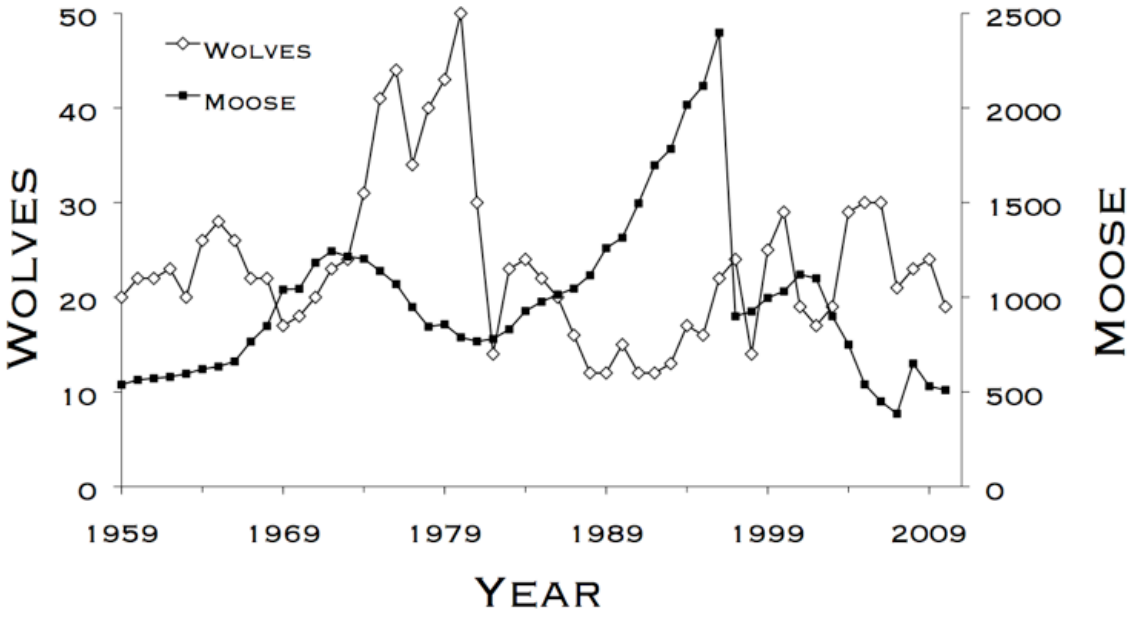
Homework 7.1 - Case Study Update #3 Name: _____

The graph below summarizes the changes in the size of the two populations you have been studying on Isle Royale.



1996 was the year that there was intense competition for declining forage during a severe winter and an outbreak of winter ticks. Due to these factors the moose population crashed the following year. Many years earlier there was a wolf population crash from 1980 until 1982. This was caused by the spread of a disease accidently introduced to the island by humans.

But between these two temporary disturbances, there was a period of about 13 years where the moose population increased year after year, but the wolf population didn't do the same, even after some years of delay.

- What was the smallest (minimum) size of the moose population during that 13-year interval? (Remember to use the y-axis scale on the right side of the graph to estimate your result). _____
- What was the largest (maximum) size of the moose population during that 13-year interval? _____
- What was minimum size of the wolf population during that period? (Remember to use the y-axis scale on left side of the graph to estimate your result): _____
- What was the maximum size of the wolf population during that time period? ____

That trend in the size of the wolf population during that period, from 1983 to 1996 is a bit of a mystery. Why didn't the wolf population increase as well over those years? That larger size of moose population should have meant more food for wolves. This should have provided building blocks and energy needed for more wolf reproduction and greater survival rates.

It was particularly mysterious because there was no observable environmental changes or temporary disturbances in the ecosystem that could account for this.

Maybe there are other factors that could explain why the moose population was increasing but the wolves weren't. What are your ideas?

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Scientist have a hypothesis that there was something about the traits in the wolf population that was making them less able to survive in this environment.

Read the article on the following pages for clues as to what that might be. Highlight text in the article for important connections to ideas you discovered in class. Annotate the text with any questions or insights you have, before you get to the remaining questions on last two pages of this packet.

