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Ecological Studies of Wolves on Isle Royale

Wolves and Moose of Isle Royale

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Ecological Studies of
Wolves
on Isle Royale

2005–2006



“The voyage of discovery lies not
in finding new landscapes,
but in having new eyes.”

—*Marcel Proust*

Ecological Studies of Wolves on Isle Royale

Annual Report 2005-2006*

by

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and

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Results reported here are preliminary and, in some cases, represent findings of collaborators; please do not cite any material contained herein without consulting the authors.

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Ecological Studies of Wolves on Isle Royale



“The more we come in contact with animals and observe their behaviour, the more we love them, for we see how great is their care of their young. It is then difficult for us to be cruel in thought, even to a wolf.”

I. Kant's *Metaphysics of Ethics*

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In summer 2005, Rolf Peterson and John Vucetich directed ground-based field work, aided by Matt Abbotts, Reid Andress, Marcy Erickson, Sam Gardner, Carolyn Peterson, and Leah Vucetich. Fieldwork continued from early May through August. In 2006, the annual winter study extended from January 19 to February 28. Peterson, John Vucetich, and pilot Don E. Glaser participated in the entire study, assisted in the field by Leah Vucetich and the following personnel from Isle Royale National Park: Jean Battle, Kate Goodwin, Phyllis Green, Beth Kolb, Marshall Plumer, and Mark Romanski. Bert Frost, Deputy Associate Director of the National Park Service, visited the study in January. Steve Martin from Isle Royale helped with mainland driving, and Bob Glaser and Jack Huhta provided invaluable logistical help on the mainland. US Forest Service pilots Wayne Erickson, Dean Lee, and Pat Lowe flew several

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Summary

During 2005-2006, the wolf population was unchanged in number, thirty in all, while moose declined for the fourth year in a row to 450 (fig. 1). The ratio of moose to wolves, 15-to-1, is the lowest ever documented at Isle Royale. Three territorial wolf packs raised a total of seven pups, offsetting a mortality rate of 23 percent in the past year. Wolves maintained a high rate of predation on moose, and one pack invaded the territory of the neighboring pack and appropriated at least two kills.

Moose calves, relatively abundant in summer 2005, but subject to intense predation pressure, were relatively sparse in winter 2005. The wolf population has maintained itself on cohorts of moose born in the early 1990s. The effect of moose ticks diminished somewhat in spring 2005, but hair loss was still common in winter 2006. Moose will probably decline further, until wolf numbers decline. Inter-pack conflict in 2006 was significant, resulting in the death of one alpha male.

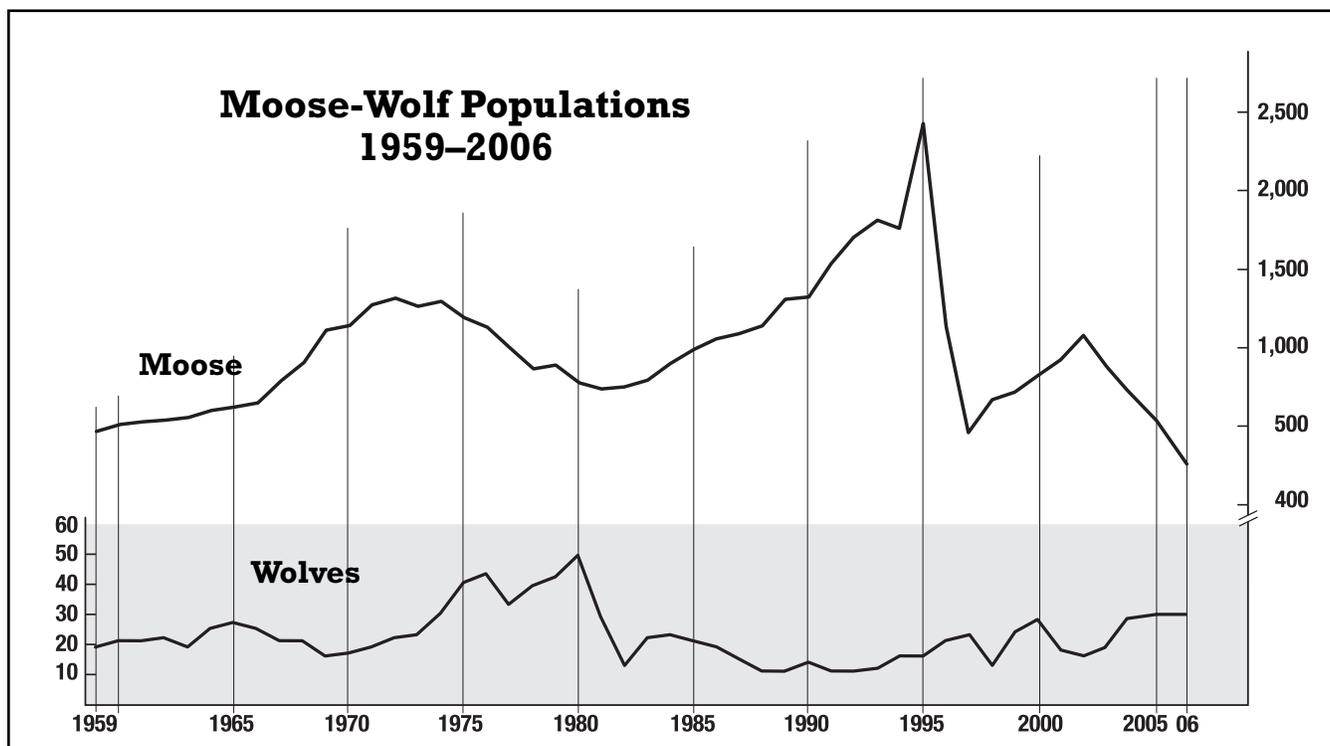


Figure 1. Wolf and moose fluctuations, Isle Royale National Park, 1959-2006. Moose population estimates during 1959-1993 were based on population reconstruction from recoveries of dead moose, whereas estimates from 1994-2006 were based on aerial surveys.

The Wolf Population

During the 2006 winter study, the wolf population contained thirty individuals, a number identical to the previous year. This is the third year in a row of relatively high wolf numbers, partitioned into three territorial packs that have maintained their integrity since 2000 (fig. 2, p. 4). Wolf social organization and maximum pack sizes changed little from last year:

| | |
|----------------------------|-----------|
| East Pack III (EP) | 9 |
| Middle Pack II (MP) | 13 |
| Chippewa Harbor Pack (CHP) | 8 |
| 2006 Total | 30 |

We observed dispersing wolves and “loners” infrequently in 2006, so our wolf estimate is based on the

maximum number of wolves observed in the three territorial packs between 26-30 January. Usually the Middle Pack numbered eleven while Chippewa Harbor and East packs commonly numbered six to eight wolves each.

