

Ecological Studies of Wolves on Isle Royale

# Wolves

2014-2015





"And then there are the times when the wolves  
are silent and the moon is howling."

— George Carlin

# Ecological Studies of Wolves on Isle Royale

Annual Report 2014–15

by

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To learn more about how you can join one of our research expeditions, visit [www.isleroyalewolf.org](http://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Results reported here are preliminary and, in some cases, represent findings of collaborators; please do not cite without consulting the authors. All images were taken by J. Vucetich or R. Peterson, except the antler image on the inside back cover. The views expressed here do not necessarily reflect those of the funding agencies.



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# 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 comprises between 18 and 27 wolves, 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 57th 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. The lives of Isle Royale moose would never be the same. Researchers began annual observations of wolves and moose on Isle Royale in 1958.

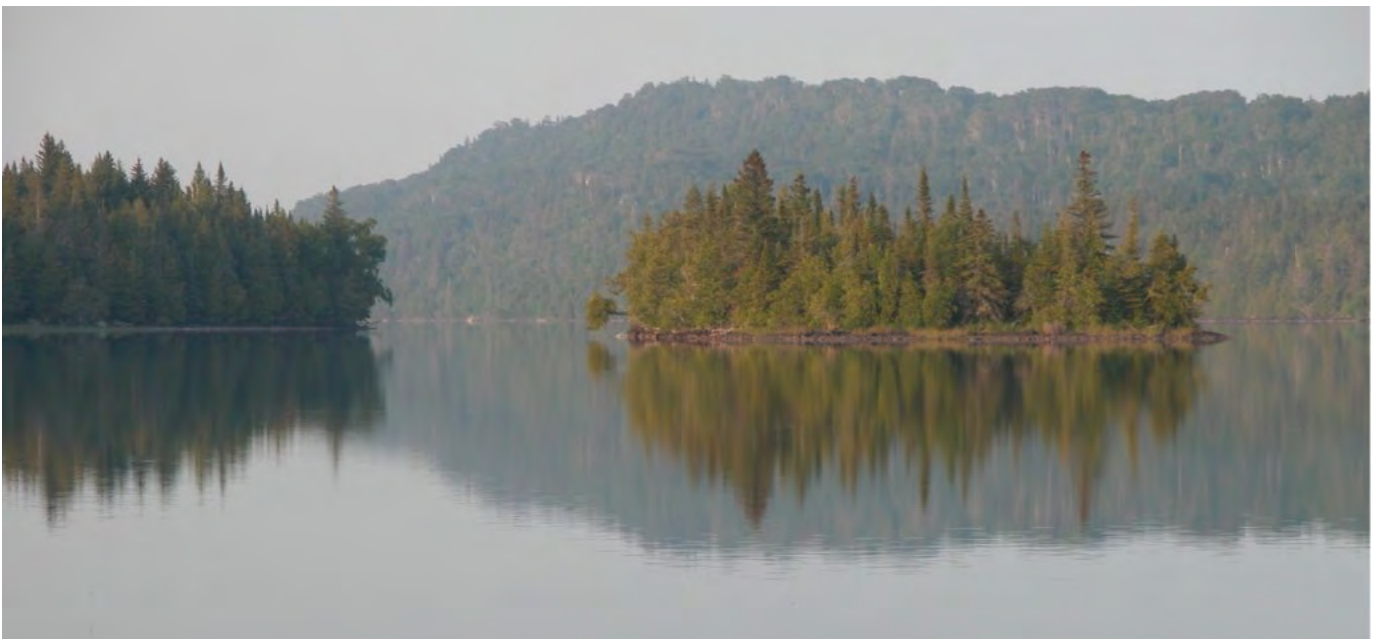
Isle Royale's biogeography is well-suited for the project's goals. That is, Isle Royale's wolves and moose are isolated and the population fluctuations we observe are due primarily to births and deaths, not the mere wanderings of wolves and moose to or from the island. Nature is difficult to understand because it usually includes interactions among so many species. It helps to observe where ecological relationships are

relatively simple. On Isle Royale, wolves are the only predator of moose, and moose are essentially the only food for wolves. To understand nature it also helps to observe an ecosystem where human impact is limited. On Isle Royale, people do not hunt wolves or moose, or cut the forest.

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 had been that knowledge about wolves would replace hateful myths and form the basis for a wiser relationship with wolves.

After five decades, the Isle Royale wolf-moose project continues. Today, wolves also prosper again in several regions of North America. However, 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](http://www.isleroyalewolf.org).



## Personnel and Logistics

In summer 2014, we conducted ground-based fieldwork from early May through mid-October. Rolf Peterson and John Vucetich directed that fieldwork with assistance from Antoine Chery, Kadie Mercier, Roberta Ryan, Keith Toornman, Carolyn Peterson, and Leah Vucetich. Leah Vucetich also led a number of people working in our lab, especially John Henderson, Grace Parikh, John Bennett, Melissa Bergstrom, Shane Kleiman, and Alexandria Leech.

