

Ecological Studies of Wolves on Isle Royale

Wolves

2015-2016





“On its 100th anniversary, the National Park Service now benefits from the realization that much of its business is systems ecology, and it will be judged on how it incorporates that realization into its management priorities.”

Michael Soukup, NPS Associate Director (retired), Natural Resource Stewardship and Science, in *The George Wright Forum* 32:212, 2015.

Ecological Studies of Wolves on Isle Royale

Annual Report 2015–16

by

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To learn more about how you can join one of our research expeditions, visit www.isleroyalewolf.org and click “Contribute & Participate” 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Results reported here are preliminary and, in some cases, represent findings of collaborators; please do not cite without consulting the authors. The views expressed here do not necessarily reflect those of the U.S. National Park Service or the U.S. National Science Foundation.



www.isleroyalewolf.org and Wolves and Moose of Isle Royale (Facebook)

Ecological Studies of Wolves on Isle Royale

Background

Isle Royale National Park is a remote island located about fifteen miles from Lake Superior's northwest shoreline. The Isle Royale wolf population typically varies from 18 to 27 animals, organized into three packs. The moose population usually numbers between 700 and 1,200 moose. The wolf-moose project of Isle Royale, now in its 58th year, is the longest continuous study of any predator-prey system in the world.

Moose first arrived on Isle Royale in the early 1900s, then increased rapidly in a predator-free environment. For fifty years, moose abundance fluctuated dramatically, limited only by starvation. Wolves established themselves on Isle Royale in the late 1940s by crossing an ice bridge that connected the island to mainland Ontario. Researchers began annual observations of wolves and moose on Isle Royale in 1958-59.

Isle Royale's biogeography is well-suited for the project's goals. That is, Isle Royale's wolves and moose are isolated, and the population fluctuations we observe are due primarily to births and deaths, not the movements of animals to and from the island. Also, the small number of mammal species provides a rather simple system for study. The wolves are the only predator of moose on Isle Royale, and their effect on the moose population is relatively easy to monitor and understand. Moose are essentially the only food for wolves, although beaver are significant at times. Finally and importantly, human impact is limited. Since people do not hunt wolves or moose or manage the forest, the island provides an outstanding natural laboratory for ecosystem science.

The original (and current) purpose of the project was to better understand how wolves affect moose populations. The project began during the darkest hours for wolves in North America—humans had driven wolves to extinction in large portions of their former range. The hope was that knowledge about wolves would replace hateful myths and form the basis for a wiser relationship with wolves.

After nearly six decades, the Isle Royale wolf-moose project continues. Today, wolves prosper again in several regions of North America. But our relationship with wolves in many parts of the world is still threatened by hatred, and now we face new questions, profound questions about how to live

sustainably with nature. The project's purpose remains the same: to observe and understand the dynamic fluctuations of Isle Royale's wolves and moose, in the hope that such knowledge will inspire a new, flourishing relationship with nature.

Many of the project's discoveries are documented at www.isleroyalewolf.org.

Personnel and Logistics

In summer 2015, we conducted ground-based fieldwork from early May through mid-October. Rolf Peterson and John Vucetich directed that fieldwork with assistance from Carolyn Peterson and Leah Vucetich. Leah Vucetich also led a number of people working in our lab, especially John Henderson, Grace Parikh, Joe Lazzari, and Andrew Kalembar. Post-doctoral researcher Sarah Hoy is working hard to transform field insights from Yellowstone and Isle Royale into scientific publications.

During the course of the year, many park staff and visitors contributed key observations and reports of wolf sightings and moose bones.

