MOOSE AND WOLVES

Predator Prey Relationships

© DR WILLIAM NEWMARK

A male moose (Alces alces) in Salmon-Challis National Park, Idaho, U.S. Earthwatch scientist Dr. William Newmark is researching movements of large mammals between forest patches along wildlfe corridors in research complementary to that of Dr. Rolf Peterson.

Summary of the research project

The wolves *(Canis lupus)* and moose *(Alces alces)* of Isle Royale National Park, in Michigan, US, have been the focus of long-term research since 1958. The single major research goal remains unchanged - to clarify the role of wolf predation in the population dynamics of moose. Originally distributed throughout North America, wolves are now found in northern Minnesota, northern Wisconsin, the Upper Peninsula of Michigan, and Isle Royale (plus the newly-introduced arrivals in the Rocky Mountains.) Earlier, humans armed with poison, traps and guns eliminated the species, and human intolerance remains a significant impediment to wolf conservation and recovery throughout the world.

As a research area, Isle Royale provides unique assets found nowhere else in the world. Only 15 of the 45 or so mammal species from the mainland have reached the island, so it is a simplified animal community. Problems of immigration and emmigration are eliminated, and all species are protected from harvest or persecution by humans. The long lifespans and generation times of wolves and moose require long-term studies to understand population dynamics and interactions between these species.

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Research Location

Isle Royale National Park, Michigan, was established in 1931, and today is the least-visited national park in the US outside of Alaska. The island is visited by about 15,000 people between mid-April and November, and it is closed to visitors during the winter. Most visitors come in late July and August. Isle Royale was established as a national park to preserve its unique and isolated northern forest environment.

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Scientist using radio telemetry to locate animals. This antenna picks up a signal transmitted from collars around an animal's neck.

Meet the Scientist

Dr Rolf Peterson is a Professor of Wildlife Ecology at Michigan Technological University. He received his B.A. in Zoology from the University of Minnesota and his Ph.D. in Wildlife Ecology from Purdue University. He has conducted research on wolves in Alaska and several other mammalian species in the Great Lakes area.

Components of the Research Ecosystem

Wolf Predation of Moose

In the 1970s, after a decade of stability, both wolf and moose populations fluctuated dramatically. When moose were at peak numbers, a series of four severe winters led to starvation, and a generation of moose that were small at birth suffered life-long vulnerability to wolves. Wolf numbers tripled during the 1970s, producing the world's highest wolf density in 1980. Moose numbers were cut to perhaps one-third of their former level, and wolves gradually culled vulnerable moose from the population. As a result, wolf food supply dropped to starvation levels, and the wolf population crashed from 50 to 14 in 1980-82. An introduced disease, canine parvovirus, was probably a contributing factor to the wolf crash. With forage recovered, (after milder winters), moose immediately began increasing, a trend that continued until 1996, with the exception of a drop in 1989 and 1992 because of winter ticks. Meanwhile, the wolf population faltered because of unusually low reproductive success.

1996 was a pivotal year for Isle Royale's moose. Having built to a record 2500 animals, the moose were acutely affected by a combination of deep snow, winter ticks and a very late spring, and in 1997 there were only 500 moose left. The wolves rallied in 1997, producing two litters of five pups apiece, but food shortage brought the wolf population down to 14 in February 1998. Wolves rebounded to 28 in 2000 but fell back to 17 in 2002. Wolves may be short of

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Moose remains – the jawbone clearly shows the incisors and molars which distinguish it from a wolf jawbone which would have canine teeth.

available prey because the moose population now has a young age structure (wolves predominantly feed on weaker, older moose). The wolves of Isle Royale are highly inbred, but it is not clear whether their reproductive rate has suffered as a result.

From recent trends in wolves, moose, and growth of trees at Isle Royale we infer that the Isle Royale food chain is controlled by wolf predation (and hence is a top-down population dynamic). Wolves regulate moose numbers, and herbivory by moose in turn determines tree growth rates. This represents a considerable revision of our earlier ideas, which emphasised the importance of bottom-up factors such as moose nutrition. In the absence of predation by a top carnivore (wolves, bears, or humans), we argue that prey populations will not stabilise or reach an equilibrium arising from density-dependent reductions in reproduction or survival. Given the chronic decline in Isle Royale wolves since the population crash of 1980-1982, the moose on this island have been largely released from predation pressure. Moose increased until 1996, save two small die-offs caused by winter ticks in 1989 and 1992. The catastrophic mortality of 1996 confirmed that moose stretched the absolute limits of the food supply.