Two wolves had long-term radio-collars that continued to transmit: male 670 (alpha male in East Pack, collared in 2001) and female 410 (alpha female in Chippewa Harbor Pack, collared in 2003). Alpha female 1071 from the Middle Pack, collared in 2001, is still alive and recognized by her radio-collar, but the radio signal failed in 2003. Two-year-old female 1060 died just prior to the 2005 winter study, and her carcass was recovered from a beach in May 2005 (fig. 3, p. 4). Two additional

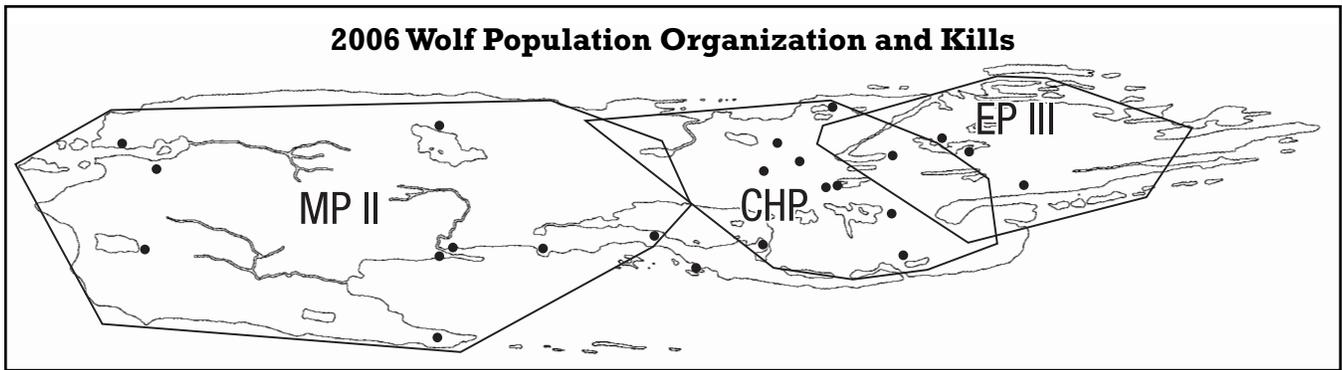


Figure 2. Wolf pack movements and moose carcasses (all fresh wolf-kills) during the winter study in 2006. All three of the packs were observed scent-marking.

wolves from the East Pack were collared without handling in summer 2005, and one of these transmitters proved very useful until it fell off during the 2006 winter study (see sidebar, p. 16).

In 2006, four of the six breeding individuals (fig. 4, p. 5) in the wolf population were identified by radio-collar or appearance as the same breeders in 2005. Two very old alpha wolves (female in East Pack and male in Chippewa Harbor Pack) died in the past year and were replaced by wolves of unknown origin that were probably much younger. The East Pack female died in late September 2005 on a park trail, and her intact carcass was recovered and necropsied. She weighed 45 pounds and apparently had starved to death, probably because of an “incarcerated bowel,” the pathologists’ term for a partially strangulated hernia. The Chippewa Harbor male was killed when the East Pack invaded on 31 January and caught him and a pack-mate on a moose-kill (fig. 5, p. 5 and sidebar, p. 11).

During 21-26 February, courtship behavior was observed in all three packs, but copulation was not observed. The alpha pair in the Middle Pack is long-established, but in the East Pack, a presumably young female was paired off with a very old male (fig. 6, p. 6). The Chippewa Harbor Pack lost its alpha male on 31 January, but by 21 February a male was showing preliminary courtship behavior toward the alpha female of long-standing, also quite old. If she survives until spring, we anticipate that three litters of wolf pups will again be born, one in each pack. Another courting pair was evident in the East Pack, but they engaged in relatively little courtship behavior while under observation by the alpha pair (fig. 7, p. 6).

Annual mortality (23 percent) during 2005-2006 was near average (fig. 8, p. 6). Three of the seven wolves that

died in the previous year were recovered—carcasses of two washed ashore while the third (identified by DNA as the alpha female from the East Pack) was found dead from starvation on a park trail (see above).

The key event during 2006 was the conflict that ensued when East Pack repeatedly moved into lands traditionally held by the Chippewa Harbor Pack. Moose density in the East Pack territory was markedly reduced, especially the formerly moose-rich Blake Point peninsula on the northeast end of the island. After the East Pack killed the Chippewa Harbor Pack alpha male, the Chippewa Harbor Pack retreated to the middle or opposite side of its territory and seemed to be very much on the defensive. East Pack scent-marked prominently, traveled extensively within former Chippewa Harbor Pack territory, and seemed to have a solid claim to some of the highest concentrations of moose on the island.

Ironically, the kill rate of the Chippewa Harbor Pack



Figure 3. Radio-collared female 1060 died on or under the ice of Lake Superior in January 2005, and her carcass was recovered from the beach of Siskiwit Bay in May. Cause of death was unknown.



Figure 4. At least four of the six pack leaders in 2006 were highly experienced and probably 8-10 years old. Top left photo: Alpha female (radio-collared, front) and the whitish alpha male of Middle Pack. Right top photo: Radio-collared alpha female of the Chippewa Harbor Pack. Right photo: Radio-collared alpha male of the East Pack.

was higher than either of the other packs, but its continued existence is uncertain because of territorial encroachment by the East Pack. Compared to the long-term average kill rate of about two moose per wolf per 100 days, the kill rate of the CHP (2.6) was above average while the EP (1.4) and MP (1.2) attained below-average kill rates. Kills were invariably well-used, so scavengers found few leftovers (fig.9, p. 6).

The present island-wide ratio of fifteen moose per wolf is the lowest recorded in the past 48 years on Isle



Figure 5. Pilot Don Glaser inspects the scavenged carcass of the alpha male from the Chippewa Harbor Pack, killed on 31 January (left) when the invading East Pack surprised him on a moose carcass (see sidebar, pp. 11-12). This uncollared wolf had very heavy toothwear (right).



Figure 6. The East Pack leaders in 2006 included a newly-recruited female (left) and a very old (and tired?) male, radio-collared in 2001.



Figure 7. (Left) Beta male 1423 (after radio-collar was lost) in mutual courtship with a subordinate female in the East Pack. (Right) The East Pack alpha pair carefully scrutinized the second courting couple, and only sometimes intervened.

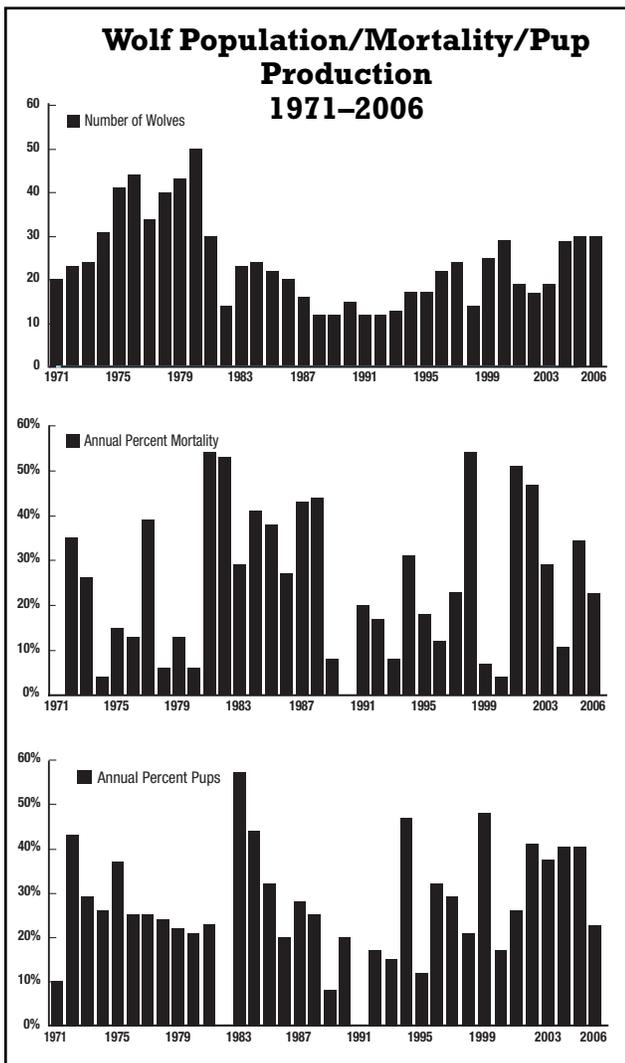


Figure 8. Wolf population size (top) is explained by patterns of mortality (middle) and reproduction (bottom).