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

In 2015, the annual Winter Study extended from January 30 to March 5. John Vucetich, Rolf Peterson, and pilot Don E. Glaser participated in the entire study, assisted by Leah Vucetich, Molly McDevitt, and Kelsey Ward. Molly and Kelsey's efforts focused on collecting urine (yellow snow) and pellet samples to assess the nutritional condition of moose. Bob Glaser provided ground transportation on the mainland. U.S. Forest Service (USFS) pilots Pat Loe and Scott Miller flew supply flights to Isle Royale from Ely, Minnesota. Several National Park Service employees also attended a portion of Winter Study; they are Cory Process, Erin Haglund, Mark Romanski, Bill Route, and James Dahl.

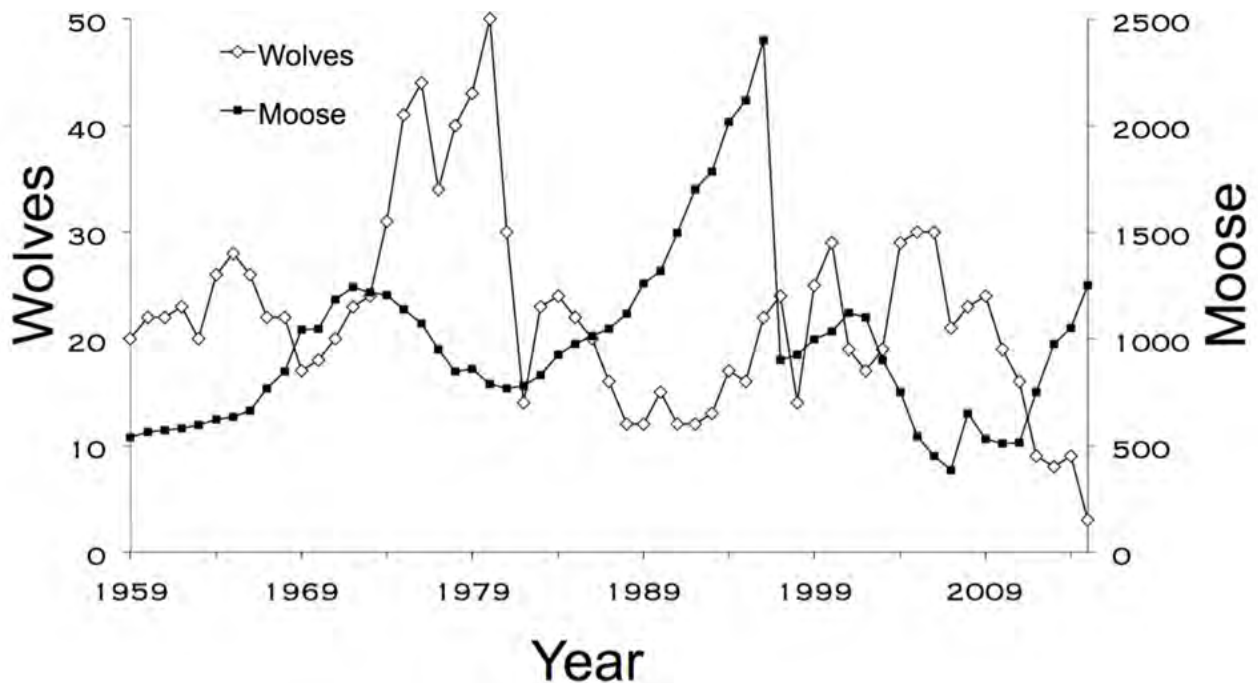
## Summary

From late-January to early March 2015, we conducted the 57th annual Winter Study of wolves and moose on Isle Royale. Between January 2014 and January 2015, the wolf population decreased from 9 to 3 (Fig. 1). In the same time period, the estimated abundance of moose increased by 19% from 1050 to 1250.

These changes are part of a longer trend. Since 2009 the wolf population has dropped by nearly 90%. As a result of very low wolf abundance, each of the past four years has seen unprecedented low rates of predation. In response, the moose population has been growing at a mean rate of 22% per year for each of the past four years. If that growth rate persists, the moose population will double in size over the next three years.

The wolf population was organized into a single social group. The sex and pack of origin for these wolves is unknown.

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 effectively been nil for the past four years and is expected to remain so for the foreseeable future. The



**Figure 1.** Wolf and moose fluctuations, Isle Royale National Park, 1959-2015. Moose population estimates during 1959–2001 were based on population reconstruction from recoveries of dead moose, whereas estimates from 2002–15 were based on aerial surveys.

**Figure 2.** In 2015, the Isle Royale wolf population was reduced to just these three wolves.



National Park Service has said that it had been considering genetic rescue as a means of mitigating this loss of predation. There is now a very good chance that it is too late to conduct genetic rescue.

## The Wolf Population

In February 2015, we counted three wolves in the population. Wolf abundance was down from last year's count of nine wolves and reached the lowest level on Isle Royale since studies began in 1959. Since 2009, the population has declined by 88%, from 24 to 3 wolves (Fig. 1). These three wolves all lived in the same social group (Fig. 2).

