**Michigan
Technological
University**

Michigan Technological University
Digital Commons @ Michigan Tech

Ecological Studies of Wolves on Isle Royale

Wolves and Moose of Isle Royale

3-31-1999

Ecological Studies of Wolves on Isle Royale, 1998-1999

Rolf O. Peterson

Michigan Technological University, ropeters@mtu.edu

Follow this and additional works at: <https://digitalcommons.mtu.edu/wolf-annualreports>

Recommended Citation

Peterson, Rolf O., "Ecological Studies of Wolves on Isle Royale, 1998-1999" (1999). *Ecological Studies of Wolves on Isle Royale*. 23.
[10.37099/mtu.dc.wolf-annualreports/1998-1999](https://digitalcommons.mtu.edu/wolf-annualreports/1998-1999)

Follow this and additional works at: <https://digitalcommons.mtu.edu/wolf-annualreports>

Ecological Studies of Wolves on Isle Royale

1998-1999

A composite image featuring a moose in a lake, a wolf's face in the foreground, and two people on a grassy hill. The moose is in the upper left, standing in blue water under a dark, cloudy sky. The wolf's face is in the lower right, looking towards the viewer with its mouth slightly open. Two people are in the lower left, walking on a grassy hill with yellow flowers. The quote is overlaid on the left side of the image.

*"If you wish to advance into
the infinite, explore the finite
in all directions."*

—Johann Wolfgang Goethe

Ecological Studies of Wolves on Isle Royale

Annual Report 1998–99*

by

Rolf O. Peterson

School of Forestry and Wood Products

Michigan Technological University

Houghton, Michigan USA 49931-1295

31 March 1999

* During the past year, major support of these studies was received from the National Park Service (Co-op Agreement No. CA-6310-9-8001), National Science Foundation (DEB-9317401), Earthwatch, Inc., Robert Bateman Endowment Fund, and John B. Hakala.

Additional contributions were received from the following organizations and individuals: Ameritech Foundation, Randall F. Absolon, Dorthey L. Behrend, Charles C. Blackwell Jr., Alison J. Clarke, James E. Deignan, Ronald D. Eckoff, Edith N. Greene, Horace D. Jackson, Timothy G. Laske, Leila K. Newcomb, Michael W. Palmer, Rolf O. Peterson, Darcy R. Rutkowski, Donald J. Saveria, Loyd G. Schemenauer, and Billie E. Smith.

At Michigan Tech, William A. Tembruell, Arlene L. Johnson, Robert J. Slater, and Marianne A. Brokaw (all of University Relations) were instrumental in producing this report.

Important contributions of personal time and financial assistance from the following Earthwatch volunteers are gratefully acknowledged:

Team 1: Ron Eckoff, Stefan Hinterkeuser, Andrew Thompson, William Wilson; leader: Tim Pacey

Team 2: Carol Emrick, Tara Emrick, Gerry Sugarman, Stuart Sugarman; leader: Tim Pacey

Team 3: Kay Hajek, Cheri Harrington, Jim Heaton, Tony Matic, Ajay Nath, Jesse Riechman, Lisa Smith; leaders: Jeff Plakke and Marcel Potvin

Team 4: Haley Breniser, Mike Dundas, Karen Eley, Ellen Jedrey, Dina Maltagliati, Vince Skandunas, Pete Teasdale, Mike Thomas (11th year in a row!), Jeff Wojtowicz; leaders: Justin Gude and Marcel Potvin

Tax-deductible donations to support continuing research on Isle Royale wolves and moose can be sent to Wolf-Moose Study, Michigan Tech Fund, Michigan Technological University, 1400 Townsend Drive, Houghton, Michigan 49931-1295. THANK YOU to all who help!

Results reported here are preliminary and, in some cases, represent findings of collaborators; please do not cite without consulting the author.

Cover photo: East Pack wolf walks along a beaver dam at midnight in July 1998; photographed by automatic Trailmaster® camera, triggered by breaking of infrared beam.

