolf tracks and scats were commonly seen on park trails in mid-May, but they became increasingly scarce through June and rare from July through October.

Moose observations

Routine information gathered on the moose herd during the past three summers is summarized in Table I. Also in Table I are data obtained during 10 hours of aerial classification in October after leaf-fall.

Table I. Moose herd composition and productivity, 1970-72*

	June 9 to Sept. 4, 1970 (ground)	May 18 to Sept. 7, 1971 (ground)	May 9 to Sept. 25, 1972 (ground)	October 17-20, 1972 (aerial)
Total seen	192	142	231	114
Males	64	47	106	49
Females	91	64	92	53
Calves	35	19	23	12
Unknown	2	12	10	--
Sex ratio	70mm/100ff	73mm/100ff	115mm/100ff	93mm/100ff
Percentage of females w/ young (after June 1)	27.5	25.0	25.6	20.8
Calves per 100 adult females** (after June 1)	38.5	26.6	28.0	22.6
No. sets twins	5	1	2	1

* Hiking mileages for 1970, 1971, and 1972 were 442, 606, and 891 miles, respectively.

** Includes yearling females, which are at times impossible to distinguish from older moose.

Using "calves per 100 adult females" as a relative index to calf production, we see that the figures for 1971 and 1972 are somewhat lower than 1970. The relatively severe winters of 1971 and 1972 appear at least partially responsible for this decline. The winter of 1973 was mild by comparison and should provide some interesting comparisons.

The change in the observed sex ratio from 1971 to 1972 (ground) does not reflect true conditions. An unusual number of bulls were seen utilizing aquatic areas in early summer, thus biasing the results.

Moose mortality

Remains of 152 dead moose were examined during the summer, including 26 that were discovered last winter but not examined because of unfavorable ice conditions and flying weather.

We have now examined 81 moose that died of natural causes (including wolf predation) on Isle Royale from October, 1971, through October, 1972. The age distribution and cause of death are given in Table 2. As in 1971, wolves killed an unusual number of calves during the winter of 1972 (50 percent of 54 kills). This is attributed to the effect of deep snow on the mobility of the cow-calf pair when confronted by wolves and perhaps also to lowered vigor of both cow and calf.

Table 2. Age specific mortality of 81 Isle Royale moose dying from Oct. 1971 to Oct. 1972*

Time and cause of death	Age at death																	
	Calf	1+	2+	3+	4+	5+	6+	7+	8+	9+	10+	11+	12+	13+	14+	15+	16+	Total
Fall, 1971																		
Wolves	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Other	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Winter, spring, '72																		
Wolves	27	5	5	3	-	1	3	2	1	2	1	1	-	-	-	1	1	54**
Malnutrition	3	-	-	-	-	1	1	-	-	3	-	1	-	-	1	-	-	10
Accidental	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	2
Undetermined	-	-	-	-	-	-	-	1	-	-	-	2	-	-	-	-	-	3
Summer, fall, 1972																		
Wolves	2	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	4
Other	3	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	4

* Includes carcasses found during random searching in summer as well as those located from the air in winter.

** Includes one adult whose age could not be determined.

It will be recalled that in past years of this study the killing of a "prime age" (1 to 5 years old) moose by the wolves has been a relatively rare occurrence. Thus, our findings of 1971-72 are of unusual interest, since the young age classes are heavily represented in the kill. Moose in the 1+ to 3+ year group accounted for 50 percent (n=26) of adults killed by wolves during winter and spring 1972. It is noteworthy that individuals of these age classes were either born after a particularly severe winter (1969, 1971, or 1972) or experienced a severe winter as a calf. During these winters deep snow caused moose to concentrate in conifer cover along heavily-browsed shorelines, and calves suffered an obvious nutritional handicap. This suggests that the vulnerability of these age groups to wolf predation increased due to residual effects of severe winter conditions early in life. Relative to this point, metatarsus collections made since the winter of 1971 may provide a valuable index to body growth in each age class.