In 2016, the annual Winter Study was planned from January 18 to March 5. In reality, winter study activities were limited to 33 days between January 22 and February 25. The only people that were actually on the island during this period were Rolf Peterson, and (successively) pilots Don E. Glaser and Don G. Murray. Bob Glaser and Sue and Mark Edgington provided ground transportation on the mainland. Events conspired to prevent all other planned participation, by John Vucetich, Leah Vucetich, field volunteers Dieter Weise and Beth Kolb, Isle Royale National Park staff Rob Bell and Marshall Plumer (all of whom were ready to fly from Minnesota to the island), and several additional staff from Isle Royale who did not even make it as far as Minnesota. The less-than-expected winter study resulted from administrative constraints emanating from the U.S. Forest Service (their planes were not available) and the National Park Service (in response to the Forest Service problems).

Summary

Between January 2015 and January 2016, the wolf population decreased from 3 wolves to probably just 2 wolves (Fig. 1). The moose population likely increased,

but constraints on field operations prevent us from reliably saying by what amount.

These changes are part of a longer trend. Since 2009 the wolf population has dropped by >90%. As a result of very low wolf abundance, each of the past five years has seen uniquely low rates of predation. In response, the moose population has been growing at a mean annual rate of 19% or more over the past five years. If that growth rate persists, the moose population will double in size over the next three to five years.

The wolf population in 2016 likely consisted of a single male-female pair, closely related to one another. In the absence of new incoming wolves, the present wolf population of Isle Royale is almost certainly headed for extinction. During the winter study in 2016, when flying was severely curtailed about 50%

by administrative order (to only 25 hours on eight days), no wolves were actually observed (only fresh tracks), and no kills were detected. During summer 2015 we did not detect any evidence of reproduction or hear howling of more than two wolves.

Conservation scientists believe that predation -- the ecosystem function that wolves provide -- is vital to the health of ecosystems inhabited by large herbivores such as moose. On Isle Royale, predation has been effectively nil for the past five years and is expected to remain so for the foreseeable future. The National Park Service has said that it is considering genetic rescue (among other alternative management options) as a means of mitigating this loss of predation. It is almost certainly too late to conduct genetic rescue. That is, a new wolf population would now have to be re-established if wolves are to remain an ecological force on Isle Royale.