Opposite photos: Top, bull moose seeking refuge from summer heat in Lake Superior in August 1998; center, red fox scavenging a meal from a wolf-killed moose in February 1999; bottom, Earthwatch volunteers Cathy Love and Jon Benner search for moose bones in June 1997.

Inside back cover photos: Top right, moose carcass draws the attention of scavenging red fox and ravens; center, breeding male in Middle Pack in 1998; bottom, Middle Pack travels shoreline in 1999.

Printed on recycled paper, produced by a chlorine-free process

Ecological Studies of Wolves on Isle Royale

*“ . . . We will not come to any deep understanding of our place in nature
except as we delve into its basic documents, and these documents are our wild places.”*

*—Paul Gruchow, *The Necessity of Empty Places**

Personnel and Logistics

In summer 1998, Rolf Peterson directed ground-based field work, aided by Justin Gude, Carolyn C. Peterson, Trevor S. Peterson, and Marcel Potvin. Fieldwork continued from May 16 through the end of August. In 1999 the annual winter study extended from January 12 to March 1. Peterson and pilot Don

Glaser participated in the entire study, assisted in the field by volunteers Ellen L. Jedrey, Carrie L. Schaefer, and the following personnel from Isle Royale National Park—Larry A. Kangas, Jack G. Oelfke, Mark C. Romanski, and Robert K. Whaley.

Summary

Following a year when more than half the wolves died, the wolves rebounded in 1999 at the highest rate ever documented, increasing from 14 to 25 wolves (see figure 1). The sudden drop the previous year was apparently a short-lived echo of the moose die-off in 1996, and the wolf population is once again on the rising track that began in 1993. All four wolves captured live in 1997 and 1998 were disease-free.

The wolf population continued to live in three territorial packs, but one pack, facing a chronic shortage of moose, enlarged its territory at the expense of the other two. All three packs produced pups in 1998, and two packs brought six pups through to winter. Only one adult wolf died during the previous year, apparently killed by other wolves in a territory dispute. Because of large pack sizes and a recovering moose population with a normal complement of calves, wolves killed moose at a relatively high rate in winter 1999.

Heavy wolf predation, a significant load of winter ticks, and unusually hot summer weather combined to keep moose numbers from rising very much (from 700 in 1998 to 750 in 1999). We have now located remains of 295 moose that died in 1996, when an estimated three-quarters of the moose population succumbed to starvation.

There are now enough wolves (30 moose:1 wolf) on Isle Royale to limit the rate of increase for moose, and we expect the vegetation to recover somewhat. However, another 5–10 years of low moose density will be required for heavily browsed balsam fir to escape from moose herbivory at the west end of the island. Meanwhile, the beaver population has continued a long-term decline that reflects poor habitat as the forest matures after disturbance by fires in 1936 and during the 19th century.

Figure 1. Wolf and moose fluctuations, Isle Royale National Park, 1959–99. Moose population estimates during 1959–88 were based on population reconstruction from recoveries of dead moose, whereas estimates from 1989–99 are based on aerial surveys.

The Wolf Population

In a striking turnaround from the high mortality of 1998, the wolf population recovered quickly to the highest level since 1981. The wolves were organized in 1999 as follows (see figure 2):

East Pack III	 10+1
Middle Pack II	 10
West Pack II	 2
Singles	 2
Total 1999	 25

The largest packs more than doubled in size from last year (see figure 3). The East Pack and Middle

Pack each raised six pups. This unusually high reproduction was coupled with very low mortality last year, when only one wolf died (see figure 4). Radio-collared female 450 in the Middle Pack died in the Todd Harbor campground on the island's north side, probably in a territorial skirmish with the neighboring East Pack. Only a large area of matted hair and bone chips could be found about one kilometer from her radiocollar. This was reminiscent of a radio-collared East Pack wolf that died one year ago and was completely consumed by other wolves.

In early May 1998, two wolves were live-captured

Figure 2. Wolf pack movements and moose carcasses (wolf kills and otherwise) during the 1999 winter study. All packs actively scent marked their territory.

Figure 3. Ten wolves in the Middle Pack, the largest pack seen on Isle Royale for almost two decades, hunt in single file along Houghton Ridge.