To evaluate both long-term dynamics of moose and the short-term future of the faltering wolf population, we need data on moose population size, age structure, and survival. The best long-term source of these demographic data comes from a process called "population reconstruction", in which moose recovered after death are used to "reassemble" the previous population. For example, a 15-year-old moose that died in 1990 was known to be alive during 1975-1990. By adding together all such records and comparing the sum to moose population estimates from aerial census for the same period, it appears that about one-third of all moose are recovered by ground crews, in both summer and winter. Thus each moose skeleton recovered, especially those whose date of death can be estimated accurately, contributes directly to the effort to understand past moose fluctuations. In a new project researching the impacts of climate change on animal populations, skeletal remains of moose in our collection are being used to track the amount of carbon dioxide in the earth's atmosphere over the past 50 years.

Animal species

Mammals include moose, snowshoe hare, beaver, red fox, and red squirrel. River otter have increased dramatically in the past decade. Since wolves have traditionally suffered from intense hunting by humans, sightings of wolves are extremely rare because of strong avoidance behaviour. Therefore, wolf signs (droppings) and tracks are used to survey these animals. Bird life is similar to that of the surrounding mainland, with a wide variety of northern warblers, thrushes, ducks, and raptors. Ospreys and bald eagles are becoming more evident as pairs become re-established following a ban on DDT which decimated populations through poisoning, as occurred in the UK.

Trekking through a forest clearing looking for moose and wolf signs

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Plant species

There are abundant species of bog plants, several species of plants more typical of Arctic regions (along Lake Superior), and an outstanding array of several dozen orchid species. Various kinds of edible wild fruit are available in August, especially blueberries, raspberries, and thimbleberries.

Topography

The topography of Isle Royale is dominated by a series of parallel bedrock ridges which run the length of the island. Valleys between ridges tend to contain wet swamps or beaver ponds. Northern hardwood forests in the interior contain yellow birch and sugar maple, but most of the island is dominated by boreal forests of white spruce, balsam fir, white birch, and aspen. Northern white cedar dominates most wetland forests. The southwest end of Isle Royale contains fewer inland lakes than the northeast end, and is less dissected by bays of Lake Superior. Topography is a bit more rugged at the northeast end, where glacial sediments are thinner. Throughout Isle Royale maximum elevation above Lake Superior is only about 213m.

Climate

Surrounded as it is by the cold waters of Lake Superior, the island tends to be cooler than the mainland in summer.

Temp. range:	7.2°C (extreme low in May) to 29.4°C (extreme high in August)
Altitude:	183m to 396m
Normal rainfall:	May – 6.4cm; June – 7.9cm; August – 8.1cm

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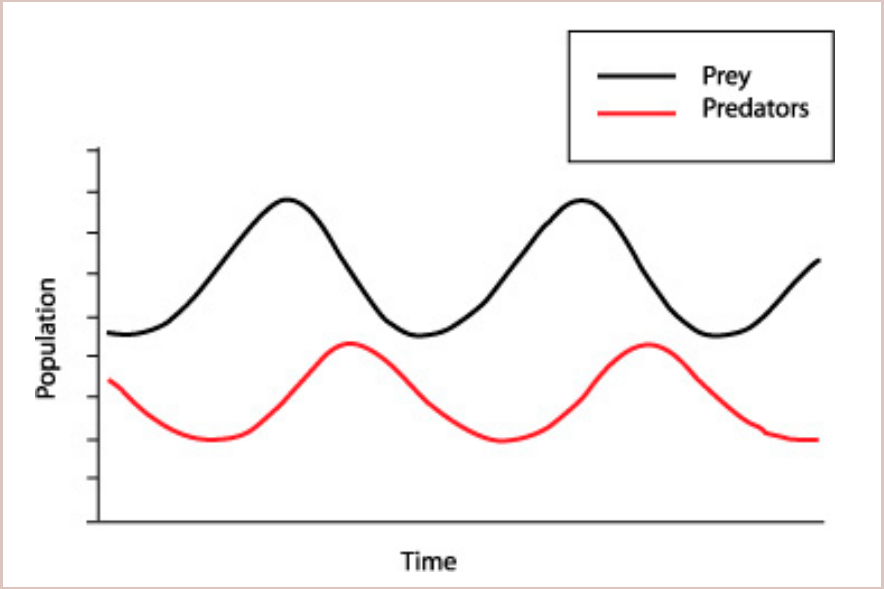
Objective of the Research Project