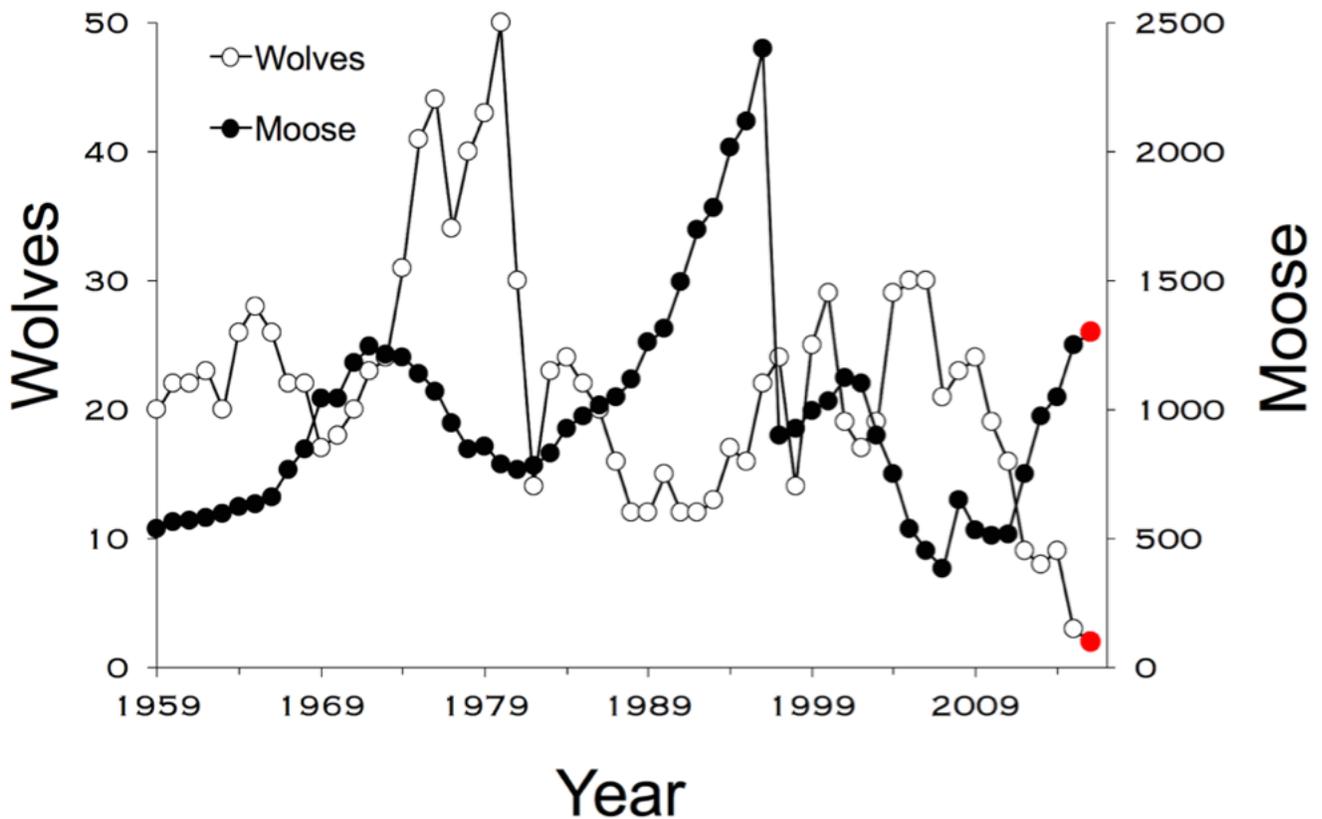


Figure 1. Wolf and moose fluctuations, Isle Royale National Park, 1959-2016. Moose population estimates during 1959–2001 were based on population reconstruction from recoveries of dead moose, whereas estimates from 2002–16 were based on aerial surveys. The 2016 estimate of moose abundance appears as a red circle because there is reason to believe it is an underestimate, owing, in part, to the having counted moose on only three-quarters of the plots that are usually surveyed. The 2016 estimate of wolf abundance appears as a red circle because the only evidence of wolves detected in January and February of 2016 were tracks of what appeared to have been two wolves.

The Wolf Population

In early February 2016, we found evidence suggesting that two wolves remained alive on the island (details below). Wolf abundance, down from last year's count of three wolves and the 2015 total of nine wolves, has now declined to the lowest level on Isle Royale since studies began in 1959. Since 2009, the population has declined by 92%, from 24 to our present best estimate, just 2 wolves (Fig. 1).

The two adult wolves present in 2015 were identified by analysis of fecal DNA at a kill made by these wolves in February 2015. The presumed pup found last year, with visible physical anomalies, was not detected in the scat sample collected on 5 March 2015 from a kill that was visited frequently by wolves in the last half of February, so it may have already succumbed by then. Follow-up scat collections for DNA analysis are planned for summer, 2016.

The two wolves that likely remain on Isle Royale in 2016, believed to be a male-female pair, are probably the two adults identified by fecal DNA collected on 5 March 2015. They both originated in the Chippewa Harbor Pack (CHP), born to the same mother. The female is also the daughter of the male, so any offspring from this pair would be extremely inbred and probably non-viable. Mechanisms to avoid inbreeding exist in most species of plants and animals (e.g. the incest taboo that is universal in human cultures), an evolutionary response to the deleterious outcome of such matings.

From a pedigree, or "family tree", geneticists are able to calculate an "inbreeding coefficient" (F) that quantifies the level of inbreeding among offspring. The remaining CHP father-daughter (and half-sib) pair has an F of 0.43. By comparison, self-fertilization



Figure 2. Wolf tracks in slush on Lake Eva on 1 February 2016.

produces an F of 0.50, as does three consecutive generations of full-sibling mating.