Figure 4. Wolf population size (top) is explained by patterns of mortality (middle) and reproduction (bottom). The increase in 1999 arose from exceptionally high reproduction and low mortality in the previous year.

and radio-collared in the East Pack, male 670 and female 1070. Prior to that, all radio-collared wolves in the population had died, five of these in the previous year.

In an unusual move, the Middle Pack significantly enlarged its territory, both to the east and to the west, where they actively scent marked, killed moose, and encountered no resistance from the resident West and East packs (see figure 5). The West Pack reversed its travel direction within their usual territory when they encountered tracks of the Middle Pack. The East Pack made a prominent scent-marking excursion into areas also claimed by the Middle Pack, but no direct contacts were recorded. The Middle Pack territory has very few moose, so this range expansion gives them access to critically needed prey.

Wolf pups were documented in all three territorial packs during summer 1998. The East Pack included six pups in June, all of which survived to winter (see figure 6). Likewise, the Middle Pack brought six pups through to winter. The West Pack had at least three pups alive in October 1998, but none survived until winter, when the pack consisted of just a breeding pair. The West Pack has produced only one surviving pup in the past decade, and the 1996 moose die-off reduced their food supply considerably.

The fourteen wolves in 1998 appeared to be poised for maximal reproduction, with four breeding pairs. In 1999 the number of breeding pairs was just three, one in each territorial pack. A second male-female pair was present in both East and Middle packs, but these additional pairs were socially subordinate to the breeding pairs (see figure 7). In the East Pack, radio-collared male 670 was repeatedly suppressed by the breeding male yet allowed to fraternize closely with the radio-collared breeding female 1070 when she was in heat. On 26 February 1999, the subordinate pair (including radio-collared male 670) left the pack at a kill and went off together during the height of courtship activity

Figure 5. The Middle Pack rests after consuming a calf they found dead in the East Pack territory. They were unchallenged on this foray into new country, and these wolves left behind plenty of scent marks, claiming it as their own.

Figure 6. The Middle Pack spreads out while crossing Siskiwit Lake, the largest interior lake on Isle Royale.

Figure 7. Frequent and often intense social interaction occurs within packs during the breeding season in February. Here the East Pack alpha female 1070 stands over and intimidates a subordinate female (lower right) while the alpha male with raised tail gives a hard stare toward subordinate male 670.

among the alpha pair. The pack leaders searched out the subordinate pair and thoroughly intimidated them.

The East Pack was often seen at maximum pack size of ten wolves during the 1999 winter study, but for ten days in this period, the pack split as the four sexually mature adults and one pup departed from a kill, leaving the remaining five pups behind. A single wolf that frequented East Pack territory then joined the five pups. He remained with them while they killed an adult moose and traveled within pack territory. When the pack reunited, the eleventh wolf departed, apparently not welcomed by the leaders of the pack.

The wolf decline of 1998 was attributed to a sudden decline of food—the moose die-off of winter-spring 1996. In 1997 wolves were seen feeding on dried hide from moose that died a full year before. The low 1998 winter count of just fourteen wolves was understandable. Just as suddenly, the wolf population recovered in 1999, and the explanation for this rise is not clear. Possibly the abundance of moose calves (almost absent in winter 1997, but near average in winter 1998) influences wolf demography directly. Additionally, the moose population suffered from severe summer heat in 1998 and appeared to be quite vulnerable to wolf predation. In any case, wolves' food supply appeared ample, and pups were abundant and large-bodied. Pups appeared to be as large

as adults and were identified only after extensive observations of behavioral interaction (adolescent wolves generally appear to be playful and “irresponsible”).

The wolf kill rate was relatively high in 1999, probably because of the large size of the East and Middle packs. The island has not seen more than one large pack (numbering ten or more) since 1980, and predation rates have been relatively low for a long time (see figure 8). The future course of wolf-moose dynamics will depend on whether the wolves are able to maintain packs of large size during the next few years, indicating high food availability. It is likely that the impressive increase in 1999 was simply a strong recovery from the unusually low point in 1998.