One of the three wolves was distinctive with respect to the shape and color of its tail (see cover photo & Fig. 2). In particular, its tail was only about half or two-thirds the length of a normal tail, and the end of the tail was marked with two dark bands. We have not in previous years seen a wolf on Isle Royale with such a tail. This wolf was also considerably smaller than the other two wolves (Fig. 3). Those observations give reason to believe that this wolf was a nine-month old pup. The prospect that this wolf is a pup is noteworthy, in part, because we had not detected any evidence of pups during the summer of 2014.

Even as a pup, this wolf appeared smaller than average. In images taken on February 15th (e.g., Figure 2) this wolf was also characterized by a thin waist line (while the other two wolves appeared to have full bellies). This wolf also consistently displayed an unusual posture: a slightly arched back and guard

hairs on its back that tended to stand upright. This is not a wolf that we would expect to live for too much longer. Moreover, on the last day of Winter Study we investigated the site near Lake Richie where the wolves had been feeding from the carcass of a moose. Tracks that we had observed on earlier flights at a nearby pond suggest that these wolves may have been present at this kill site for a week. The degree of carcass utilization was also consistent with that inference.

The identity of the two larger wolves is uncertain. They could be the alpha pair of West Pack. Or, one could be a survivor of West Pack and the other could be a survivor of the Chippewa Harbor Group. These wolves may or may not be of the same sex. The pup may or may not be their offspring. For example, it is possible that the alpha female died after the pup was old enough to survive without a mother.

We collected about two dozen scat samples on March 5th from the site where the wolves had been feeding from a moose carcass. We expect the DNA from those scats will help us determine the identity of these wolves and whether the third wolf had been alive and present at that site.

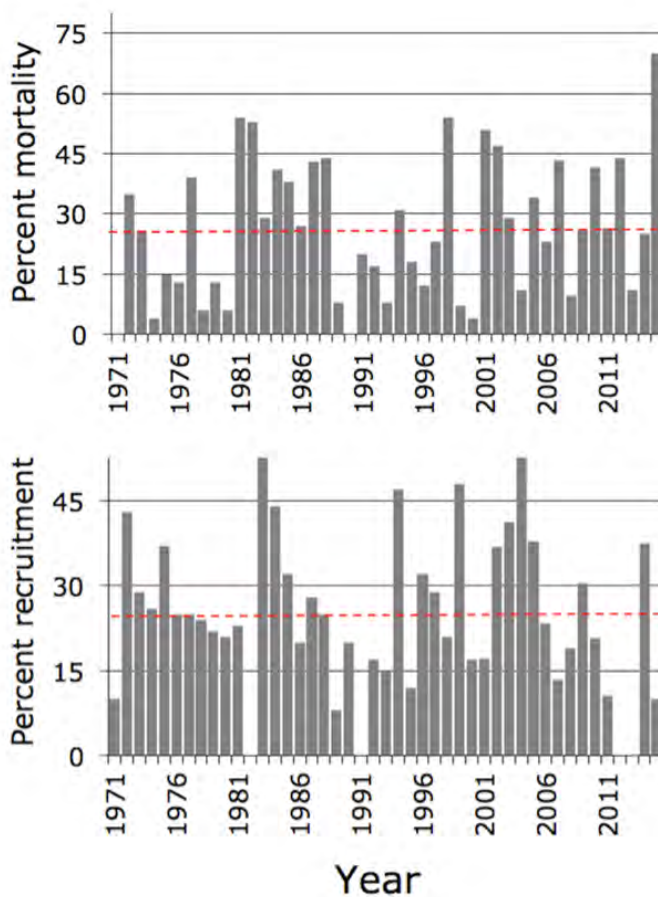
We did not detect any signs of courtship or mating among the wolves. However, we did not observe them often enough to provide a useful indication.

It is possible, though not likely, that some of the nine wolves in last year's population left Isle Royale on the ice bridge that persisted for 48 hours after the

end of last year's Winter Study. If the smaller wolf in Figure 2 is indeed a pup, and if no wolves left Isle Royale on those three days in March 2014, then the mortality rate during the past year was 70%, the highest ever recorded (Fig. 3). One of the wolves from West Pack that had been alive last year wore a radio-collar that emitted a mortality signal during this winter season. The mortality signal suggests that this wolf died. That likelihood will be further understood this spring when we travel to the site to look for the carcass.

If the Isle Royale population is comprised of additional wolves that went undetected, their presence will likely be detected through the analysis of DNA extracted from scat collected later this summer and next winter.

Recruitment rate is the percent of the population that are pups who survived to see their first winter. The survival of one pup in a population of nine wolves



**Figure 3.** Percent mortality and recruitment for Isle Royale wolves, 1971-present. The dotted lines mark long-term averages.

yields a recruitment rate of 10%, which is among the lowest recruitment rates that we have ever observed (Fig. 3).

During the 2015 winter field season, we observed only one site where wolves killed a moose. This is the fewest observed kill sites in the project's 57-year history. Per capita kill rate is estimated from the number of moose killed and the number of days during which those kills were made. The wolves were first observed on February 14th and last observed on March 5th. It is plausible that the wolves killed and fed from one moose during the last week of that period (see above). Their location and activities for the previous twelve days are unclear. In that time they may or may not have killed a moose. Less likely is their having killed two moose in that time. If they kill more than the one detected moose, then the most likely sites of these killings would be near Little Todd Harbor. We will search that site this spring for signs of a kill site.