The CHP has not produced any viable pups since the alpha male died, along with two pack mates, in a historic mine shaft in December 2011. The alpha female died in 2014, leaving the present twosome (duo) as the last male-female pair in 2014 - 2016. The third wolf present in 2015 was probably their pup, born in 2014, but it probably died in its first year of life. There is no evidence of reproduction by this pair in 2015. Tracks left by this ill-fated pair on Lake Eva in early February 2016 suggested mutual courtship (side-by-side cavorting). For the last two wolves, there are no options for other mates.

Between successive winter studies in 2014 and 2015, the wolf population dropped from nine wolves to just three, with a mortality rate of at least 70%. The causes of this mortality, which claimed the entire six-member West Pack, remain unknown. Only one of the wolves that died was recovered, a radio-collared male (nicknamed "Pip") from the West Pack who had been born in the Chippewa Harbor pack but later moved to the West Pack (see inset). He died late in 2014, but we were not able to recover his carcass, still transmitting a mortality signal, from under the snow during the winter study in 2015. However, in May 2015 we pulled his intact carcass out of a beaver pond. From a field necropsy we deduced that he had died after a recent attack by other wolves but that he survived long enough (weeks) to have overgrown claws and evidence of healing broken bones.

All wolf skeletons examined since 1994, now numbering more than three dozen, have exhibited vertebral anomalies, including extra vertebrae, asymmetrical vertebrae, and abnormal rib-like bones unattached to other bones. These conditions correlated with increased inbreeding in the population, which allowed expression of deleterious recessive genes. It is commonly, but mistakenly, thought that a higher proportion of deleterious genes has built up in the wolf population over time, but there is no evidence that this is the case. Where genetic rescue has occurred, either naturally (as with Isle Royale wolves in 1967, 1997, and perhaps other times) or by management (e.g., Florida panther rescued by translocation of females from Texas in 1995), dominant normal genes mask the actions of deleterious recessive genes. This explains why congenital problems caused by inbreeding can disappear within one generation of a genetic "rescue".

“Pip” born in 2008, died in 2014 (necropsy #5028 and CL149)

The carcass of the last wolf wearing a radio-collared (nicknamed “Pip”) was recovered in May, 2015. He had been born in the Chippewa Harbor pack (and weighed only 59 pounds when one year old). By 2013 he was with the West Pack, which contained the most distantly-related female. We detected his mortality signal on the first flight during the 2015 winter study, far in the interior of the island, but we were not able to recover his carcass until spring. At that time we pulled his intact carcass from under the flowing waters of a beaver pond, a tributary to the Little Siskiwit River.