The high reproductive success in the past year is of obvious interest in this highly inbred wolf population. We have expected a gradual reduction in reproductive success as genetic variability is lost with each generation, but perhaps increased variance in reproductive success is a more-telling indicator of genetic problems caused by inbreeding. In the next year or two, we will investigate the possibility of monitoring genetic characteristics of wolves through analysis of DNA in wolf scats, allowing a more-extensive look at genetic makeup of the population. At present, only a few wolves are periodically live-captured and their blood sampled for genetics studies.

Figure 8. Moose mortality rate in midwinter was relatively high in 1999, a result of large wolf packs and vulnerable moose.

The Moose Population

In an aerial census of moose in February 1999, 154 moose were counted during intensive circling over 91 plots, each one square kilometer in area (see figure 9). Assuming that 75 percent of the moose in each plot were counted (based on experiments with radio-collared moose during the 1980s), the resulting estimate was 750 moose (with 95 percent confidence interval of ± 141), or 1.4 moose per square kilometer. As usual, moose density was highly variable, with the center of the island (burned in 1936) generally vacant and shoreline areas with ample balsam fir containing an average of 6.8 moose per square kilometer. Proportion of calves on plots was 14 percent, near the long-term average (see figure 10).

The moose population continues to live primarily at the east end of the island in winter, in places where balsam fir regeneration is vigorous (see figure 11). While fir is not considered a favored browse species, fir played a critical role in survival for many moose in desperate winter conditions in 1996 (see figure 12). On the east end, moose immobilized by deep snow

survived in patches of abundant fir. The pattern of different moose density on the two ends of Isle Royale has persisted, which may have implications for future growth of the forest (see figures 13 and 14). While we consider that the moose population is limited by wolf predation, other factors such as winter snow and habitat quality have much influence on moose dynamics.

Moose condition was evaluated in part from marrow fat in long leg bones of moose killed by wolves. In winter 1999, mean marrow-fat content for calves was 31 percent, compared to 59 percent last year. The proportion of older moose with undepleted marrow fat was 33 percent, compared to 54 percent last year (see figure 15). Marrow fat values in 1999 were similar to levels seen in the mid-1990s, when a high proportion of the moose killed by wolves were withdrawing marrow fat to meet daily energetic demands.

These indicators tell that nutritional stress was relatively high in the moose population in 1999, in spite of low population density (for Isle Royale). Studies elsewhere have indicated that hot summer weather

Figure 9. Moose distribution on Isle Royale during the aerial census in February 1999.

Figure 10. Moose calf abundance (at approximately six months of age) on Isle Royale, as a proportion of the total population. These are single-best estimates, a weighted mean of aerial counts in fall and/or winter.

Figure 11. Cow moose forages in Washington Creek at the island's west end, still a good place to view moose in spite of a reduced moose density at this end of Isle Royale.

Figure 12. Ratio of moose density, east/west ends of Isle Royale. Note divergence after 1996 die-off of moose.

Figure 13. Rolf Peterson measuring a balsam fir tree that has been trimmed by browsing moose for several decades at the island's west end. If moose density remains low for another 5–10 years, such trees might grow into the forest canopy.

Figure 14. Where balsam fir density is high, the tree has managed to continue growth in spite of high damage by moose. This is especially true at the east end of Isle Royale and, here, at Beaver Island in Washington Harbor at the island's west end.

Figure 15. Long-term trends in moose bone-marrow fat. Data for calves (which best reflect current conditions) represent mean levels, whereas data for adults is the proportion with greater than 70 percent marrow fat