Royale (fig. 10, p. 7), but it seems unlikely that it will persist long at this level. With one exception, all the moose-kills collected in 2005 were either calves or more than thirteen years old. These old moose were born during years of rapid expansion when the moose population experienced relatively little predation. However, these abundant cohorts of moose are soon to expire completely, leaving a moose population with a relatively young age structure. For this reason, we expect wolves to decline in the next year or so, allowing the moose population to stabilize. It is now evident that there were no changes in the leadership of all three



Figure 9. Wolves relied primarily on old adult moose during winter 2006.

packs for at least the past five years, but two alpha wolves have died in the past six months. It is possible that stable leadership by experienced wolves contributed to pack success in recent years (fig. 11).

During the 2005 visitor season, “fearless” wolves were seen near human concentrations in Windigo (May) and Rock Harbor (July). The wolf near Rock Harbor became known as male 1423 after radio-collaring (see sidebar, p. 16), and he is a relatively high-ranking (beta) male in the East Pack. Analysis of fecal DNA (an effort headed by Dr. Leah Vucetich at Michigan Tech) will allow us to determine his age and trace his history. In 2004, a two-year-old radio-collared wolf (female 1060) entered the empty tent of a lone camper at Hatchet Lake Campground, but this wolf died in early 2005. Fearless wolves are a public safety concern, heightened by the possible death from wolf attack of a young man in Saskatchewan in November 2005 (see www.wolf.org). Virtually all recent wolf attacks on humans in North America have involved wolves habituated through access to garbage or foods provided by humans. At Isle Royale, visitors are routinely instructed in “leave no trace” principles, including proper food storage and

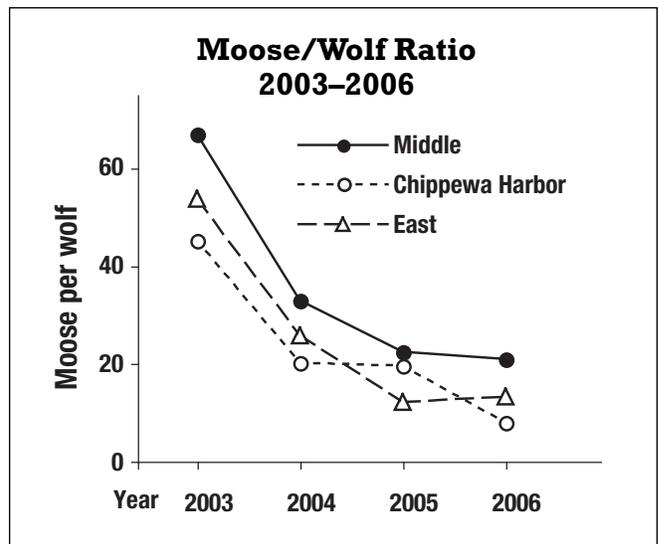


Figure 10. The number of moose per wolf has declined steadily over the past three years, to one of the lowest levels observed at Isle Royale.

garbage disposal. Park staff are continuing to focus on eliminating all access by wolves to other human-derived food sources (e.g., disposal of fish offal).



Figure 11. The Middle Pack roams over three-quarters of Isle Royale. Moose are sparsely distributed in this area, and the pack did not face challenges from neighboring packs in 2006.

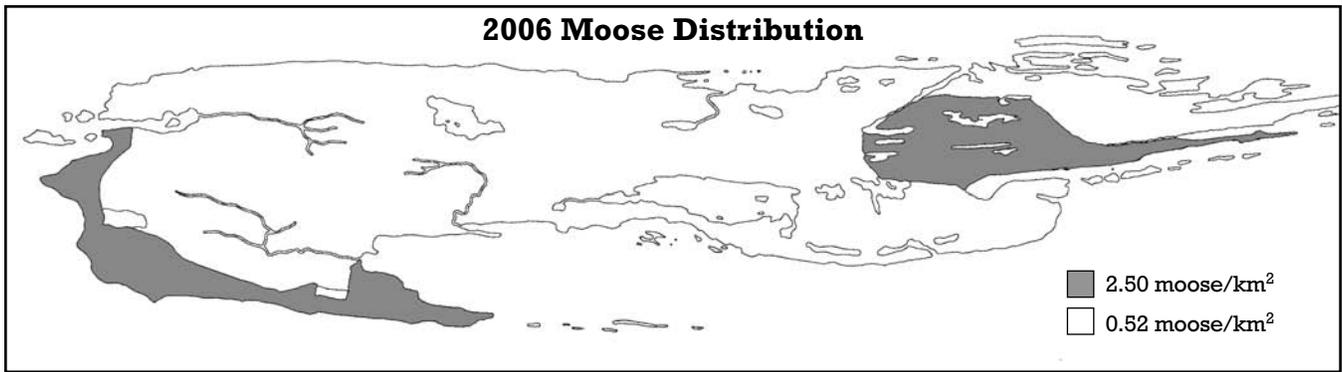


Figure 12. Moose distribution on Isle Royale was more uniform than usual in winter 2006. Only two strata were delineated, based on habitat types and results of the aerial counts on ninety-one plots that comprised 17 percent of the main island area.

The Moose Population

During February 2006, the moose population was estimated at about 450 animals (+/- 90 percent confidence interval of 330-590), or 0.8 moose/km² (fig. 12), about half the level of three years ago. The ninety-five moose counted on ninety-one census plots comprised 11 percent calves (fig. 13), slightly below average. It is likely that high mortality from intense predation pressure led to the 16 percent drop in moose numbers from 2005 to 2006. During the summer 2005 field season, calves were relatively numerous, at forty-six calves per one hundred cows. No twin calves, however, were observed by project personnel during either summer or winter in the past year.

Unusually warm temperatures, that characterized springtime weather in several recent years, moderated somewhat in 2004, probably leading to the decline in moose ticks observed on moose in spring 2005 (fig. 14, p. 9). We continue to map hair-loss patterns for moose observed in spring, and these surveys provide our best long-term data on tick abundance.

Carcasses of twenty-four dead moose were discovered during aerial surveys in the 2006 winter study, and fifteen were inspected on the ground (fig. 15, p. 9). All of these moose were killed by wolves, and one kill was observed (see sidebar, p. 14). About one-third of the kills were calves, near the

long-term average for wolf-kills in winter. Twelve of fourteen moose killed by wolves exhibited significant loss of fat from marrow cavities, suggesting relatively poor condition (fig. 16, p. 9). Hot weather was noteworthy in July 2005, possibly contributing to poor forage intake during the growing season.