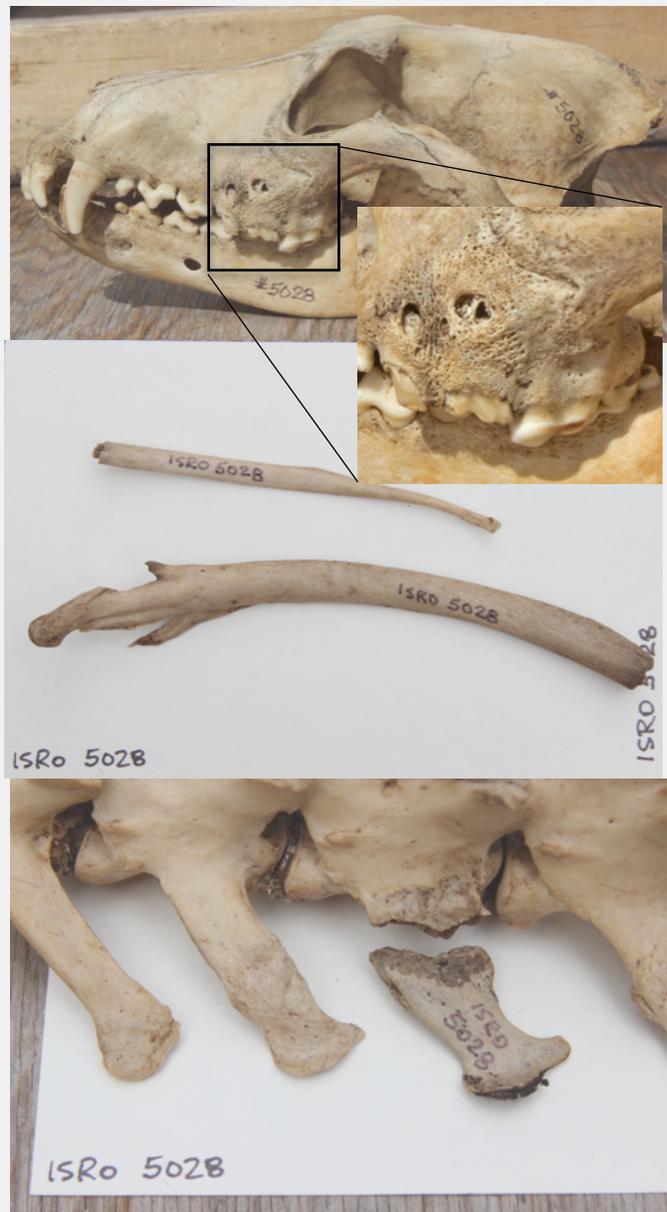
From a field necropsy we deduced that he had died after being attacked by other wolves, but he survived long enough (weeks) to have overgrown claws and evidence of broken bones healing.

Park visitor Heather Simmons, a veterinary pathologist from the University of Wisconsin, was able to examine the skeletal remains of this wolf, along with photos of the carcass when pulled from the water. Subsequently, Luc Janssens, a veterinary pathologist with the Clinic for Orthopedic Surgery of Companion Animals in Ghent (Belgium) who specializes in canid skull pathologies, examined photos of the skull and explained plausible causes for the severe infections evident in the skull, and how health may have been impacted.

Pip exhibited a range of pathologies that were surprisingly numerous for a wolf of middle age (six years old), the legacy of subordinate status and subsisting on large prey that are difficult to kill. Serious infections in his skull developed after at least two severe traumas. One resulted in the fracture of several teeth, including the lower left canine. This could have been caused by a kick from a moose. The second event involved biting a large bone positioned obliquely in the mouth (as from a struggling moose) - this broke off the crowns of two lower teeth. These traumas left a legacy of pain - first, from the original tooth fractures, and later from denuded roots that became infected creating large abscesses. Bacterial infections of teeth and surrounding tissues create fever, pain, and septicemia with possible bacterial colonization of kidneys and heart valves.

Pip also had osteoarthritis in several vertebrae, and healed fractures in many ribs and vertebral processes. And he exhibited an extra lumbar vertebra, not unlike many wolves from Isle Royale examined over the past two decades, plus two unique structures in the rib cage that appear to have been anomalous ribs.

Photos below show skull (top) with inset of major abscess resulting from broken teeth, anomalous ribs (middle), and lumbar vertebrae with one broken lateral process with evidence of healing (bottom).



On 16 March 2016, the National Park Service (NPS) announced that it is revising and narrowing the scope of the environmental impact statement (EIS) being prepared. The EIS will now focus on the question of whether to bring wolves to Isle Royale National Park in the near term, and if so, how to do so. The scope has been narrowed from when it was formally announced in July 2015. At that time, the NPS was considering a broader range of potential management actions as part of determining how to manage the moose and wolf populations for at least the next 20 years. The estimated schedule has not changed, with a Record of Decision anticipated by “Fall/Winter 2017” (another 1.5 - 2 years from the time of this writing).

