

Wolf- Moose Ecology at
Isle Royale National Park

Final Report on Research Conducted
During May 1 - November 30, 1982

Contract #CX-6000-2-0049*
U.S. National Park Service

Prepared by

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

April 30, 1983

In addition to IS funds provided for this contract, financial support was also provided by the National Audubon Society.

INTRODUCTION

The present report summarizes field work conducted at Isle Royale National Park on wolf-moose ecology during the period May 1 - November 30, 1982. Also presented are analyses of previous work that were completed during this period. Principal objectives for field work (synthesized from the National Park Service "Scope of Work") were to:

- 1) Determine extent of wolf pup production and survival, distribution of summer homesites, and food habits.
- 2) Determine moose calf production, yearling survival, adult moose sex ratio, a summer index to moose density, and characteristics of moose mortality.

PERSONNEL AND SCHEDULES

Field work was conducted during June-August and a brief period after leaf-fall in October. Field personnel in 1982 were the following:

Rolf O. Peterson, principal investigator, May 25 - July 31

Kenneth L. Risenhoover, graduate research assistant, May 25 - Aug. 15

Timothy C. Laske, field assistant, May 25 - Aug. 28

Patrick R. Charmley, field assistant, June 17 - Aug. 28

Risenhoover conducted the aerial survey of moose during October 21-23, with Donald E. Glaser (Grand Rapids, Minn.) piloting the survey Super Cub on floats. Graduate students Richard E. Page, Kenneth L. Risenhoover, Jackie Wilcox and undergraduate assistant Jane Letarte all assisted with data analysis and

PUBLICATIONS AND PRESENTATIONS

The following publications appeared during the report period (3 reprints of each have been sent to the Regional Chief Scientist in Omaha):

Peterson, R. O., J. M. Dietz, and D. L. Allen. 1982. Depletion of bone marrow fat in moose and a correction for dehydration. J. Wildl. Manage. 46:547-551.

Peterson, R. O., J. M. Scheidler, and P. W. Stephens. 1982. Selected skeletal morphology and pathology of moose from the Kenai Peninsula, Alaska, and Isle Royale, Michigan. Can. J. Zool. 60:2812-2817.

Presentations at scientific meetings included the following:

Peterson, R. O. and R. E. Page. Wolf-moose fluctuations at Isle Royale National Park. Presented at 3rd International Theriological Congress, Helsinki, Finland, August 1982. To be published in Acta Zool. Fennica.

Page, R. E. and R. O. Peterson. Recent wolf-moose interaction at Isle Royale National Park. Presented at 18th North American Moose Conference and Workshop, Whitehorse, Yukon, July 1982.

Papers accepted for publication include the following:

Stephens, P. W. and R. O. Peterson. 1983. Wolf-moose interactions in moose. Holarctic Ecology (in press).

SUMMER MOOSE OBSERVATIONS

Field personnel hiked 926 km during June-August, 1982, and observed 63 moose. Since most of this ground work is conducted in remote areas of the island, cows with calves clustered around campgrounds and developed areas (see Stephens and Peterson 1983) may not have been adequately sampled. Twin calf moose were reported from several campgrounds and 3 sets were observed by project personnel.

Summer ground observations of moose are summarized in Table 1. We observed 58 calves/100 cows, equal to the highest figure previously recorded since 1970. The frequency of moose observations (0.06 moose/km hiked) was essentially the same as the previous 5 years (Table 1).

MOOSE POPULATION INDICES

Due to the relatively low precision and accuracy of aerial censuses of moose at Isle Royale, our previous moose population estimates have been based partially on annual changes in 2 other indices of moose abundance: # moose observed/hr. flown in winter and # moose observed/km hiked in summer (Table 2). The summer moose index declined dramatically during 1970-77, and has since remained stable at a low level. Aerial surveys in winter indicate that the population level probably reached a low point of about 500 moose in 1981, then increased to about 700 in 1982 because of an exceptionally strong calf cohort in 1981. We speculate that the summer index will be the last one to show an increase because observations are somewhat removed from calf production areas near shorelines and campgrounds.

The summer and winter indices are significantly correlated, albeit with substantial variability (Fig. 1). Improved correlations will only result from

accumulation of more data points over a wider range of moose density. Thus it is important to continue all 3 methods of assessing moose density fluctuations during the immediate future, when we predict a recovery in the moose population.