Snow depth was relatively low prior to the 2006 winter study, and snow remained stable and uncrusted during the study. Neither moose nor wolves seemed dramatically affected by snow conditions. Moose moved to coniferous cover by the end of January, and wolves made extensive use of shoreline ice for travel. Collaborating filmmaker George Desort observed one moose at the west end for several days in early February, and he recorded foraging primarily on

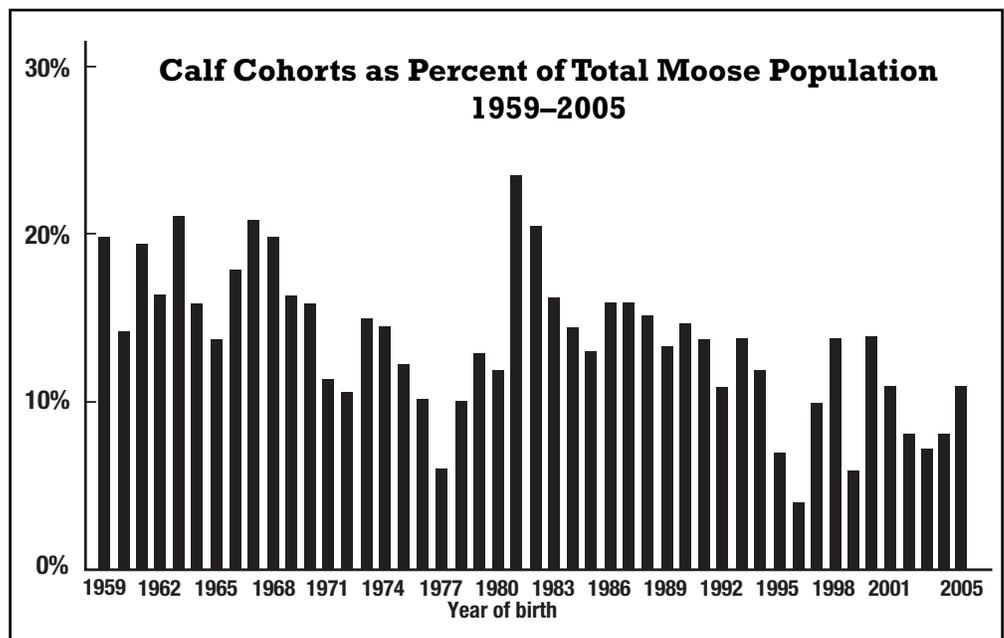


Figure 13. Moose calf abundance (at approximately six months of age) on Isle Royale, as a proportion of the total population. These are best estimates, a weighted mean of aerial counts in fall and/or winter.

balsam fir, northern white cedar, and lichens, with significant eating of snow on all days (fig. 17, p. 10). We speculate that snow provides required water during periods when forage intake is extremely low (winter forage may contain 50 percent water).

There have been significant shifts in moose distribution in the past two years. After many years of uniformly scarce moose on the western two-thirds of Isle Royale, the Houghton Point peninsula on the island's south side at the west end has emerged as a major concentration area. At the other end of the island, the zone of high moose density has shrunk, leaving the Blake Point peninsula at the extreme eastern end almost devoid of moose. The East Pack made no kills there in 2006, after more than three decades during which this area was a reliable provider of moose. It is not known if these shifts in moose density resulted from movement or mortality. We do know that the East Pack has hunted intensively in the Blake Point area during both late summer and winter for many years, and the prey supply there may have simply been exhausted.

Ph.D. student Joseph Bump is investigating the nutrient flows from wolf-killed prey at Isle Royale and Yellowstone National Parks. He has found that soil nitrogen and sodium continue to increase for at least two years beneath the point where wolves break into the rumen, or four-chambered stomach, while consuming their prey. Wolves don't eat the plant matter in a moose's stomach contents, but they generally spill the highly liquid stomach contents on the ground while feeding on internal organs. At Isle Royale, Joseph has found that animal-derived nitrogen increases even two years after a kill in large-leaved aster plants growing at the kill site. Because the presence of wolves affects where their prey live and die, wolves may influence the spatial heterogeneity of nutrients for plants and subsequent feeding by animals that seek nutrient-rich vegetation.

Figure 16. 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.

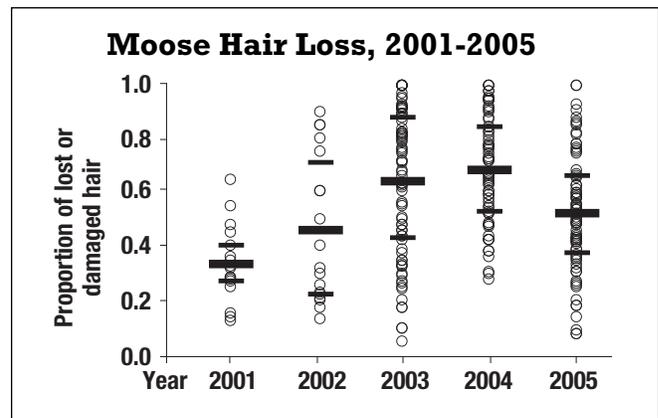


Figure 14. The extent of moose hair loss in spring, caused by winter ticks, declined in 2005 after four years of increase. Circles represent individual moose, heavy bars are annual averages, and smaller bars mark the interquartile range.

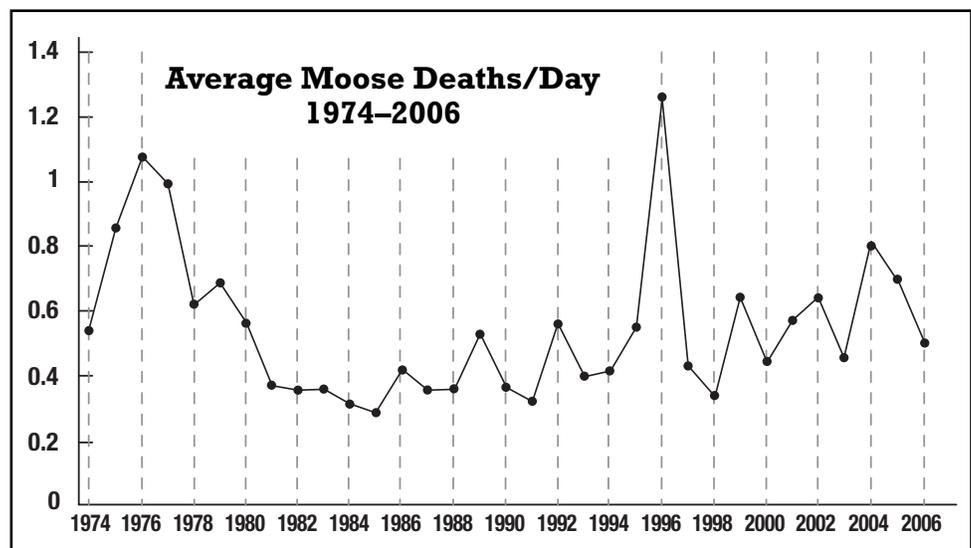


Figure 15. Moose mortality rate in midwinter was above average in 2006. All of the recorded moose mortalities resulted from wolf predation.