The Moose Population

The 2016 moose survey began on February 6 and ended on February 17. We only counted moose on 3/4 of the plots due to administrative constraints. The survey resulted in an estimated abundance of 1300 moose. The 80% confidence intervals on this estimate are [1070, 1540], and the 90% confidence intervals are [960, 1690]. Last year, we estimated 1250 moose, with an 80% confidence interval of [1050, 1450]. Using the techniques described in the 2009-10 Annual Report, we calculated this year’s estimate of moose abundance using a sightability factor (the probability of detecting a moose) of 71%.

During winter 2016 moose density throughout Isle Royale was 2.4 moose/km². Flying conditions for the count were initially excellent, but clearly declined after



Figure 3. Moose browsing, especially in winter, dramatically influences growth of woody plants.

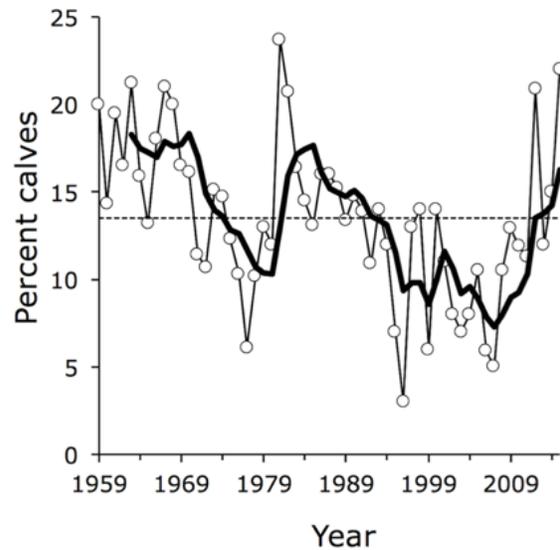


Figure 4. Long-term trends (1959–present) in the percentage of the total moose population that are 8-month old calves. The 50-year average (13.4%) is marked by the dotted line, and the curved line is a 5-year moving average.

the middle of February when refreezing following a brief thaw caused the snowpack to increase in density. As snow gets harder in mid-winter moose typically gravitate to coniferous habitats where they rely more on browse from balsam fir and are harder to see from the air.

It is likely that the point estimate of 1,300 moose for 2016 is an underestimate. Moose estimates based on aerial counts will be refined when the population is statistically “reconstructed” from remains of dead moose, but this is possible only after most of the moose present in a given year have died.

Of the moose that we observed on the census plots in 2016, 22% (of 139) were calves. This rate of recruitment is the second-highest ever recorded (Fig. 4). Recruitment rate is a useful predictor of moose population growth rate (see Fig. 11 of the 2012-2013 Annual Report). [The 2016 recruitment rate is associated with an expected growth rate of 0.15. If the moose population grew by 15%, the 2016 population estimate would be 1440 moose.] The recent multi-year increase in recruitment rate reversed a two-decade downward trend.

This winter we observed five sets of twins, four of which were on plots during the moose census. The

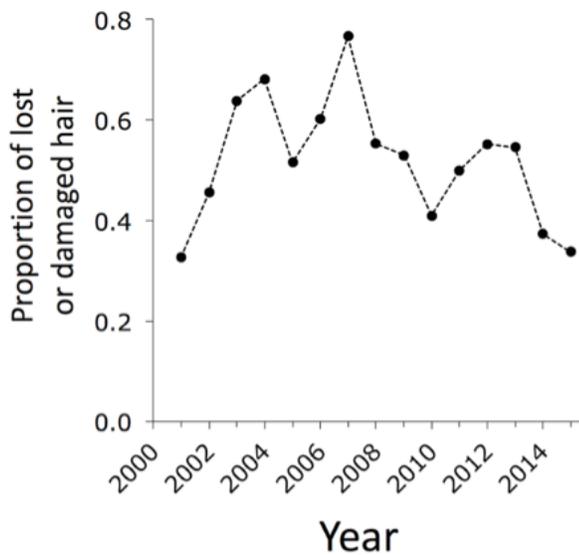


Figure 5. Trends in springtime hairloss for Isle Royale moose, 2001-present. Each observation is the average hair loss for observed moose. Hair loss is an indicator of the intensity of tick infestation.

increase in twins, consistent with an increasing trend in recent years, is the result of moose being well-nourished and exposed to negligible rates of predation. Moose are well nourished because forage is abundant (see 2013-14 Annual Report) and predation rate is low because wolves are rare.