AUTUMN MOOSE SURVEY

Since 1972 an aerial survey for moose has been flown immediately after leaf-fall to determine calf and yearling abundance and adult sex ratio (Table 3). In 1982, 150 moose were categorized in 12 hours of survey time. Partial snowcover aided moose observations. The adult sex ratio of 88 bull/100 cows in 1982 is within the normal range of variation from previous years.

Calf production in 1982 was high, although lower than the record level in 1981. Calves comprised 17% of the moose observed and 37 calves/100 cows were present. These data indicate that the 1982 cohort was the second largest in the past 11 years.

The exceptionally large calf cohort from 1981 continued to show good survival, with 18% of the bulls observed ($N=57$) in 1982 judged to be yearlings on the basis of antler characteristics (spikes or forked antlers). Thus a minimum of 35% of the autumn 1982 population was born in 1981 or 1982.

There is increasing interest in maintenance of optimum social organization in hunted cervid populations (A. B. Bubenik, pers. comm.); in the case of moose it has been recommended that about half of the bull component of the population be "prime" animals (largest antler class). In 1982, 51% of the bulls classified on Isle Royale were considered prime bulls; the remainder were "teens" or yearlings.

Fixed plots were not used in the autumn survey, but we intensively counted

the same large blocks used in previous years. Discrete areas surveyed in 1982 are shown in Figure 2. Noteworthy concentrations of moose occurred in the Windigo area, islands near Washington Harbor and Malone Bay, and the SW end of Feldtman Lake.

MOOSE MORTALITY PATTERNS

We are still processing teeth for age determination for dead moose examined since 1979. A sample of 91 teeth were recently completed, and results are presented in Table 4. Strong wolf selection for animals in the 10-15 year old group is evident. These animals were born primarily during a period of peak moose density in the late 1960's.

Degenerative joint disease (osteoarthritis) is an important debilitating condition in aged Isle Royale moose and undoubtedly predisposes moose to wolf predation. In an analysis completed in 1974, 23% of all adult moose older than 7 years exhibited arthritis; animals in that sample were born in the 1950's and early 1960's, a period of forage abundance and increasing moose density. Contrastingly, among old adult (> 7 years) moose dying since 1977; 61% exhibited degenerative joint disease. We speculate that social disorganization and/or forage limitations associated with peak densities in the late 1960's predisposed moose born at that time to degenerative joint disease in later life.

During summer, 1982, we began a long-awaited computerization of mapped data previously obtained during wolf-moose studies at Isle Royale, using the IBM 4341 computer in Michigan Tech's Graphics Lab. The island was digitized, all dead moose locations (ca. 1500) entered, and this map file was merged with tabular data previously stored on computer. This allows us to examine the distribution of dead moose that are selected for analysis on the basis of specific tabular

data. We have now completed a preliminary analysis of the distribution pattern of dead moose examined during approximately the past 20 years.

Stephens and Peterson (in press) previously showed that cows with calves frequented islands and areas inhabited by humans, probably because of the protection afforded against wolf predation. Furthermore, theoretical considerations of ungulate social organization (e.g. Geist 1982) predict that, except for the period of rut, bulls should be segregated from cows and seek areas of high-quality forage. On the other hand, cows (especially those with calves) should seek habitats most secure from predators, irrespective of forage availability. These predictions are borne out by our analysis of dead moose distribution at Isle Royale.

Calves were found to be distributed primarily along the shoreline of the main island, cows (predominantly without calves) were more randomly distributed in the island's interior, and bulls appeared primarily in the interior, especially where cows were not found (Fig. 3). This suggests that cow moose will predominate among adults killed near the shoreline of the island, a previously-unexplained phenomenon described earlier by Peterson (1977).

WOLF FOOD HABITS

Wolf scats were examined at dens and summer homesites and opportunistically throughout the summer. We examined 112 scats; food occurrences included 20% beaver, 38% moose calf, and 27% adult moose. Adult moose were more prominent, perhaps reflecting increased predation on the abundant yearling moose born in 1981. Calf moose and beaver obviously provided most of the summer food supply for the island's wolves. The relative proportion of beaver was low compared to that recorded in several recent years (Fig. 4), in spite of a substantial increase in beaver density (P. Shelton, pers. commun.).

WOLF HOMESITE DISTRIBUTION

Two wolf dens and 3 summer homesites were located in 1982; all were inspected after being abandoned by wolves. Both dens were dug out in abandoned beaver lodges, as were 2 of 3 previously known dens.