If the wolves killed one moose throughout that 19-day period, then the per capita kill rate is 0.53 moose per wolf per month, which is lower than expected, given the number of moose per wolf on Isle Royale (Fig. 4). If the wolves killed two moose during this 19-day period, then the kill rate would be close to what is expected, given the number of moose per wolf.

A lower than expected kill rate, if that is the case, may be a partial and proximate explanation for the sharp decline in wolf abundance. (Kill rate had also been lower than expected in two of the three previous years.) Again, if kill rate is lower than expected, then inbreeding depression is a likely explanation (see 2013-14 Annual Report for details). It is unlikely that lack of food is an explanation, given the extraordinarily high ratio of moose-to-wolves (Fig. 5).

On February 26, we observed two additional wolves near Mud Lake on the western portion of Isle Royale (Fig. 6). The smaller of the wolves was light in color, in a way that is uncharacteristic of Isle Royale wolves. The larger of the two wore a GPS radio collar. That evening and the next morning, these wolves traveled the south shore of Isle Royale to Cumberland Point, the southwest most portion of Isle Royale. From that point, the wolves traveled at 330 degrees, toward the U.S.-Canadian border on the mainland. We followed the wolves until they were approximately 3 miles offshore.

## “Isabelle” born in 2008, died in 2014 (necropsy #4937)

In 2014, a radiocollared female wolf from Isle Royale, five years old and unable to find a mate on the island, took advantage of her first chance to cross ice to the mainland in search of a better situation. Within days she was dead, fatally shot with a pellet gun. We have now had a complete necropsy report (by pathologists at Colorado State University), and at MTU, students have helped dissect her skeleton, now cleaned and ready for further inspection by Jannikke Raikkonen at the Swedish Natural History Museum and a specialist in wolf spinal anatomy.

Just like spinal columns from more than 30 wolves examined since 1994, the spine from Isabelle had several congenital anomalies. She had an extra vertebra in her posterior spine, the last lumbar element. She also had two highly asymmetrical cervical vertebrae which were both completely missing a lateral element.



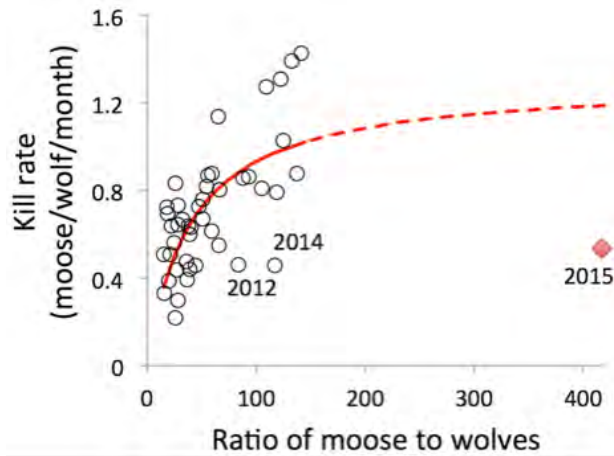
There were vestiges of her attacks that we had witnessed before she escaped from Isle Royale. There was a three-inch scar visible on the interior of her chest cavity, between two ribs. Here, we speculate a canine tooth of an attacker hooked and sliced into her side. Ironically, the fatal pellet wound was found at the end of the year-old scar.

Teeth of this wolf reflected a lifetime of stress. Both lower canine teeth had been broken off and then heavily worn. There was a chronic infection affecting the dorsal incisors, resulting in increased nasal bone porosity. Across all the teeth, there was a general and noticeable flaking and sloughing off of enamel, particularly on the dorsal canines. One lower premolar was also broken off and heavily worn.

All of the >200 bones from Isabelle are now archived along with skeletal remains of more than 70 other wolves that have been recovered from Isle Royale over the past five decades. They will be useful to scientists interested in the effect of genetic stress on the developmental biology of the skeleton.



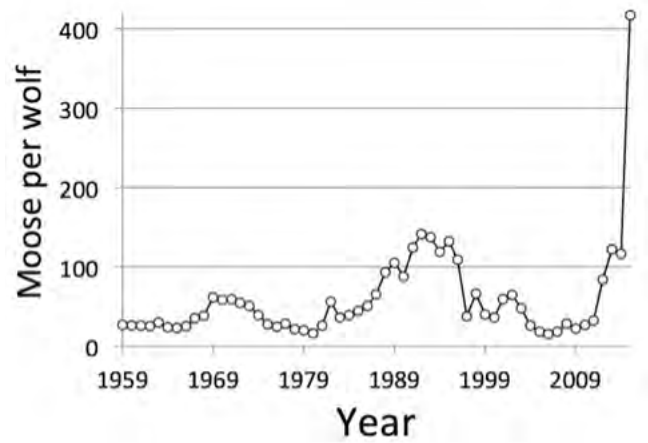




**Figure 4.** Relationship between ratio of moose-to-wolves and number of moose consumed per wolf per month, 1971-2015. The number of moose consumed is the number killed, plus those scavenged.