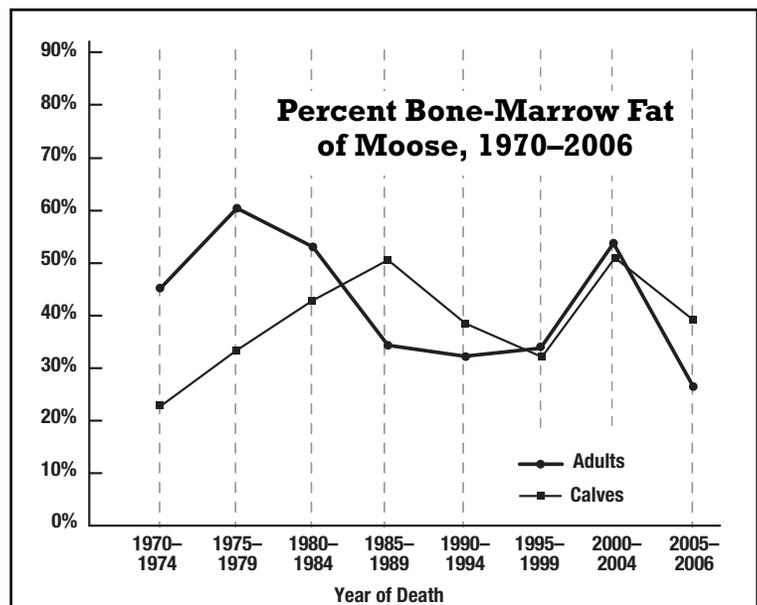




Figure 17. One bull moose observed for several days on Beaver Island in February 2006 ate snow frequently (left) as well as arboreal lichens (right).

Forest Vegetation

The forests of Isle Royale provide the context and foundation for long-term fluctuations in wolves and moose. The widespread stands of regenerating balsam fir at the east end of Isle Royale provided the forage base for most of the island's moose population during the past decade, following the catastrophic moose die-off of 1996. Moose survival was apparently higher at the east end in 1996, providing the population base for quick recovery. A third wolf pack developed after 1999, and during 1999-2006, two wolf packs shared the eastern one-third of the island with about half of the moose population. Moose on the western two-thirds of the island continued to be sparsely distributed and the Middle Pack hunted over a correspondingly larger area.

Semi-annual counts of tagged, mature balsam fir trees at the west end indicate a steady and linear decline in the number of live trees which continued unabated into 2006 (fig. 18). Consequently, the mortality rate of the remaining trees is steadily increasing, as expected for old individuals. Only about 20 percent of the 473 trees tagged in 1988 are still alive. Along this transect there are only six regenerating balsam fir stems, all inaccessible to moose because of their location on high rocks or crevices along the rugged

shoreline. All mature fir trees at the west end appear to have rotten cores. They probably were established a century or more ago when no moose were present, and many die after cracking off near the base during windstorms typical of the late autumn season. On 9 November 2005, one of these storms contributed to above-average mortality in mature fir. We project that all tagged trees will have died by 2009-2010.

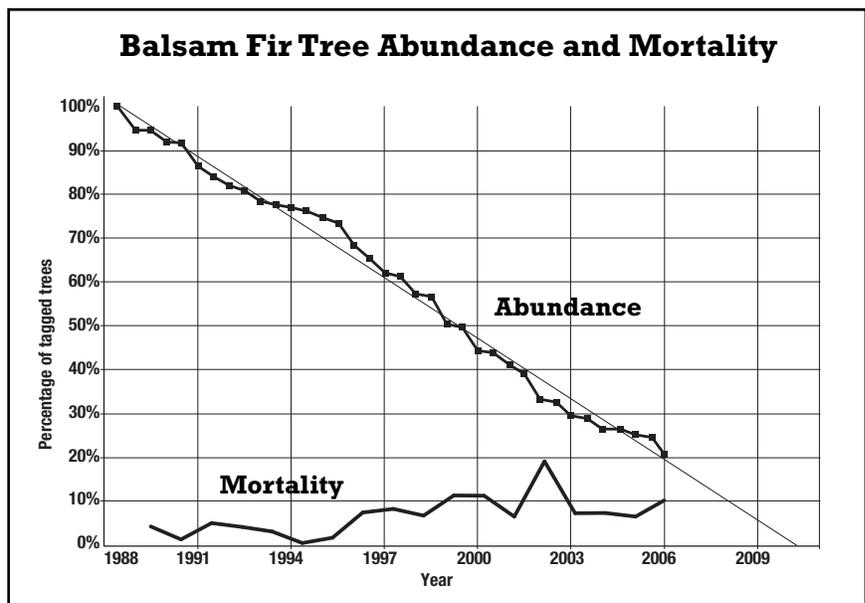


Figure 18. Balsam fir trees in the forest canopy that were tagged in 1988 have steadily died off without replacement. The remainder of our sampled trees are expected to die by approximately 2010, an indicator of a dramatic reduction over 75 percent of Isle Royale in seed source for this species. The demise of this species is ultimately caused by moose herbivory.

Wolf Wars, 2006 John A. Vucetich

Isle Royale, 1/31/06, 4:55pm The air was still. The lightly overcast sky foretold the coming of a fresh blanket of snow.

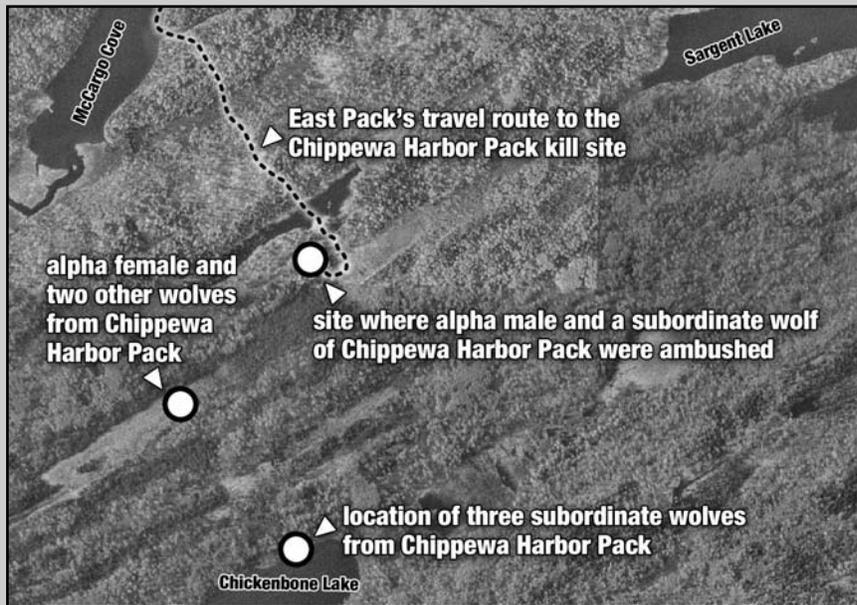
Chippewa Harbor Pack (CHP) had killed a calf in late afternoon the previous day. Now they rested. Three wolves occupied the east end of Chickenbone Lake one sprawled out on the ice while two pups play-wrestled with great enthusiasm. The alpha male and a subordinate wolf chewed bones and hide at the calf carcass in the forest a half-mile to the north. The alpha female and two other subordinate wolves were bedded between the kill site and Chickenbone Lake.