prevents moose from feeding efficiently, and summer is the time of the year when moose need to accumulate large amounts of fat to survive winter. The summer of 1998 at Isle Royale was one of the hottest on record and followed an exceptionally early spring. Two effects on moose were likely: high tick loads the following winter and poor fat accumulation. We commonly noted hair loss on moose in February, even before the usual peak in winter tick irritation. We also had anecdotal records of moose stressed by heat in the summer of 1998 when daily high temperatures often exceeded 30 degrees Celsius. We watched one bull with heaving sides from rapid respiration (moose don't perspire, but they increase their respiration rate to enhance evaporative cooling) sought refuge in Lake Superior on a hot August day (see figure 16). About the same time, a park visitor observed an old cow moose collapse and die in shallow water at midday; subsequent necropsy of the moose revealed abnormal kidneys and lungs with a high number of hydatid cysts. Normal heart, kidneys, and lungs are important for moose to effectively lose heat through rapid respiration. Finally, the East Pack succeeded in killing an old bull moose in August near our research cabin. Kills of adult moose in summer are quite rare, but one could certainly imagine that a moose might be so distressed by the heat that wolves could gain a momentary advantage. This moose provided several hundred pounds of food for the East Pack at precisely the time

Figure 16. This bull moose sought refuge from extreme daytime heat in August 1998 by lying down in Lake Superior, an unusual tactic usually seen only when the temperature exceeds 30 degrees Celsius.

of year when rapidly growing pups have high food requirements.

Most of the adults killed by wolves in winter 1999 were relatively old animals. One unique form of mortality was observed in February after a cow moose was marooned on the snow-covered ice of Moskey Basin for several days. She alternated between bedding and standing, spinning around in circles (see figure 17). She became emaciated and finally died on the ice one night as a blustery cold front moved in. We conducted a field necropsy and found that a brain hemorrhage had probably caused her to circle incessantly. She also had one long-dead eye, and the other eye was clouded by cataract.

During summer ground work in 1998, we continued to find (among many other moose—see figure 18) skeletons of moose that starved in 1996. We found that maggot casings have persisted for three years, and we hope that it may be possible to date moose skeletons from 1996 for several more years (see figure 19). So far, we have inspected carcasses and skeletons from 295 moose that died in 1996, when over 1,500 animals died.

Figure 17. These unusual groups of tracks made by a circling moose (shown bedded at upper left) were finally explained after the moose died of acute exhaustion. She was an old female that suffered a massive brain hemorrhage, causing her to circle incessantly. She also had slight

Figure 18. Earthwatch volunteers Andrew Thompson and William Wilson try to assume the final positions taken by two moose that died after locking antlers. An Earthwatch crew discovered these bones in 1998, the third set of locked antlers found at Isle Royale in 40 years. For more information on participating in this Earthwatch expedition, call 1-800/776-0188, ext 189.

Other Wildlife

In October 1998, an aircraft survey of beaver colonies on Isle Royale was conducted by Douglas W. Smith, a biologist from Yellowstone National Park. Similar surveys have been flown every two years since the 1970s. The total count of beaver colonies declined to just 91, near the lowest level recorded in the past four decades. Following a population low in 1980 that seems to have been caused by high wolf predation (see figure 20), the population rebounded in six years to 200 colonies, but it has been in decline ever since, even though wolf numbers were low during this period. The latest decline is probably due to poor habitat quality—coniferous tree species have substantially replaced more palatable deciduous species, especially aspen, as the forest continues to grow and mature after disturbance by fires in 1936 and during the 19th century. Continuous moose herbivory has also led to progressive domination of the forest by tree species with relatively low palatability for moose and beaver alike.

Continuing a long-term population increase, otter are more abundant now than at any time in the past half-century (see figure 21). Their return coincides with a remarkable recovery in lake herring populations around Isle Royale (see figure 22). It is not uncommon to see schools of herring numbering in the hundreds in protected harbors of Lake Superior. The return of this fish builds the base of an important food web involving lake trout, double-crested cormorants, otters, bald eagles, and

Figure 19. Maggot casings surrounding these moose bones identify a moose that died of starvation in 1996, laying undiscovered until 1998. Most of these carcasses were consumed by maggots, not wolves. These casings have persisted for at least three years.

ospreys. Eagles now often overwinter at Isle Royale, where they may be seen waiting above fishing sites used by otters. Eagles will attempt to steal fresh catches from unaware otters and will also scavenge any fish remains.