Later we learned that these were part of a study conducted by the Grand Portage Band of Lake Superior Chippewa on the Minnesota mainland. One of these wolves was a female of unknown age. The sex and age of the other wolf is unknown.

We do not know whether these wolves had any awareness that other wolves were on Isle Royale. The visiting wolves likely never traveled northeast of the middle portion of Siskiwit Lake, and the Isle Royale wolves did not, to our knowledge, travel that far southwest (Fig. 7).



**Figure 5.** The number of moose per wolf during each year, 1959-2015. This ratio is frequently used by predator ecologists as an indicator of the balance between predator and prey. The ratio of wolves to moose to wolves in 2015 was 417, which is approximately three times greater than any other value observed in the history of the project.

If the visiting wolves had been aware of the presence of the Isle Royale wolves, it is far from certain that genetic rescue would have occurred. For example, if the two larger Isle Royale wolves are a mated pair, they would have had little interest to mate with any immigrating wolf. It may be, for all practical purposes, too late to conduct genetic rescue on Isle Royale.



**Figure 6.** Two wolves that visited Isle Royale for six days in late February. They came and went from Isle Royale by crossing an ice bridge. The wolf in the left image had been fitted with a GPS collar. The color and build of the wolf in the right image is unlike that of wolves typically observed on Isle Royale.

## 2015 Wolf Travels



**Figure 7.** Travel routes of wolves observed during winter 2015. The diamond-shaped symbol indicates the location of the only kill site that we detected this winter. The identity of the Group of Three (Figure 2) remains uncertain, though they may be the remnants of West Pack. The visiting wolves (Figure 6) were two wolves that arrived to Isle Royale on February 22nd by crossing an ice bridge. The date of arrival is known because one of the wolves wore a radio collar. We observed the wolves leave Isle Royale on February 27th.

## The Moose Population

The 2015 moose survey began on February 2nd and ended on February 19th. The survey resulted in an estimated abundance of 1250 moose. The 80% confidence intervals on this estimate are [1050, 1450], and the 90% confidence intervals are [950, 1580]. Moose density throughout Isle Royale was 2.3 moose/km<sup>2</sup> (Fig. 8). Flying conditions for the count were good (i.e., not too windy). Using the techniques described in the 2009-10 Annual Report, we calculated this year's estimate of moose abundance using a sightability factor of 69%. Last year, we estimated 1050 moose, with an 80% confidence interval of [770, 1350]. These moose estimates 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 2015, 15% (of 165) were calves. This rate of recruitment is near the long-term average (Fig. 9).

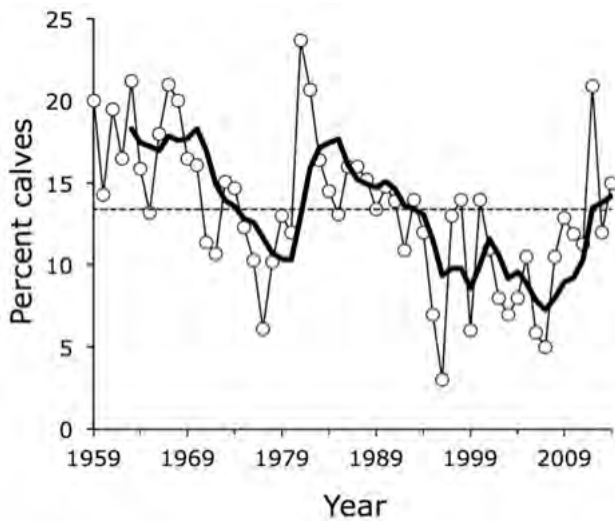
Recruitment rate is important because it explains about half the variation that we have observed in the moose population growth rate (see Fig. 11 of the 2012-2013 Annual Report). The multi-year trend in recruitment rate has steadily increased during the past seven years, reversing a two-decade downward trend in recruitment (Fig. 9).

This winter we observed six sets of twins, which represents a decade long trend in the increased frequency of observing twins (Fig. 10). The increase in twins 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.

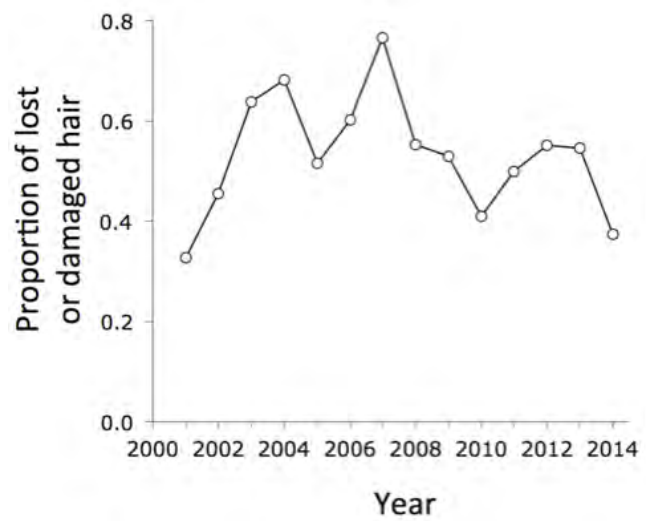
We also observed six moose that still had antlers, including one as late as February 22nd. Last winter we observed ten moose with antlers. These observations also represent a recent trend in the increased frequency of antlered moose. Most moose lose their antlers in late December. However, young bull moose