Summer homesite use has been recorded at specific sites 53 times during 1973-82. The distribution of these homesites in relation to park trails is significantly ($P < 0.05$) different from the distribution of land area on the island. Wolves show marked avoidance of areas less than 0.5 miles from a trail, which includes 56% of the main island.

WOLF POPULATION ORGANIZATION AND PUP PRODUCTION

In winter, 1982, the wolf population was reduced to 4 breeding units - one pack of 4 and 3 mating pairs. In summer, 1982, we learned that all 4 potential breeders actually had pups. In midsummer there were at least 10 pups alive on Isle Royale.

Breeding units were identified by their location. Three litters of pups were located within territories of the 3 principal packs (Gang of 4, Daisy Farm duo, and Harvey Lake duo), respectively, and the fourth litter was presumed to have been born to a wolf pair (SW duo) that had no well-established territory the previous winter. Howling of pups indicated a minimum of 2 pups in the Gang of 4, 3 pups with the Harvey Lake duo, and 4 or more in the Daisy Farm pack. Only 1 pup was present with the SW duo, which moved to the northeast end of the island. Pups were not located in the Gang of 4 after June, but pups were monitored in the other 3 litters as late as August.

MORTALITY

Two carcasses of adult wolves were recovered in 1982. Both washed in on the south shore of the island and were badly decomposed. One had numerous tooth puncture marks on its head. It is likely that both wolves were killed by other wolves, since animals dying of other causes (chronic malnutrition, injuries, or "old age") usually select secluded sites on land, not open ice.

Carcasses of 5 adult wolves have now been recovered since 1980. Three were probably killed by other wolves, while 2 apparently died of old age/malnutrition. Leg bones of another adult wolf that died of unknown causes in 1980 were also recovered.

SUMMARY

Wolf-moose research in summer 1982 at Isle Royale National Park centered on measuring the reproductive performance of both the moose population (in the early stages of an apparent recovery) and the wolf population (at its lowest level since colonization of the island over 30 years ago). A strong moose calf cohort was recorded in 1982 and at year's end at least 35% of the moose population was comprised of animals born in 1981 or 1982. Adult moose killed by wolves were once again the oldest members of the population, with a high percentage exhibiting arthritis. Analysis of the spatial distribution of dead moose revealed strong sex-age separation; cows with calves were closest to shorelines, cows without calves were distributed more randomly in the interior, and bulls were farthest from shore and somewhat separate from other groups. All 4 potentially breeding females in the wolf population bore young, and a minimum of 10 pups were alive in midsummer. The spatial distribution of wolf dens and summer homesites continued to show marked avoidance of trails and other

developments; the current park trail system effectively excludes intensive wolf use from over half of the island. Wolf reliance on beaver in summer was lower than average while feeding on adult moose increased. Additional evidence was gathered indicating intraspecific aggression played an important role in the recent wolf decline.

LITERATURE CITED

- Geist, V. 1982. Behavior. Pages 219 - 277 In J. W. Thomas and D. E. Toweill (eds.). Elk of North America. Stackpole Books, Harrisburg, Penn.
- Peterson, R. O. 1977. Wolf ecology and prey relationships on Isle Royale. U.S. Nat'l. Park Serv. Scient. Monogr. Ser. No. 11. 210 pp.

Table 1. Summer (June - August) ground observations of moose on Isle Royale, 1970-82.
These include only standardized observations made by wolf project personnel.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Total observed	158	93	152	172	114	156	104	46	66	88	47	57	63
Males	57	33	70	69	34	64	39	13	23	32	10	12	20
Females	74	44	61	69	55	65	49	26	30	33	28	30	26
Calves	26	8	19	28	21	23	12	5	11	19	8	14	15
Unk. sex (non-calves)	1	8	2	6	4	4	4	2	2	4	1	0	2
Sex ratio (males/100 females)	77	75	115	100	62	98	80	50	77	97	36	40	77
Calves per 100 females ^{1/}	35	18	31	41	38	35	24	19	37	58	29	47	58
No. sets of twins	4	1	2	3	4	1	0	0	2	2	0	1	1

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

Table 2. Winter (aerial) and summer (ground) indices to moose abundance, Isle Royale National Park.

	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>
Winter													
# hrs.	--	--	--	68	83	62	77	47	97	100	76	83	94
# moose	--	--	--	413	434	363	369	141	333	422	327	401	305
moose/hr	--	--	--	6.05	5.23	5.86	4.82	2.98	3.42	4.22	4.32	4.85	3.25
Summer													
# km	709	828	1000	1093	654	1093	1137	811	893	1519	743	876	926
# moose	158	93	152	172	114	156	104	46	66	88	47	57	63
moose/km	.22	.11	.14	.16	.17	.15	.09	.06	.07	.06	.06	.07	.06

Table 3. Autumn aerial composition surveys of Isle Royale moose, 1972-82.