This was the third moose CHP had killed in eight days, and the wolves bellies were full. But the pack had engaged in risky behavior recently, killing moose on the fringes of its territory. Just a few days earlier, these wolves had made a kill in country occasionally patrolled by Middle Pack, their neighbors to the southwest. Now, CHP was pushing its luck on the border of East Pack territory.

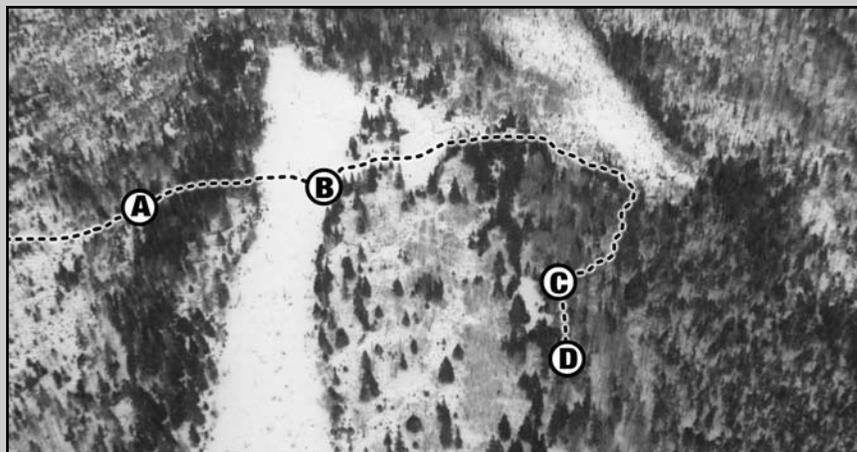
And EP was on the move. They had not made a kill in eight days. This was an especially difficult winter for this pack with nine hungry mouths to feed and the lowest number of moose in its territory in decades. For four days the pack had rested at their last kill site, just north of Daisy Farm. On 30 January, they left the Daisy Farm area and spent the entire day wandering and resting.

EP traveled north to the Minong Ridge on 31 January. By 9:30 AM they had made Robinson Bay. After sleeping away most of the midday, they continued southwest toward their mutual border with CHP. By 5:10 PM, the EP had reached McCargo Cove. Eight wolves of EP were present, traveling deliberately, mostly in single file. With no apparent hesitation, EP cut south and uphill into the forest at a creek that drained into the south side of McCargo Cove.

They crested a hill and crossed an open swamp single file all the way. Their travel had all the appearances of hunting; it was purposeful moving through more difficult and hilly terrain covered by deep snow and dense



Aerial photo of the landscape surrounding the area where East Pack killed the alpha male of Chippewa Harbor Pack.



Map of the local area where East Pack killed a wolf from Chippewa Harbor Pack (CHP). The line shows the travel route of East Pack. Sites A and B refer to sites depicted on page 12. C is the site where CHP had killed a calf. D is the site where East pack killed the alpha male of CHP.

vegetation. Were they hunting moose? Or did they somehow detect that CHP was only 600 meters away? CHP appeared to be unaware that EP was so close.

As EP crossed the swamp, their pace quickened. Pushing further south they passed through another thick strip of forest separating two open swamps. After punching through the forest and on to the second swamp, EP was less than 400 meters from the two CHP wolves (including the alpha male) at the carcass.

How and when did EP know that

CHP was just ahead? EP probably smelled CHP; the wind was to their advantage, though very light. And there were ravens about twenty at the carcass, more than usual. EP certainly heard them.

After crossing the second swamp, there was no doubt EP intended to seize their neighbors kill, now just ahead. And as for the CHP wolves they seemed to have no clue about what was happening.

On the south side of the swamp, EP rallied, wagging tails and howling.

Still, CHP did not respond.

(continued)

Wolf Wars (continued from page 11)

Then, EP ran to the southeast, swung around on the backside of the kill site, and attacked, ambushing the two CHP wolves at the moose carcass. The chase lasted seconds and covered no more than thirty meters. Under a thick clump of trees, the lead EP wolf tackled the alpha male of CHP. Immediately, all of EP surrounded and mauled the CHP victim. In less than three minutes, EP left only a lifeless carcass and blood in the snow.

Meanwhile, a half-mile away, two CHP pups on Chickenbone Lake continued play-wrestling while the third slept. After roughly ten minutes, a CHP wolf ran out of the forest and onto Chickenbone Lake, tackled the sleeping wolf and aggressively wrestled with it for almost a minute. How does a wolf communicate to another that tragedy has just taken place? It took several more minutes for the remaining three wolves of CHP to emerge onto Chickenbone Lake, and when they all arrived, they showed no sign of retreating to a safer location. Did the alpha female know what had happened to her mate?

After spending another fifteen minutes on the east end of Chickenbone Lake, the CHP wolves finally got up and ran, seven abreast, westward, down Chickenbone Lake, for about half a mile. They stopped some lay down, others looked back. Were they waiting for the alpha male?

During this entire time, EP was running, full of excitement, between the site of the dead CHP wolf and calf-kill. The pack spent the next twenty-four hours at this site. CHP, still missing their alpha male, moved that night to a much safer portion of their territory just north of Lake Richie, where they spent the next two days, mostly resting.

It is not unusual for a wolf to be killed by another wolf. In a typical year on Isle Royale, one to three wolves are killed, and a typical alpha wolf may kill two to four wolves in his or her lifetime. But, contrary to common myth, wolves do not kill others of their kind without reason. It is a matter of survival. Wolves kill other wolves so they can have more food for themselves and their offspring.

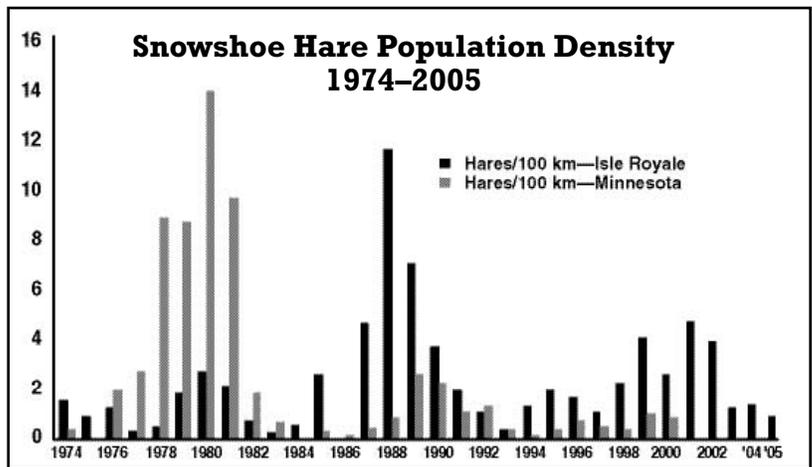


Top photo: East Pack approaches the Chippewa Harbor Pack kill site by traveling uphill through deep snow (Site A). Middle photo: Moments after howling, East Pack, led by the alpha male, charges into the Chippewa Harbor Pack kill site (Site B). Bottom photo: East pack surrounds and kills the alpha male of Chippewa Harbor Pack (Site D).

Other Wildlife

The National Park Service conducts aerial surveys of known osprey and bald eagle nests each summer. After regional declines in organochlorine pollutants in the Lake Superior watershed, both species re-established at Isle Royale in the 1980s. Eagles and ospreys are both present in low numbers, and factors limiting further expansion are poorly understood. In 2005,

Figure 19. Relative snowshoe hare density reaches a peak around the beginning of each new decade, both at Isle Royale and on the mainland in Minnesota.