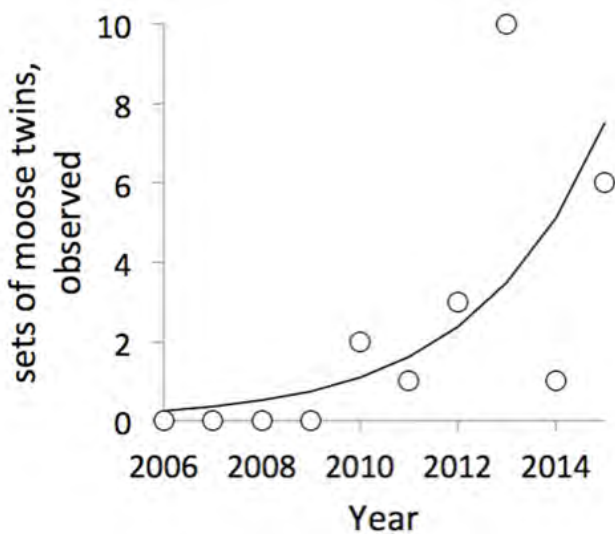
**Figure 8.** Moose distribution on Isle Royale in 2015 was uniform, as it has been for the past several years. Results are based on the number of moose observed in each of 91 plots that collectively comprise 17 percent of the main island area.



**Figure 9.** 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.

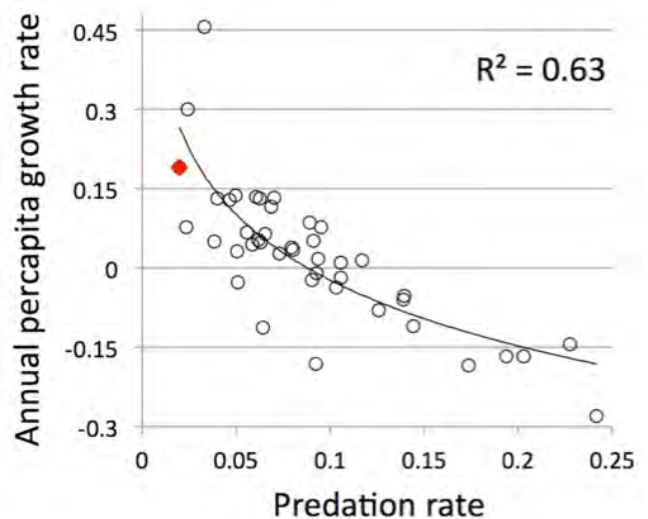


**Figure 11.** Trends in springtime hair loss for Isle Royale moose, 2001–present. Each observation is the average hair loss for observed moose. Hair loss is an indicator of the intensity of tick infestation.



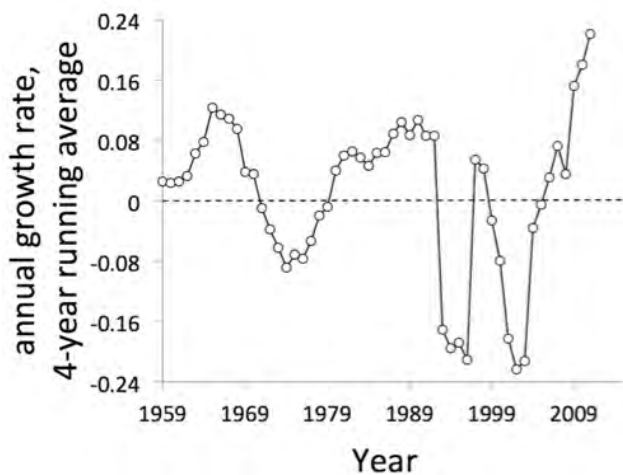
**Figure 10.** Recent trend in the number of twins observed each Winter Study. The trend line represents the best-fitting poisson regression curve ( $p < 0.01$ ). The ten sets of twins observed in 2011 is the most ever observed in the fifty-seven year history of the project.

often keep their antlers until mid winter. The increased occurrence of antlered moose during mid winter is likely attributable to a large portion of the moose population being young in age, which is characteristic of a rapidly growing population.



**Figure 12.** The relationship between predation rate and annual population growth rate of the moose population, 1971–present. The red symbol is the observation for 2015. The previous three years (2011–2014) are the three left most open circles.

Each spring we estimate the degree to which moose had been impacted by winter ticks (*Derma-centor albipictus*) during the preceding winter. This is done by photographing moose and estimating how much hair they have lost during the preceding winter. It is thought that tick abundance has been high since 2001, when monitoring began. Ticks peaked in



**Figure 13.** Four-year running average of annual growth rate for the moose population, 1959-present. For example, the most recent observation is 0.22/yr, which is the average growth rate for the four-year period, 2011-2015. Observations above the dotted line are periods of growth, and observations below the line are periods of decline. This graph demonstrates how the most recent four years, corresponding to the period when wolf predation was functionally absent, represent the strongest period of moose growth observed in the past six decades.