Evidence of the severity of the winter of 1972 was found the following spring, when we recovered 10 carcasses of moose that evidently died of malnutrition. When found, these animals were untouched by wolves, and usually they died in stands of balsam fir that had been browsed severely. This suggests that these moose had been restricted to small areas by snow and had completely consumed the food supply available to them. All six long leg bones of three of these moose (two adult, one calf) were examined for marrow fat content. The calf showed completely depleted marrow in all leg bones, and the adults showed complete fat depletion in the proximal leg bones (humerus, femur), with partial depletion in the distal bones (metacarpus, metatarsus). All bones examined from the other six moose showed partial or complete fat depletion. All but one of these carcasses were located less than half a mile from the Lake Superior shore of the island, reflecting the concentration of moose in conifer areas in response to deep snow conditions. Perhaps more important than the deep snow of February and March was the persistence of the snow cover into late April, forcing moose to remain concentrated into the spring. One moose that died of malnutrition in late April was still lying on two feet of snow when discovered during the second week of May.

Other summer observations

For three consecutive years the great aspen leaf roller (Archips conflictana) has defoliated large numbers of aspen trees on the island. Its effect was greatest in 1970, when the work of this insect could be found in almost all stands of aspen. In 1971 and 1972, defoliation was confined to the 1936 burn. Most of the trees affected in 1972 produced some normal leaves after the caterpillar entered the pupal stage in midsummer, although the recovery along Coyote Ridge was slight. Numerous species of birds were seen utilizing the larval and pupal stages of the insects.

Total species of birds recorded from May through September numbered 106, including many migrants. Evidently there were no resident bald eagles, and no osprey nests were seen, although an occasional osprey was reported. Subjective impressions of snowshoe hare and beaver abundance indicated no gross changes, although such observations are crude indicators, at best.

Winter conditions, 1973

Winter weather was characterized by unusually high temperatures. The mean daily maximum and minimum were 30.1 degrees F. and 11.6 degrees F., respectively, considerably above the 1967-72 averages of 22.8 and -0.1 degrees F. The lowest temperature recorded this winter was -14 degrees F. on Feb. 16, while the high was 45 degrees F. on March 10 and 13.

Snow depths during 1973 were about average for the period of time when we are on the island. Depths in open areas at Windigo averaged 24 inches from the opening of camp until February 22. On February 24 snow depth reached its maximum, 28 inches. Depths then decreased steadily with the warm weather and rain of late February and March. By March 15 the snow had settled to 16 inches. During the entire winter study period 17.4 inches of fresh snow fell (water equivalent 0.62 inches). In the same period we had 2.63 inches of rain, primarily during the last two weeks of the study.

Ice conditions were generally favorable for landing in the protected harbors and inland lakes. Little shelf ice formed around the island, and Siskiwit Bay was frozen for only a portion of the winter study. At no time was there stable ice between Isle Royale and Canada.

Flying was attempted on 25 of 50 days, with optimum conditions prevailing on 11 days. After February 26 we flew only 13 hours and were hampered greatly by the warm weather. On several days Washington Harbor ice softened to the extent that flying was not even attempted. Only 87 hours were flown during the winter study period, an all-time low.

Winter birds

The small fringillids that are usually present in the Windigo area were totally absent this year, apparently due to the lack of available birch seed. Winter residents in the Windigo area included black-capped chickadees, ravens, Canada jays, blue jays and downy and hairy woodpeckers. As usual, an occasional great-horned owl and pileated woodpecker were heard.

Noteworthy bird observations include an immature bald eagle over Siskiwit Bay on February 3, a black-backed woodpecker on Beaver Island on February 22, a snow bunting at Windigo on February 22, and a small flock of starlings at Windigo on March 12 and 14 (the first winter observation of this bird on Isle Royale).

In spite of open water conditions around the island, only occasional goldeneyes and mergansers were seen, and no herring gulls were observed.

Secondary species of mammals

An outstanding feature of the 1973 winter study was the unusually high otter and beaver activity, undoubtedly due to the mild conditions and great amount of open water. Signs of beaver were seen a total of 13 times, including two beavers killed by wolves (February 4 and 21). Otter sign was common and widely distributed. We saw two animals on Washington Harbor on March 15.