Counts were made at Isle Royale during all hikes in May-August, while hares were counted in Minnesota on routes used to count drumming ruffed grouse in spring (Minnesota Department of Natural Resources, with thanks to William E. Berg).

active eagle nests numbered nine, with eight eaglets fledged. The number of osprey nests was six (as in 2003 and 2004), with seven young fledged.

Snowshoe hare observations were still relatively low in summer 2005, consistent with a cyclical decline following a peak at the turn of the decade (fig. 19, p. 12). Red fox, a major hare predator, have apparently declined to exceptionally low levels (figs. 20 and 21), probably a result of low food supply. Beaver have declined as forests mature and the high wolf population at the east end exerts predation pressure—only three beavers were seen by project personnel during 2005 field work. (The National Park Service plans to count active lodges in October 2006; the last successful survey was in 2002.)

River otters continue to thrive in all parts of the island. One unusually large family group of six otters was observed at Washington Harbor in February 2006 (fig. 22). The recently established American marten will be the subject of a study by park staff beginning in 2006. Although no marten were reportedly observed in the past year, fresh tracks of several individuals were recorded in winter 2006 at the west end of Isle Royale.

Figure 21. Relative abundance of red foxes from aircraft observations in winter, 1972-2006. 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.



Figure 20. Facing a food shortage caused by low numbers of snowshoe hare (at a mid-point in population trough) and fewer scavenging opportunities left by the hungry wolf population, red foxes have become relatively scarce. However, foxes are often raised in close association with public campgrounds, so they are frequently seen in summer by visitors.

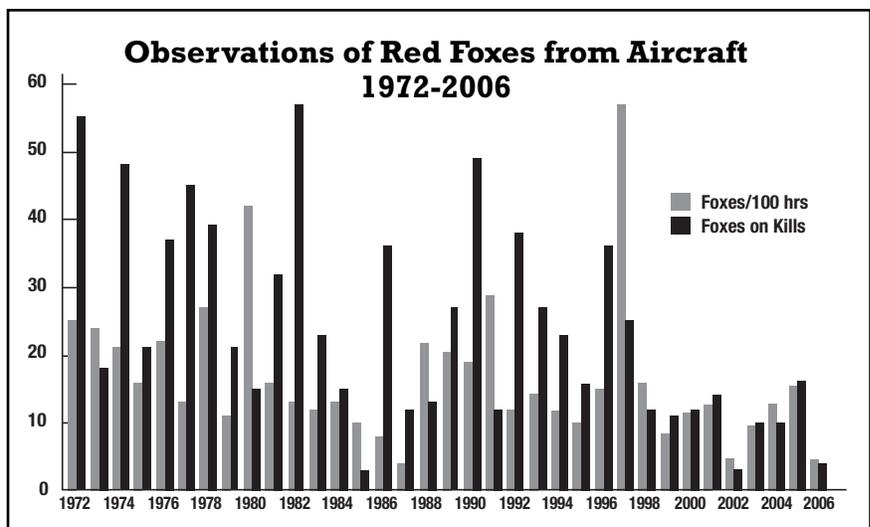


Figure 22. River otters increased dramatically on Isle Royale in the early 1990s as several strong cohorts of lake herring became available in Lake Superior. Herring abundance did not stay high, but otters persisted throughout the island and their scats are common on park trails near wetlands and shorelines.

The Rare Observation of a Common Occurrence: East Pack Kills a Moose

John A. Vucetich

2/12/06, *Isle Royale*. Don Glaser, our pilot, had just picked me up from Lake LeSage where I had spent the past several hours snowshoeing into a site where Chippewa Harbor Pack had killed a moose a few days before. I performed a necropsy and collected a few bones that we'd later study in more detail.

Before flying back to Washington Harbor, our winter base, we would make one final check on each of the packs.

We found East Pack just as they were crossing to the west side of McCargo Cove. Two weeks earlier, East Pack killed the alpha male of Chippewa Harbor Pack. Now, as they crossed to the west side of McCargo Cove, they would be in CHP territory.

I had been fortunate enough to witness East Pack kill the alpha male of Chippewa Harbor Pack. It was the most dramatic wolf event I had ever observed. I expected it would be some time before I'd see anything like that again.

We didn't have much daylight left, so we couldn't watch East Pack for long. After noting the direction of travel and number of wolves, I suggested to Don that we start looking for Chippewa Harbor Pack. As we were leaving the area, I noticed a bull moose feeding in a thinly forested area just ahead and upwind of the direction East Pack was traveling. Hmm. Should we wait and see what happens? If we waited, we wouldn't find the other packs. Besides, I'd seen this many times: a pack of wolves tests or chases a moose, the moose escapes, and the wolves regroup.

Don suggested that we wait to see what might happen.

The moose was just about 200 yards ahead of East Pack. It took a few minutes for East Pack to arrive at the other side of the cedars where the land was more sparsely covered in aspen. Just as East Pack worked through a very thick stand of cedars, the wolves and moose saw each other. They were perhaps 50 meters apart.

In an instant the bull turned and fled. The wolves were quickly at his heels, and the moose stopped, spun

around and made a stand. The wolves skidded to a stop and then lurched back a few steps. The next moment, the bull was surrounded. Wolves grabbed any hold available at the moose's rear. The moose tried to turn and face each lunge. But every turn left some area exposed. For a brief moment, there was a break in the circle of wolves. The moose bolted for that opening, heading for the thick cedar stand from which the wolves first came. As the moose passed one of the wolves, it lunged and bit deeply into the moose's right hindquarter. Running through deep snow, the moose dragged 80 pounds of wolf, attached by sharp, powerful canine teeth. With each forward lunge, the moose struck the wolf in the belly with its rear leg.

After 20 meters, the moose broke free, but the wolves pursued. The moose didn't quite make the edge of the thick cedar stand when the wolves caught up, and one managed to bite and hang onto the moose's hindquarter. The moose slowed down considerably. A second wolf leaped up and latched onto the moose's rear.

Now the moose was moving slowly enough for the alpha male to run to its front end. Although the moose was stopped, it was still standing and extremely dangerous. The alpha male waited and maneuvered to find a safe angle and timing for his attack. But the moose never yielded such an opportunity, and the alpha male never succeeded.

During this time, four wolves, about 320 pounds, had grabbed the bull's rear end, causing his hind legs to collapse. Amazingly, the moose's front remained upright, and still no wolf could bite his nose and, unbelievably, the moose shook himself free from all four wolves and stood up. He was, however, surrounded by the nine wolves of East Pack. Some were focused and waiting for the right moment to attack; others milled around just waiting to feed.

After several minutes, one wolf attacked, then a second, third, and fourth. The moose's rear was brought to the ground once again where it remained for several minutes. The pounded-out snow had begun to turn pink and then red with the moose's blood. After a few minutes,



the moose managed to once again shake the wolves. This cycle of being brought half-down and then recovering repeated itself two more times. In the final cycle, forty minutes after the wolves first chased the bull, his front end collapsed. As the once powerful and magnificent body of this bull moose hit the ground, all nine wolves struck the moose and began tearing its flesh from all sides. From the ground, he could no longer kick. For a few moments, the wolves fed while the moose was not quite dead.