2007 and then generally declined, with this past spring being the lowest level of tick abundance except for the first year of monitoring (Fig. 11).

Predation rate is the proportion of the moose population killed by wolves each year. That statistic is calculated from estimates of kill rate and the ratio of wolves to moose. On the basis of those observations, the estimated predation rate is less than one percent (i.e., 0.8%). The four lowest predation rates have occurred in the past four years and the average predation rate for that four-year period has been 2.2%. Prior to this period, the average predation rate had been 9.9%.

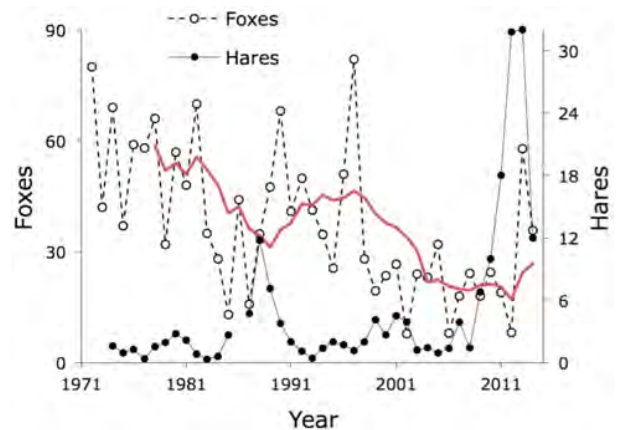
Over the past four and a half decades, predation rate has been the best predictor of moose population growth rate (Fig. 12). The moose population has not been limited by wolf predation for the past four years (see 2013-14 Annual Report). Vegetation is also still plentiful (see 2013-14 Annual Report). The recent growth of the moose population is the strongest that has been observed in the project's history. That strong growth is in spite of two of the past four winters being severe (2012-13 and 2013-14). Consequently, the primary limiting factor for the moose population has been winter severity. If the

recent trend in growth continues for just four more years the moose population will be in excess of 2400 moose (Fig. 13). The only previous time (during the project's history), when moose were that abundant was 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).

## Other Wildlife

From Isle Royale, long-term population counts or indices are available for beaver, snowshoe hare, river otter and red fox, in addition to wolves and moose, although only the beaver population has been rigorously estimated. Annual fluctuations for some of these species is influenced importantly by the number of wolves on the island.

Beaver are an important secondary prey species for wolves during the open water season. Aerial counts of active beaver sites have been used for over a half century to estimate abundance and trends in beaver. During 2006-2010, intensive double counts using two teams of observer/aircraft were used to evaluate counting methods and population trends. During this time, beaver were experiencing intense wolf predation pressure, and there was a slight

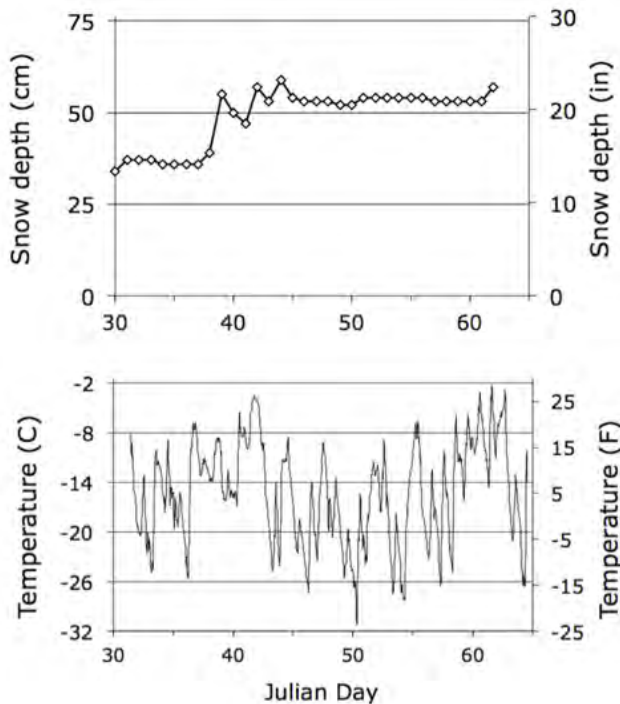


**Figure 14.** Indices of abundance for red foxes and snowshoe hares on Isle Royale, 1974-present. The hare index is the number of hares seen per 100 km of summer hiking. The fox index is the number of foxes seen from the plane during Winter Study, the sum of the maximum number seen at kills and the number seen otherwise per 100 hr flight time. The red line is a moving average, highlighting a longer term trend in fox abundance.

downward trend in the number of colonies. In 2009-2010, the number of active sites was estimated at 92 and 99 colonies, respectively. As the wolf population collapsed in subsequent years, the beaver population expanded dramatically. The estimate for 2012 was 167 colonies, and by 2014, there were 189 colonies. Thus simultaneous with the wolf decline and a doubling of the moose population, data also suggests a doubling in the number of active sites inhabited by beaver. To our knowledge, Isle Royale is the only site in the world where there have been long-term and systematic population counts of both wolves and beavers.