The problems of comparing aerial fox observations on a year-to-year basis were discussed in the 1972 report. When foxes make disproportionate usage of mountain ash fruit or moose carcasses along lakeshores, they are seen more often. To avoid tabulating the same fox day after day (e.g. while feeding on a moose carcass) we calculated the sum of the maximum number of foxes seen on each moose carcass, and added this to the total seen unassociated with a carcass. In 1972, foxes were seen utilizing 23 of 38 carcasses (59 percent), with a mean maximum of 2.4 (previous report was in error) foxes/carcass (n=23). In contrast, during 1973 foxes were observed utilizing 14 of 30 carcasses (47 percent), with the maximum averaging only 1.3 foxes/carcass (n=14). We add the sum of these maximum figures (18) for 1973 to the number of foxes seen away from carcasses (21) to arrive at an index of 39 foxes in 87 hours (45 in 100 hours), a decline from the 1972 index of 76 in 100 hours. Rather than reflecting a change in the fox population, these figures probably reflect a change in fox food habits and distribution. A drop in fox utilization of moose carcasses in 1973 is clear. However, fox tracks were common in areas of hare activity, which were more evident in non-conifer cover in 1973 than 1972. We believe that foxes, perhaps aided by favorable snow crusting conditions, increased their utilization of snowshoe hares in 1973. There was no change in the number of foxes observed away from moose carcasses (1972: 25 per 100 hours; 1973: 24 per 100 hours). Thus the decrease in aerial fox observations is not necessarily a reflection of a smaller fox population. We see no evident change from 1972 to 1973.

A silver fox and a cross fox were seen on the island this winter, both in the Windigo area. In addition, a total of eight different foxes visited the bunkhouse area (4 females, 3 males, 1 unknown). This was the third consecutive year of appearance for two of the individuals (1 female, 1 male), and second for two others (1 female, 1 male). Courtship behavior was clearly evident by the middle of February, although no copulation was observed.

Our subjective impression is that hare tracks were slightly less plentiful, in 1972 than in the winter of 1971. We would regard them as plentiful, but not abundant.

max #

1972 59 (n=38) 23 w/ foxes x 2.4 = 55

1973 47 (n=30) 1.3 (n=14) 14 w/ foxes x 1.3 = 18

1974 65 (n=37) 1.9 (n=26) 26 w/ foxes x 1.9 = 49

Winter Moose Distribution and Mortality, 1973

Moose distribution was stratified throughout the winter study, with highest densities in conifer cover, as in past years. The degree of stratification was not as great as in 1971 and 1972, when unusually deep snow prevailed. A few individuals made considerable use of the 1948 burn east of Lake Desor. In general, the 1936 burn was little used, especially the area north of Siskiwit Lake.

As a result of crusted snow in late February and March, moose were quite inactive and were rarely visible except in conifer cover, where crust formation due to rain was not as apparent.

This winter 30 moose carcasses were located from the air, including 22 that were killed by wolves during the study period. Seven kills were examined; the rest will be checked during spring and summer. The age distribution of the examined kills plus data from the previous four winters are given in Table 3, which contains several additions and corrections not included in a similar table in the previous report. The decrease in mean age of adult kills is due primarily to an increase in kills in the 1+ to 3+ year group, as discussed earlier.

A cow and her calf were shot for necropsy purposes this winter. The cow was 8 years old, weighed 800 pounds, and was not carrying a fetus. The calf weighed 410 pounds. An additional calf was found which had fallen off a 6-foot high bank and was unable to use its hind legs. When it was autopsied, the rear leg bones and pelvis were found normal, suggesting that a spinal injury had disabled the calf. Unfortunately, the untimely return of the calf's mother precluded further examination and necessitated Peterson's retreat to a tree overhanging the lake shore.

An adult bull was successfully tranquilized with succinylcholine chloride (Sucostrin) and marked with an ear tag and a vinyl-coated nylon collar. Another bull received a dosage insufficient to permit handling. We have not attempted to remove an incisiform tooth from a tranquilized animal, though the technique appears satisfactory.

Table 3. Age distribution of Isle Royale moose killed by wolves[1] in winter, 1969 - 1973.

Age (years)	Frequency				
	1969	1970	1971	1972	1973[2]
Calf	18	7	28	27	2
1+	3	3	0	5	1
2+ - 4+	0	1	5	8	2
5+ - 7+	2	0	3	6	0
8+ - 10+	8	1	9	4	1
11+ - 13+	2	1	2	1	1
14+ - 16+	2	3	0	2	0
Unknown adult	1	0	3	1	0
Total	36	16	50	54	7
Percent calves	50.0	43.7	56.0	50.0	--
Mean age (adults)	8.3	7.8	7.4	5.3	--

[1]Includes both known and "probable" wolf kills (found in summer and winter).