To clarify the role of wolf predation in the population dynamics of moose.

In a typical predator/prey population dynamic, the predators thrive when there are plentiful prey but, ultimately, outstrip their food supply and decline. As the predator population is now low the prey population will increase again. These dynamics continue in a cycle of growth and decline. However, this model of population dynamics assumes that 1) the prey population will grow exponentially when the predator is absent; 2) the predator population will starve in the absence of the prey population (as opposed to switching to another type of prey); 3) predators can consume infinite quantities of prey; and 4) there are no environmental variables (such as adverse weather). In reality, any number of factors and variables can create a distinctive and changing population dynamic. Within this basic model, there are two extreme views on the dynamics of wolves and their prey. One view, termed "bottom-up", holds that prey populations are ultimately regulated by factors other than predation, primarily food supply (or other environmental factors), and so predator numbers simply follow those of their prey. The other view, "top-down", is that predation regulates density of prey and so has a fundamental influence on community structure.



Predator Prey Population Dynamic Model (Lotka-Volterra model)

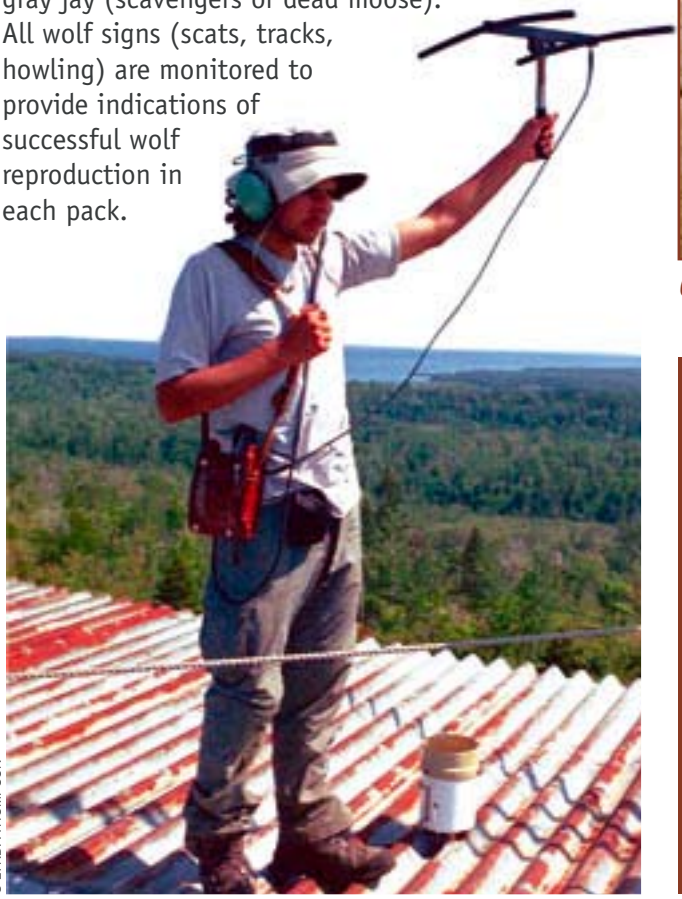
Methods

To attain the above objective, the following methods are used:

Essential long-term data from Isle Royale wolves and moose are gathered during field surveys in both summer and winter. Both animals are censused during aerial surveys from light aircraft in winter. By backtracking wolf packs, a complete record of their travel and kills is gathered for a 50-day period. All dead moose discovered during aerial surveys are subsequently ground-checked, either in winter or the following summer. The following collections are made from each dead moose:

- Lower jaws and incisors (to determine age)
- Skull (for brain volume, sensitive to early nutrition)
- Metatarsus (a leg bone also sensitive to early nutrition)
- Any pathology (usually dental infections or arthritis in hip joints and lower back)

The dead moose discovered each year provide the basis for long-term analysis of moose survival and population reconstruction. Ground crews in summer also gather other types of data. For example, wolf scats are inspected for contents, revealing wolf diet. Frequency of sightings of certain species provides an index of abundance for moose, snowshoe hare, and gray jay (scavengers of dead moose). All wolf signs (scats, tracks, howling) are monitored to provide indications of successful wolf reproduction in each pack.



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Listening to radio telemetry signals from focal animals

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Researchers locating moose remains and determining cause of death

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Collection of moose skulls found in Isle Royale

Results

Click here for sample datasets and statistical exercises

Click here for guidelines on how to do statistics

Applications of the Data – Conservation Management

The future of Isle Royale wolves continues to be uncertain, as the degree of genetic inbreeding increases with each passing generation (since the population is fairly small). While we have documented some congenital abnormalities (the occasional fused toes, asymmetrical vertebrae, and extra vertebrae), wolves continue to reproduce successfully in each pack, proving that our scientific understanding of inbreeding significance in wild populations is very incomplete. The possibility that Isle Royale's wolves might become extinct is very real. Wolves could be introduced from the mainland in an effort to improve genetic viability, but management philosophies of the National Park Service traditionally stress a "hands-off" approach for managing wildlife in national parks. This management philosophy will be carefully evaluated by scientists, park managers, and the public.

Findings from Isle Royale have influenced wolf conservation worldwide. Early data revealed the pronounced selectivity of wolf predation in culling prey, contributing to a heightening of public interest in the species. Airplane hunting, poisoning, and wolf bounties began to disappear in the 1960s throughout the remaining range of the wolf in North America. In the former Soviet Union, where most of the world's wolves exist, strong government controls on wolf populations were replaced by more tolerant approaches, and the resulting resurgence of wolves led to a substantial wolf recovery in Finland and the possibility of wolf re-colonisation for the remainder of Scandinavia. Where moose are very abundant, findings from Isle Royale are most pertinent. In the 1970s, moose declines at Isle Royale mirrored those occurring in many parts of North America. The typical management response elsewhere was to kill wolves, but at Isle Royale natural regulation achieved the same end, a major recovery of moose in the 1980s.

Wolves at Isle Royale have remained fearful of people, in spite of 50 years of complete protection. In other protected areas wolves have sometimes become dangerous campground nuisances. Management at Isle Royale aims to provide adequate remote areas for wolves to remain secluded during the critical pup-rearing period so that future generations of wolves keep a healthy distance from people.

Useful websites and sources of information

Project website (provides link to the book A View from the Wolf's Eye):
http://forestry.mtu.edu/research/isro/

Isle Royale National Park:
http://www.isle.royale.national-park.com/

National Park Service, Isle Royale:
http://www.nps.gov/isro/

Glossary

DDT – an insecticide that combats insect-borne diseases like malaria. In the 1970s DDT was banned in many countries following the discovery that it caused cancer and harmed bird reproduction by thinning egg shells. Widespread agricultural use of DDT in the UK caused a dramatic decrease of birds of prey.

Hardwood trees – The term 'hardwood' designates wood from broad-leaved as opposed to conifer trees. On average, hardwood is of higher density and hardness than softwood.

Boreal forests – Boreal forests, or taiga, represent the largest terrestrial biome. Occurring between 50 and 60 degrees north latitudes, boreal forests can be found in the broad belt of Eurasia and North America: two thirds in Siberia with the rest in Scandinavia, Alaska, and Canada. Seasons are divided into short, moist, and moderately warm summers and long, cold, and dry winters.

Glacial sediments – Glacial sediments are particulate matter that was transported by glaciers and is deposited as a layer of solid particles on the bed or bottom of a body of water.

Earthwatch is an international environmental organisation which promotes the understanding and action necessary for a sustainable environment.

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