Red foxes and snowshoe hares are linked in a predator-prey relationship that involves many other species as minor players. After two years of extraordinarily high population density, snowshoe hares were somewhat reduced in 2014 (while still above average). The fox index, consisting of counts of foxes both on and off kills, was within the usual range. We felt that foxes in 2015 had unusual mobility along shorelines where wolves usually travel, and this may have inflated the number we observed.

River otters continue to exist at high abundance, and it is not uncommon to see a female accompanied



**Figure 15.** Snow depth (daily) and ambient temperature (30-minute intervals) during the 2015 Winter Study on Isle Royale.

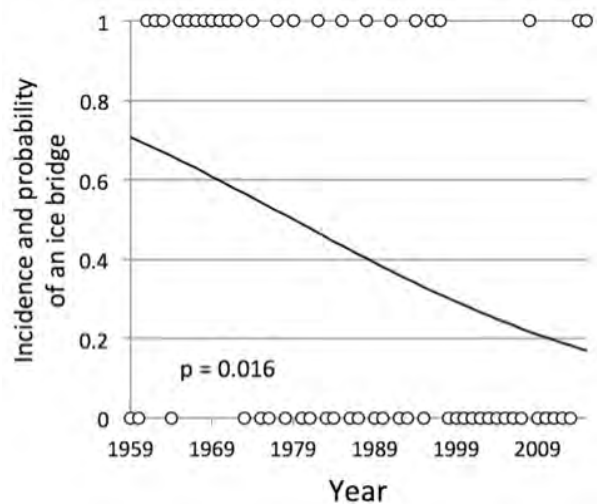
by three or more offspring, occasionally up to six. Aerial observations of otter tracks (and the occasional sighting) are mapped each winter, and in 2015, otter sign were recorded in 101 square-mile sections of the U.S. Geological Survey map, or about half of the island.

## Weather, Climate, and Ice

Winter weather in 2014 was colder than average, with daily low temperature usually less than -15 degrees C (Fig. 15). Maximum temperature never reached 0 degrees C. As a result, no crust ever formed on the surface of the snow. Snow crusts tend to impede moose in their effort to forage.

When we arrived in late January 2015, snow depth was relatively low (approximately 30cm) and increased to 53 cm by mid February (Fig. 15). Overall snow depth was close to the long-term average. Lacking any thawing temperatures, snow was consistently soft without crusts through the entire Winter Study.

During the winter of 2015, an ice bridge connected Isle Royale to the mainland for 20 days (February 15th to March 7th). The five decade trend in declining frequency of ice bridges has not been overturned by the formation of ice bridges in each of the past two years. This ice connection was just the third in 17 years. For additional context, ice bridges formed during 7 of 10 years during the 1960s (Fig. 16). Anthropogenic climate change is the cause of the declining frequency of ice bridges.



**Figure 16.** Incidence and probability of an ice bridge forming between Isle Royale and the mainland for the period 1959-2014.

## Don Murray, *in memoriam*

A devoted supporter of the wolves and moose in Isle Royale National Park passed away on 14 November 2014 in northern Minnesota. Don Murray, 88 years old, was the pilot for the Winter Study at Isle Royale during 1959-1979. With superb piloting skills and personal generosity, he was completely dedicated to learning everything possible about wolves and their prey. Don had an extraordinary ability to see animals in the field. His intuitive understanding of animal behavior and his “feel” for flying small aircraft proved indispensable to his annual work at Isle Royale. Without Don’s contribution as a foundation, it is doubtful the study would have continued. He was featured in books by Durward Allen, Rolf Peterson, and Carolyn Peterson, and in a recent documentary film, *Fortunate Wilderness*, by George Desort. Interviewed in that film, Don considered himself to be “luckiest man alive,” for all of the things he had seen on Isle Royale over the years.

Born in 1928, Don was independent-minded, and definitely self-made. He was largely on his own by the age of 12. He completed his formal education through the 8th grade, and his first job driving a truck by around the age of 14. He earned 3 Bronze Stars while serving in the Army in Korea. He officially learned how to fly an airplane after returning to Minnesota from military service, but he reported “barnstorming” with a friend at an early age, flying loops, and other acrobatics until they made each other airsick. Don married Helen Eastman from Bemidji, MN, in 1950, and they had 7 children – Mary Lou, Larry (Skip), Michael, Ron, Pat, Cheryl, and David. Don was buried with military honors on 21 November, in

Virginia, Minnesota. His wife of 63 years passed away in 2013.

In response to interest in a memorial opportunity to honor Don, a fund

has been established to support wolf-moose research at Isle Royale, at the following site: [https://www.banweb.mtu.edu/pls/owa/gift.p\\_give?desig=1816\\_Wolf\\_Moose\\_Fund](https://www.banweb.mtu.edu/pls/owa/gift.p_give?desig=1816_Wolf_Moose_Fund) (indicate “Don Murray Memorial Fund”). Specifically, donations will support the work by a two-person volunteer field crew in the winter, dedicated to collecting samples to monitor the nutritional condition of moose. In his day, Don would have been thoroughly involved in such an activity, with his customary good cheer and creativity.







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THANK YOU to all who help!