[2]Partial listing, to be completed after summer, 1973.

The Wolf Population, 1973

The total number of wolves on Isle Royale has changed little since last year, although litters evidently were born in both packs. The two packs, West and East, each occupied about half of the island (as in 1972). An additional duo and a loner make a total of 24 wolves, summarized as follows:

West Pack	8	(numbered 7 after Feb. 20)
East Pack	13	
One duo	2	
One loner	1	
	24	probable total population

The "boundary" between the two large packs appeared to run through Siskiwit Lake and included an area of overlap on the north shore between Little Todd Harbor and Todd Harbor, where each pack visited old kills made by the other pack. No direct interaction was observed. The pair, seen only three times, did not travel extensively, though they ranged from Little Todd Harbor over to Intermediate, Siskiwit, and Whittlesey lakes. The loner, positively identified as a male, was seen only once, although tracks indicated that he at least ranged along the north shore from a point opposite L. Desor to the northeast end of Amygdaloid Island, a distance of 25 miles.

The structure of the West Pack has been altered considerably since last winter. The black lead male and the lead female undoubtedly died between September, 1972, and January, 1973. The black male was at least 6 1/2 years old when he died, since he appeared to be a pup when the pack containing four black wolves arrived from Canada in 1967. In addition, two other wolves that were recognizeable in the West Pack in 1972 were not present in 1973, implying quite a high turnover rate in the past year. From their appearance and especially their behavior, four wolves were considered to be pups this winter. One of these animals disappeared from the pack in mid-February, and was not seen again. In addition to the lead pair, there was another adult male and adult female. This male courted the second female on several occasions, but was never accepted by the female. The lead pair were observed copulating on February 16.

The East Pack numbered either 12 or 13 wolves for the entire winter study, an increase of 3 over the maximum number of last year. When initially located in 1973 this pack was extremely afraid of the aircraft, to the point of leaving a fresh kill upon hearing the plane. They probably had been buzzed extensively by an aircraft earlier in the winter. Eventually the pack became accustomed to the study craft and would tolerate overhead circling. Behavioral observations of this pack have always been hampered by the uniformity in physical appearance of most of the pack members. The lead pair were recognizeable again this year, so we know that pack leadership has not changed in the last year. Only one other wolf is distinguishable, and is now two years of age. The increase in pack size indicated a minimum of three pups surviving into the winter of 1973, also supported by a close examination of pack photographs. The lead male consistently courted the lead female and presumably mated with her, although copulation was not observed.

Due to strong crusts near the surface of the snow (and perhaps partially due to a lack of extensive shore ice in some areas), both wolf packs made extensive use of inland areas, in contrast to the shoreline travel routes of the past two winters. The distribution of kills reflected this change in travel patterns. Only 9 of 30 kills were less than 100 yards from a shoreline, and 17 kills were more than a quarter-mile inland.

A fairly complete travel and kill record was kept for each pack this winter, representing 32 days for the West Pack and 36 days for the East Pack. These data are summarized in Table 4. Travel rates were similar for each pack, and were relatively constant for the duration of the observation period. Over a short period of time wolves may show extremes in activity patterns. For example, the West Pack killed three moose in five days early in February. The four adult members of the pack then separated from the pups for at least two days, traveling most of the time. During these two days and the next five days the adults fed briefly on only one old carcass, and traveled over 80 miles before making another kill.

Table 4. Travel and kills of two wolf packs on Isle Royale, 1973.

	West Pack (Jan. 25 to Feb. 26)	East Pack (Jan. 25 to March 4)
Average daily mileage	9.4*	8.9
Known moose kills	9	11

*Includes travels made by the four adults only, who traveled 35 miles in 24 hours on Feb. 4 - 5 without the pups.

Snow Studies

The importance of snow in the moose-wolf relationship has been impressive in recent years, and the need for a systematic monitoring of snow conditions became evident after the periods of deep snow in 1969 and 1971.