	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	Oct. 25-26, 1979	Oct. 18-20, 1980	Oct. 19-22, 1981	Oct. 21-23, 1982
Total observed	114	192	117	157	120	75	118	250	106	198	150
Adult bulls	47	73	43	61	50	29	53	102	51	65	47
Yearling bulls ^{1/}	2	8	7	4	3	1	1	2	3	6	10
Cows	53	81	51	76	55	41	51	119	45	79	68
Calves	12	30	16	16	12	4	11	27	7	48	25
Bulls/100 cows	93	100	98	86	96	73	106	87	120	90	88
% Yearlings ^{2/}	4	10	14	6	6	3	2	2	6	8	18
% Calves	11	16	14	10	10	5	9	11	7	24	17
Calves/100 cows ^{3/}	23	37	31	21	22	10	25	23	16	61	37
Yearlings/100 cows ^{3/}	8	20	27	11	11	5	4	3	13	15	29

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

^{2/} % Yearlings = yearling bulls/(adult bulls + yearling bulls).

^{3/} Yearling females are included in the total number of cows observed.

Table 4. Ages of adult (more than 1 year old) moose dying on Isle Royale, 1979-82.

	Age (yrs)																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
Freq.	0	1	2	1	0	1	4	6	6	5	7	18	12	10	10	3	4	1	0
%	0	1	2	1	0	1	4	7	7	5	8	20	13	11	11	3	4	1	0

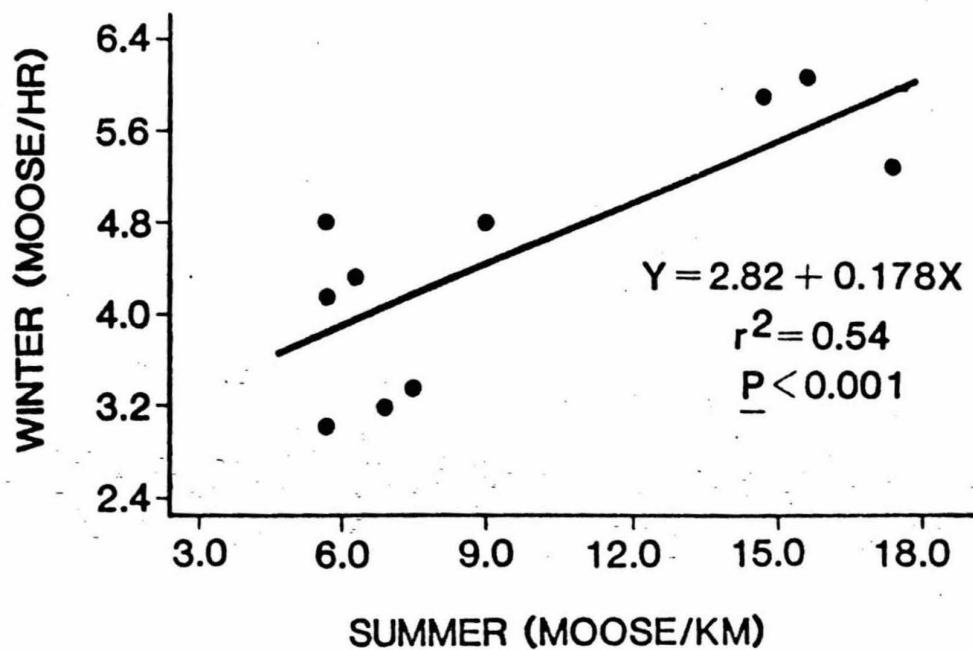


Figure 1. Correlation between summer and winter indices of moose abundance, Isle Royale National Park.