At some unknown moment, the moose's life ended and the life of the East Pack wolves was renewed. This miracle of passage occurs several times a week on Isle Royale. Worldwide, more than 250 species live by the flesh of other warm-blooded animals. Except for plants and scavengers, all animals require the flesh of some other organism. In such a world, if one is aware, no day is routine. Only lack of awareness makes the day seem routine.

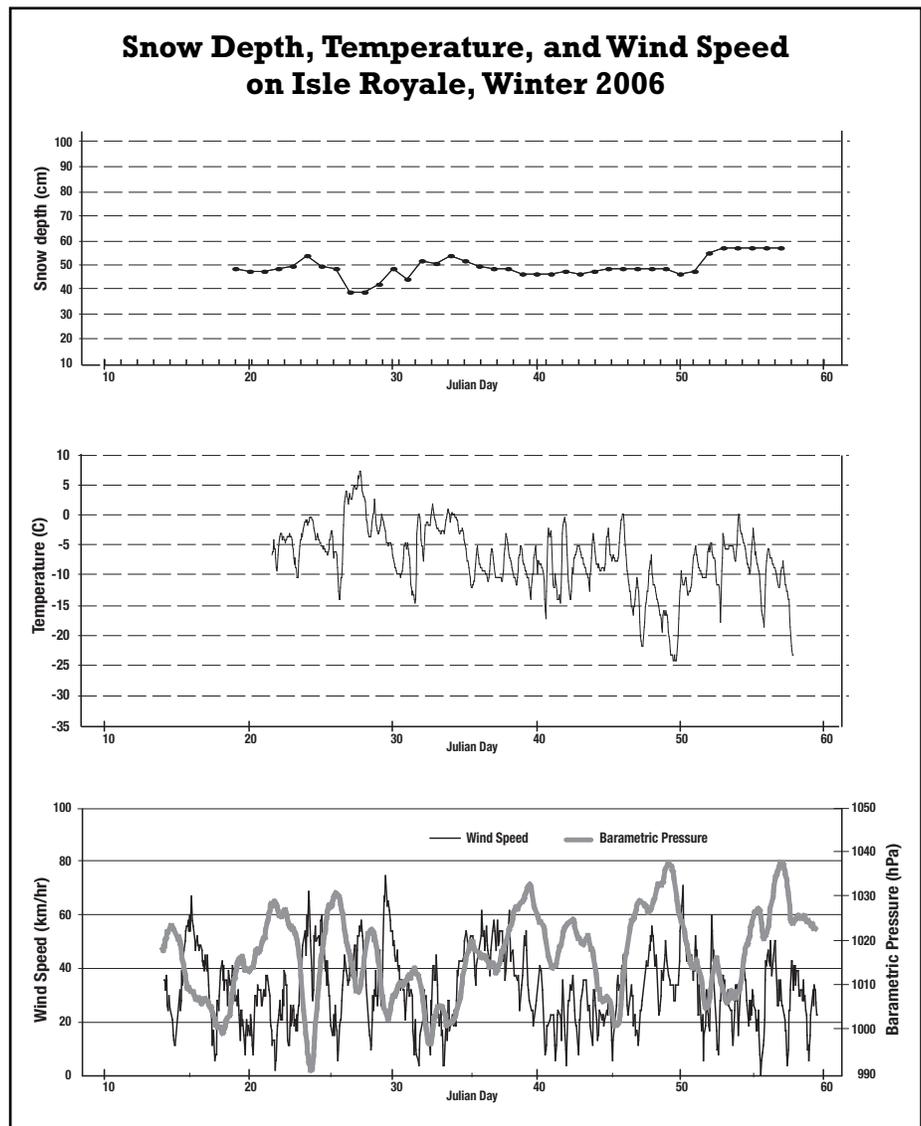


Photo series: East Pack in successful pursuit of a bull moose in the usual range of the neighboring Chippewa Harbor Pack. The chase lasted a few hundred meters before the wolves pulled the moose down by hanging onto its rear. A wolf secured a nose-hold only after the moose was down and immobilized.

Weather, Snow, and Ice Conditions

Snow depth was average and stable during the 2006 winter study (fig. 23). On the other hand, temperatures were considerably above-average early in the study, then declined to near-average levels by the end of February. At no time was there an ice bridge to the Ontario mainland, and for most of the winter study, very little ice existed, even in protected bays of Lake Superior. During the 2006 winter study, as in 2005, winds (reported every hour at Rock of Ages lighthouse) were somewhat stronger than average. Excellent flying conditions require wind speeds of less than 25 km/h. In a typical year, calm conditions prevail about 40 percent of the time. This year, however, winds were less than 25 km/h for 33 percent of the time (fig. 23). Also, winds exceeded 50 km/h for 12 percent of the time (typically, winds exceed this value for about 8 percent of the time).

Figure 23. Snow depth (daily), ambient temperature (hourly), and wind speed (measured hourly at Rock of Ages lighthouse) during the 2006 winter study on Isle Royale.



Can Wolves Radio-Collar Themselves? Rolf O. Peterson

For the past two years, we have been attempting, along with researchers in three other locations, to devise a way to radio-collar a wolf without capture or handling. Such an advance would not only facilitate research in wilderness areas and national parks, but also expand opportunities for attaching radio-collars in winter, when foot-hold traps cannot be used because of the risk that wolves feet might freeze, and in densely forested areas, where helicopter-darting is impossible. The idea is not new over forty years ago, Lou Verme from the Michigan Department of Natural Resources published an article on self-attaching collars for deer.

In summer 2005, we were finally ready to deploy these collars for wolves at Isle Royale, using a design that followed, for the most part, one developed by Ron Schultz from the Wisconsin Department of Natural Resources. The device uses a snare that incorporates a radio-transmitter and antenna into a fabric dog-collar, with a breakaway link that detaches the collar after it is pulled tight over the neck. Ideally, after the wolf tugs briefly at the restraint, the breakaway gives way and the newly-collared wolf simply runs off. Foxes can shake off the collar over their small heads.

We weakened the breakaway from the Schultz design, making it easier to release, but this allowed wolves to release themselves before the collar attached. After retrofitting a stronger release in mid-summer, two wolves were radio-collared in a month. One collar ended up on a mature male from the East Pack, and it worked fine until the fateful day in late January when his pack attacked and killed the alpha male from the Chippewa Harbor Pack we found the collar lying on the ground at the site of the battle. The second successful collaring ended when another wolf simply chewed through the heavy nylon fabric.

The device has proven to be safe for wolves and foxes, but the presence of non-target animals is a major consideration. In 2005, we deployed the self-attaching collars through the summer period and, unfortunately, one young moose calf was collared in early June (when it was evidently *not* following its mother). Murphy's Law is not to be ignored. With timely assistance from Dean Beyer of the Michigan Department of Natural Resources, we were able to immobilize the mother with a tranquilizer dart, but were unsuccessful in capturing the calf, by then weighing about 75 kg. Mitigation planning continued on our part but, within a month, wolves intervened and killed the calf. In future work we will avoid deploying the devices when moose calves are young, but the basic approach has promise and we will continue to attempt improvements.



Top and middle photos show adult male from East Pack (1423) before (July 2005) and after (February 2006, wolf on right) being radio-collared with a self-attaching device. Bottom photo shows the collar after it was pulled off in a violent skirmish with the neighboring pack.





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