Current snow studies utilize a "compaction gauge," or "penetrometer," to measure the support quality of the snow, as outlined in the previous report. These tests are carried out every 7-10 days in the Windigo area, under three basic canopy types (open, deciduous, and conifer). In addition, physical characteristics of the snow profile are measured about every two weeks in an open area at Windigo. These measurements are taken more frequently if the snow profile is changing as a result of new snow.

An outstanding feature of the snow cover in 1973 was the strong crust produced by a thaw before we arrived, probably in early January. Unexpectedly, crusts were strongest under conifer canopies, which are normally protected from the crust-forming effects of sun and wind. However, when a thaw melts an accumulation of snow from a conifer tree the resultant dripping of water creates a strong crust beneath the canopy. This crust was evident under conifers over the entire island, and it persisted even through the rains that came late in the study period. In January the crust was less strong in open areas, although it would occasionally support a man without snowshoes. In the open the snow profile showed typical density stratification, with the density of each layer determined by the length of time since deposition. This stratification disappeared with rains and above-freezing temperatures.

Moose chose to bed under conifer canopies, even though crusts were stronger in such areas during most of the winter study, suggesting that snow is of less insulating value to the moose than the canopy itself. Due to generally shallow snow depths crusts probably did not increase the vulnerability of moose when encountered by wolves, although wolves generally found travel easy throughout the island.

Considerable time was spent this winter measuring moose track depth and determining the weight-load of the compaction gauge which best simulates moose track depth. This knowledge, coupled with compaction gauge tests in various habitats, can help us understand the effect of specific snow conditions on moose and wolf mobility. Over the past two winters we have measured a total of 220 tracks of 17 moose, and calculated an average track depth for each set of tracks. Compaction tests were then conducted nearby to determine the weight-load that best simulated track depth. The average value was 230 g/cm^2, with a standard deviation of 43 g/cm^2. This is considerably less than the static foot-load obtained by dividing the weight of an animal by the area of its four feet (the hoof and area distal to the dewclaws). Calculated in this manner, the foot-load figures for the cow and calf autopsied this winter were 488 g/cm^2 and 381 g/cm^2, respectively. Track depths for this same cow and calf were duplicated by the compaction gauge when loaded at 244 g/cm^2 and 260 g/cm^2, respectively. Similar tests on a small sample of wolf tracks indicated that duplication of wolf track depth was best achieved with a weight-load of approximately 100 g/cm^2, which is close to the static weight-load of a wolf as calculated by other workers.

OUTLINE OF PROPOSED RESEARCH, 1973-74

In the coming year the field work schedule and general objectives will be similar to the past year. Peterson will again be in the field as much as possible, and will begin work on his thesis. Allen will emphasize fall field work. He will begin work on a book that will include observations over 18 years at the time it is expected to be finished, in 1976.

Summer study, 1973

The primary objective of the summer field work will again be moose carcass examination and specimen collection. Wolves will be located when possible with the howling technique. Data on moose herd characteristics will be gathered during summer ground work and during an aerial composition count in the fall.

Peterson, his wife, and two Purdue students will comprise the summer personnel. Two hiking teams will be active in May, the best time for locating carcasses. It will be important in the next few years to monitor closely the vulnerability of various age groups to wolf predation, thus a large sample of wolf kills gathered on a year-to-year basis is essential. Extensive cross-country hiking will furnish this sample, in addition to moose observations and limited information on summer wolf activity.

Winter study, 1974

The winter study schedule will probably be identical to this year, opening during the third week of January and closing in mid-March. Peterson and pilot Murray plan to participate for the entire seven-week period, and Allen will stay until about the end of February.

If weather permits we will conduct a mid-winter aerial moose census, in a manner similar to previous aerial counts. Flying time will be at a premium for this purpose, although we will try to make sufficient observations of the various wolf groups to enable us to monitor changes in pack structure, social relationships, and the status of the 4 or 5 recognizeable wolves now present.

Locations of all wolf-killed moose will be marked, with most of them left to be examined in the summer of 1974. At least half of the yearly sample of kills are initially spotted from the air during winter. We will continue to improve our moose immobilization and marking technique on a small-scale basis as time and opportunity permit.

Snow conditions will be monitored, and additional emphasis placed on compaction gauge studies of moose and wolf tracks.

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