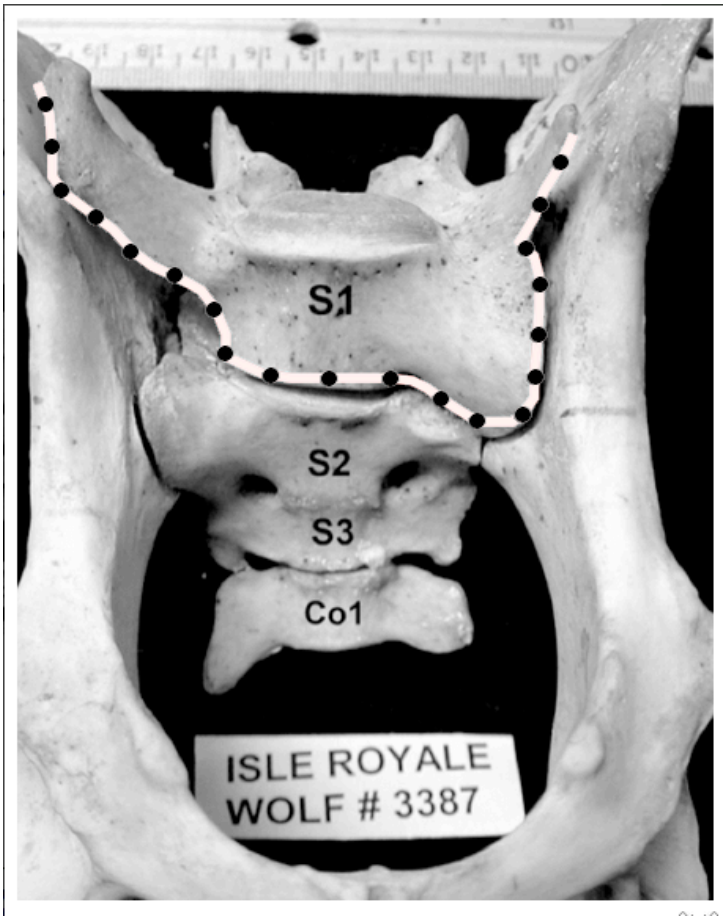
Article on Inbreeding

Adapted from http://www.isleroyalewolf.org/data/data/home.html

The Isle Royale wolf population was founded when wolves crossed an ice bridge from Canada in about 1949. They were believed to have been isolated ever since. Comprised typically of just a couple dozen wolves, the population is also small. Small, isolated populations exhibit high rates of inbreeding – the mating of close relatives.

The negative effects of Inbreeding accumulate over the generations.

In 2009, with the help of Jannike Räikkönen, an expert in Canid anatomy from the Swedish National Museum, we systematically inspected the skeletal remains from 50, or so, Isle Royale wolves that had been collected over the past five decades. A surprising number of these wolves suffered from several different kinds of congenital malformation in the spine.

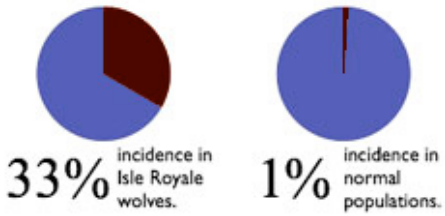


Left, is an image of the ventral side of a wolf pelvis and sacral vertebrae. The dotted line highlights a gross asymmetry between vertebrae 52 and 53. This wolf would have likely suffered damage to nerves that control its tail and hind legs.

A particular kind of deformity, known as a lumbosacral transitional vertebrae (LSTV), is particularly well studied in dogs and wolves.

Among healthy, outbred populations LSTV occurs in one out of a 100 wolves. On Isle Royale, a third of the wolves suffered from this malformation.

Not only did Isle Royale wolves exhibit LSTV at a high rate, but also the rate of malformations had once been relatively low and increased over the decades, as the population became increasingly inbred.



If the number of malformations of the spine was increasing in offspring over time and this may lead to nerve damage, what do you predict was happening to the wolves' effectiveness at hunting?

Could this account for why the wolf population wasn't increasing when (or after) the moose population did? Why or why not?

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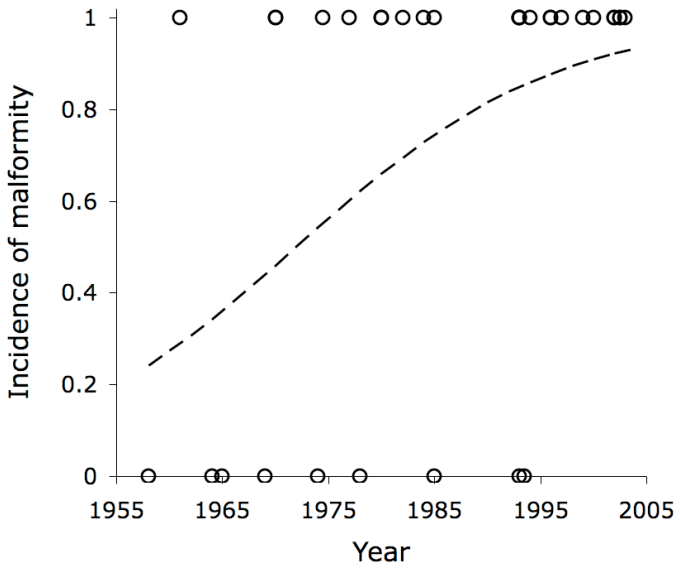
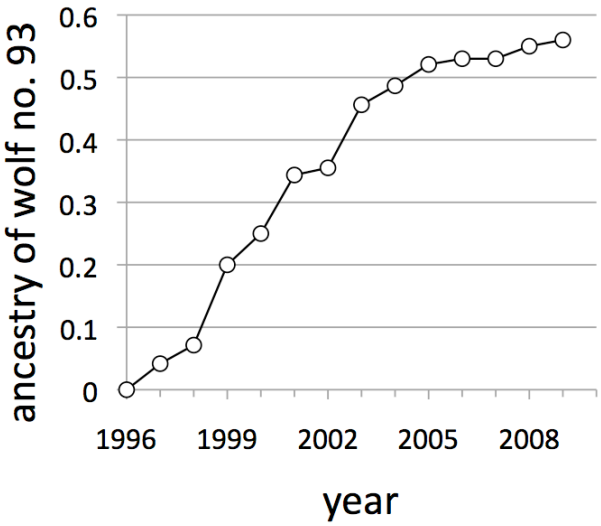
In the graph to the right, each symbol indicates the year of birth for a different wolf and whether it was born with a spinal malformation (0 = normal; 1 = malformed). The curve represents logistic regression, which predicts the incidence of malformations for each year, based on the observed data. In the 1950s, the expected incidence of malformation was approximately 20%. By the late 1990s, the expected incidence was well over 80%.