Reports from park visitors suggest that in recent years visitor sightings of moose have not increased commensurate with the moose increase. This may be because moose are not gravitating to visitor-inhabited shorelines and campgrounds to avoid wolves. Additionally, visitors reported seeing multiple moose beds in small areas, corresponding to a single moose moving very little over the course of a day or more. Again, this could result from lack of wolf presence and the resulting reduced movement among moose.

Each spring we estimate the degree to which moose were impacted by winter ticks (*Dermacentor albipictus*) during the preceding winter. This is done by photographing moose and estimating how much hair they have lost. Tick numbers peaked in 2007 and then generally declined, with the spring of 2015 having the lowest level of tick abundance except for 2001, the first year of monitoring (Fig. 5). The decline in tick abundance coincides with cold and long-lasting winters (2013-2014 and 2014-2015), in contrast to the warm autumn and late-arriving winter in 2015-2016. The response of tick populations to this

abrupt change in environmental conditions will inform us whether residual tick populations determine tick numbers the next year or if tick numbers fluctuate in response primarily to short-term change in weather parameters.

Over the past four and a half decades, predation rate has been the best predictor of moose population growth rate. The moose population has not been limited by wolf predation for the past five years, and forage is still plentiful (see 2013-14 Annual Report). Since 2012 annual predation rate has been <4%. Historically, predation rate has been a strong predictor of moose growth rate, explaining >60% of the annual variation in growth. If predation rate in the past year was <4%, we would expect moose population growth rate to have been >17.6%, which corresponds to >1,470 moose.

The recent growth of the moose population is the strongest that has been observed in the project's history. That strong growth occurred even though two of the past four winters were severe (2012-13 and 2013-14). Absent significant predation, winter severity will be the primary limiting factor for the moose population. If the recent trend in growth continues for just three more years the moose population will approximate the level of the mid-1990s, just prior to the die-off in 1996. At that time the moose population had considerable impact on forest vegetation. Concerns remain that the upcoming increase in moose abundance will result in long-term damage to the health of Isle Royale's vegetative community (see 2013-14 Annual Report).



Figure 6. Moose are increasing in number, but reduced anti-predator behavior may contribute to fewer moose being observed by park visitors in summer.

Other Wildlife

As an important prey of wolves, beaver have, like moose, experienced dramatically less predation pressure since 2012. Biennial counts revealed a two-fold increase in the number of active beaver lodges during 2010-2014. Ground coverage in 2015 indicated at least seven active lodges on the Lake Superior shoreline, while in 2008-2010 there were none. We would expect that in recent years the average number of beaver per lodge has also increased along with the increase in the number of active lodges.

During winter 2016 tracks of marten were observed at Windigo, and during 2015 a marten was observed several times at Windigo. Since 1991 marten sign has been observed every year but three, while sign was completely absent during 1959-1990.

Indices of abundance are available for red fox and snowshoe hare, a predator-prey system that impacts many species because of the potential for snowshoe hares to reach very high population densities. Observations of foxes have declined for most of the past decade, coincident with a reduction in the availability of wolf-killed moose, and this fox decline probably contributed to the all-time peak in snowshoe hare observations during 2011-2013 (Fig. 8). In 2015 snowshoe hare observations again declined, which may further impact an already-declining fox population.