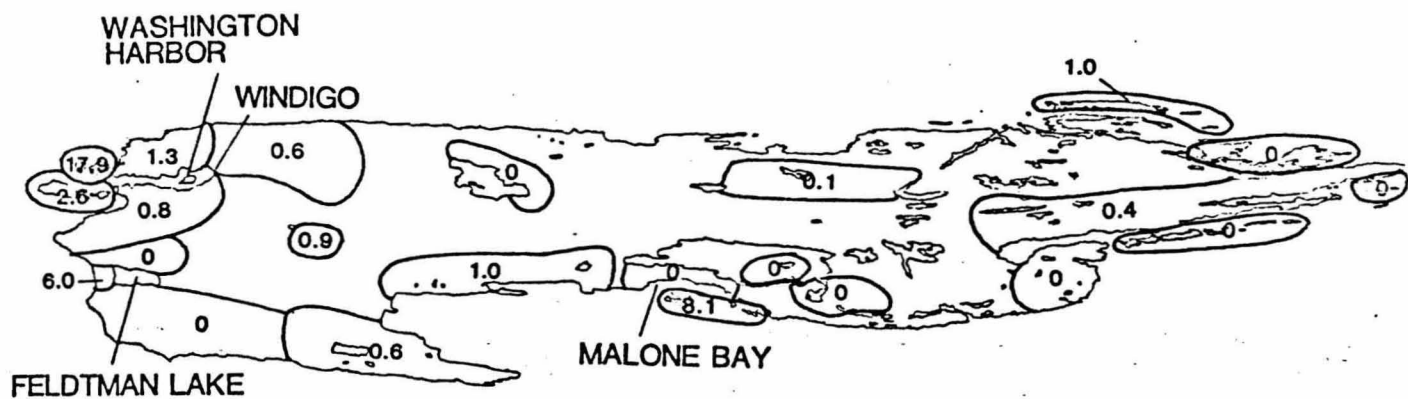


Figure 2. Moose density (moose/km²) in areas surveyed in October, 1982.



Figure 3. Spatial distribution of dead moose at Isle Royale. The following designations apply: "C" = calves, less than 12 mo. old; "F" = females more than 12 mo. old, primarily those without calves; "M" = males more than 12 mo. old.

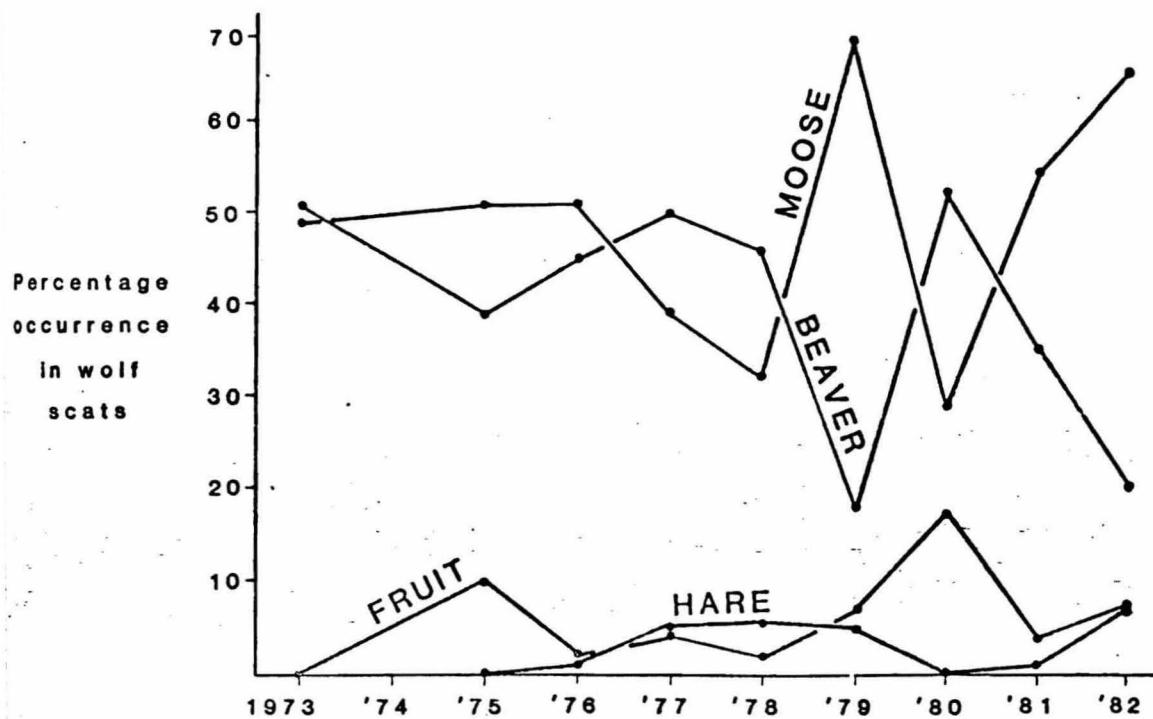


Figure 4. Prey and food occurrence in summer wolf scats examined on Isle Royale in 1982.