Then something remarkable happened. In 1997 a wolf from Canada walked across the frozen ice bridge that had formed that winter. We had known his identity all along - he was the "old grey guy," alpha male of Middle Pack during their most successful years. He was physically large and light in the color of his coat (see image below).

Through the analysis of DNA obtained by collecting scat, the "old grey guy" became wolf no. 93. And through that genetic analysis, we learned that no. 93 was not a native Isle Royale wolf, but instead an immigrant from Canada. He represented a badly needed infusion of new genes and new traits into the population. Within a decade of his arrival, 7 of the 8 breeding wolves on Isle Royale were either no. 93 or his immediate offspring. Wolves that had some of his genes were taking over the entire population.

In large outbred populations, each individual's ancestry is typically very small. The graph to the left shows how the ancestry of wolf no. 93 steadily grew as he produced more and more offspring and grand offspring. By 2010, more than half the genes in the Isle Royale population were descended from this single immigrant wolf.



So, how has inbreeding and the subsequent genetic rescue affected population dynamics on Isle Royale? A precise understanding is beyond us. However, we have some important general understandings.

In previous studies we have already indicated how the disease-induced population crash of 1980 seemed to trigger an important change in population dynamics for wolves.

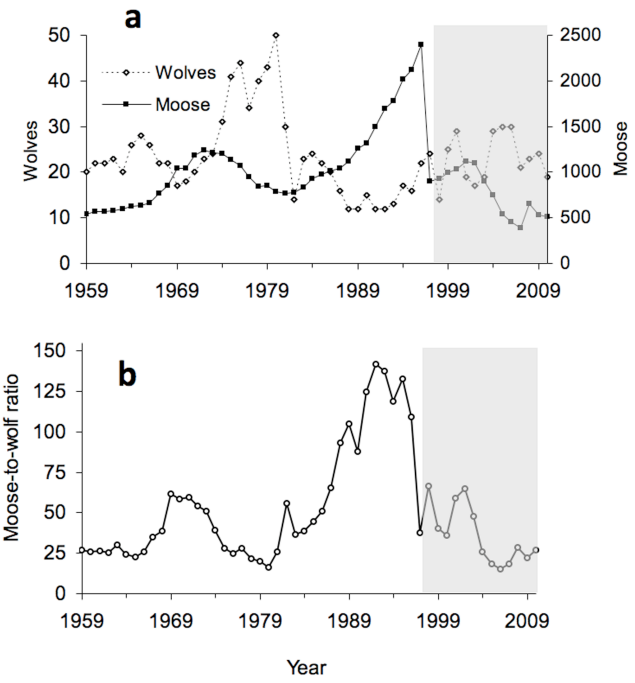
During the 1980s and early 1990s, wolf abundance never really recovered. Prior to 1980 wolves are an important influence on wolf population dynamics (and older-aged moose were an important predictor of wolf abundance

However, after 1980, climate replaced wolves as the dominant predictor of moose dynamics, and wolf abundance became completely uncoupled from the abundance of old-aged moose. In retrospect, these changes were likely the result, at least in part, of inbreeding and the resulting loss of genetic diversity and accumulation of trait malformation in the population.

So did wolf demography improve after the immigrant's arrival? The answer is complicated. After no. 93's arrival, wolf abundance may have generally increased, but that increase was pretty erratic (shaded area of panel A, to the right).

However, the immigrant's arrival was associated with a time when the number of moose per wolf declined dramatically (shaded area of panel B, to the right).

Recall that the number of moose per wolf is an important indicator of food availability for wolves (section 3).



Given that circumstance, the wolf population should have declined, and probably by quite a bit, at the time when the immigrant arrived. The arrival of wolf no. 93 is almost certainly the reason why the wolf population showed a slight tendency to increase at a time when food was not particularly plentiful.

Summarize the main claim(s) this article is making

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What ideas from the computer modeling activities and class discussions are related to the explanations used in this article?

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What new questions do you have about this case study?