The National Park Service's count of nesting bald eagles and osprey in 1999 revealed continued slow increase for eagles with nine active eagle nests that fledged fourteen young, while the osprey count was seven nests with seven fledged young. Eagles, with more permanent nest sites, are more easily counted.

Snowshoe hares seemed more abundant than in recent years but much lower in number than a decade ago (see figure 23). Usually this species at Isle Royale seems to exist at low levels, perhaps an effect of competition with moose for food, but the historical record shows that they can break out of this pattern and increase to very high levels, much like the species does every decade or so in the boreal forest of North America. Coincident with low hare density was a relatively low population of red foxes (see figure 24). They were less visible in winter 1999 because they fed extensively on fallen fruit of mountain ash that lay buried in the snow and were not congregated around moose carcasses. Also, large packs of wolves left little behind for scavengers this winter.

Tracks of marten were found in the Windigo area in February 1999. This species seems to persist at very low levels after colonizing Isle Royale in the early

Figure 20. Beaver abundance dropped in 1980 when wolves reached a peak, but their recent decline seems tied to forest change.

1990s. With the exception of red squirrels, the island does not support abundant prey for marten (small rodents and occasional snowshoe hares). The island completely lacks voles, the most-favored prey for this rather specialized carnivore. Similarly, the short-tailed weasel exists at very low levels at Isle Royale.

Cone crops in 1998 were heavy for balsam fir, white cedar, and, to a lesser extent, white spruce. In 1998 there was a significant defoliation of aspen trees throughout the island by the great aspen leaf-roller

(*Tortrix*). The last such eruption of these larval moths was in 1971. Present at relatively low levels in 1999 was the spruce budworm, documented each year for the past decade, after a half-century of virtual absence.

Precipitation was very low in summer 1998, after a winter with record-low snow accumulation. As a result, Lake Superior was at a low level through 1998 and into 1999. During the hot summer of 1998, surface water temperatures reached 20 degrees Celsius even in the middle of Lake Superior, and blooms of algae were

Figure 21. The river otter has staged a remarkable recovery on Isle Royale, probably because of the return of lake herring in Lake Superior. Shown here are locations of otter tracks in winter.

Figure 22. The recovering lake herring represents food not only for the large lake trout (shown), but otter, eagle, and osprey. These predators link the lake ecosystem with the terrestrial part of Isle Royale National Park.

Figure 23. Snowshoe hares on Isle Royale seem to be slowly increasing again after reaching a population low in the early 1990s. Index is the number seen per 100 km hiked in summer.

Figure 24. Relative abundance of red foxes from aircraft observations in winter, 1972-99. Grey bar is the number of foxes seen away from moose carcasses/100 hours, while the black bar is the number of foxes seen on carcasses. Foxes were easily seen in 1997 while feeding on shoreline mountain ash.

Weather, Snow, and Ice Conditions

The winter of 1998–99 started in a very benign fashion, with little below-freezing weather before the middle of December. A month of cold weather and frequent snow followed, then the remainder of the winter was mild (see figures 25 and 26). A couple of snowstorms during the winter study period kept snow

depths near the 60-cm mark, about average for Isle Royale in winter. Little ice formed on Lake Superior during the winter of 1998–99, and at no time was there an ice connection between Isle Royale and mainland Ontario.

Figure 25. Range of average daily maximum and minimum temperatures during annual winter studies at Isle Royale, 1972–99. Average temperature in 1998–99 was comparable to the “El Nino” year in 1997–98.

Figure 26. Snow depth (top) and temperature extremes during the 1999 winter study on Isle Royale.

\$3.95

Available from:

International Wolf Center

1396 Highway 169
Ely, MN 55731-8129
(218) 365-4695
<http://www.wolf.org>

800 East Lakeshore Drive
Houghton, MI 49931-1869
(800) 678-6925
<http://www.portup.com/irnha/home.htm>

MichiganTech

Tax-deductible donations to support
continuing research on Isle Royale
wolves and moose can be sent to:

Wolf-Moose Study
Michigan Tech Fund
Michigan Technological University
1400 Townsend Drive
Houghton, MI 49931-1295

THANK YOU to all who help!