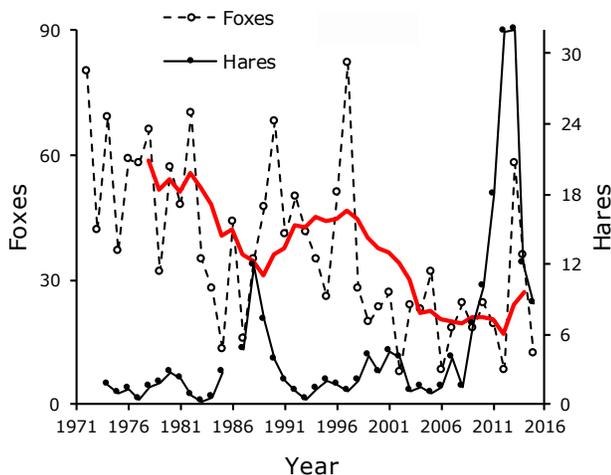


Figure 7. Indices of abundance for red foxes and snowshoe hares on Isle Royale, 1974-present. See 2015-2016 annual report for details on calculations. The red line is the seven year moving average of fox abundance.

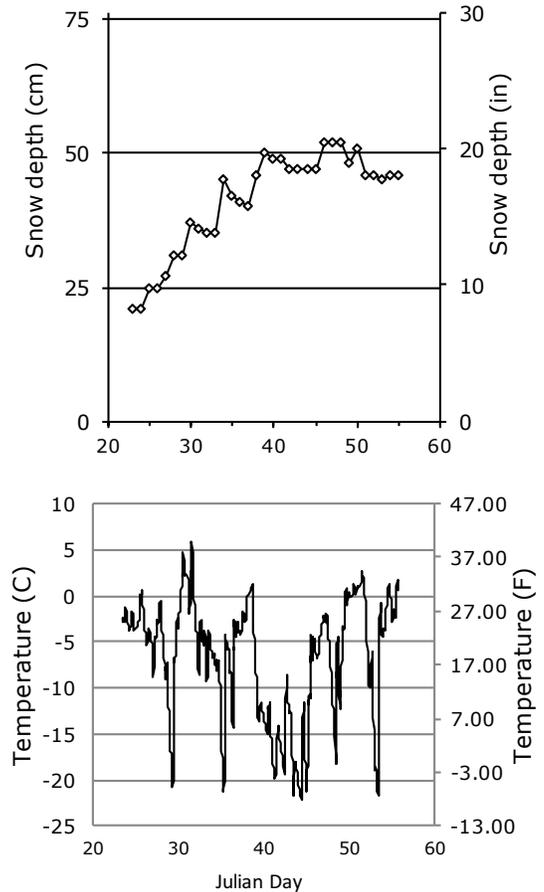


Figure 8. Snow depth (daily) and ambient temperature (30-minute intervals) during the 2016 Winter Study on Isle Royale.

Weather, Climate, and Ice

An intense El Nino pattern dominated the first half of the winter, resulting in warm temperatures and perhaps contributing to strong winds that delayed ice formation at Isle Royale. The opening of winter study was postponed for one week, and even then ice was scarce around the island. During the winter study there were several thaws that eventually resulted in a hardened snowpack, which reduced moose mobility, and temperatures were considerably above average.

When we arrived on 23 January, snow depth was low (approximately 20cm), but frequent snowfalls brought snow depth to 52 cm by mid February (Fig. 8). Overall snow depth was below the long-term average.

During the winter of 2016 there was never an ice bridge connecting Isle Royale to the mainland. An ice bridge to the mainland has formed in only three of the past 18 years. It is this decline in connectivity to the mainland that has resulted in genetic decay for the wolf population.



“Once again I look, as I have for years, at the designs and the wake made on the surface of the water, this lace that is incessantly made and unmade, this liquid marble...and once more I look for the exact comparison that will hold for me. This marvelous flowering sea, water and light that has escaped me for so long now. Still in vain. For me, it’s a recurring symbol.”

Albert Camus, *American Journals*, from the notebook of Tim Pacey (1959-2015), Moosewatch leader for 20 years.



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