Lemming outbreaks

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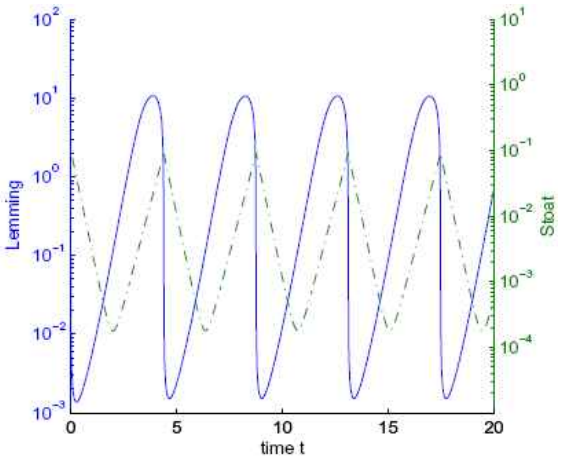
For many years the cause of mammalian population cycles has interested naturalists and scientists, especially the population cycles of lemmings has caught their attention. Lemmings are small rodents, usually found in or near the Arctic, in tundra biomes. They are subniveal animals, meaning they live in the zone under the snow.

In this essay I will be looking at the determinants for lemming outbreaks. Lemming outbreaks tend to fluctuate in cycles with a 3-4 year periodicity. As I come from Norway, and live only a few hours from the mountains I have personally experienced these lemming outbreaks several times. The most recent outbreak that I witnessed was the summer of 2010 in Sirdal (a mountainous region in the south-west of Norway).

There are many speculations to why the lemming outbreaks fluctuate in a 3-4 year period, but there are two main hypotheses which I discuss in this essay. Some scientists believe that the exponential outbreaks of lemming are caused by ecological factors, whereas others believe the fluctuations are caused by predator- prey interdependencies, predators such as stoats, arctic foxes, snowy owls and long-tailed skuas.

In Northeast Greenland all 4 predators (stoats, arctic foxes, snowy owls and long-tailed skuas) have a role in the lemming population cycles; however the stoats seem to be the most decisive factor. The stoat population cycles seem to be closely related to the lemming population cycles, as the stoat population hits minimal density during the winter just before the lemming population peaks. As a result the stoat population will peak the winter before the lemmings hit minimal density. Further evidence also shows that the lemming density is held low for at least two successive years by stoat predation. This explains why at the low point the lemming population density tends to become very small. When the lemming population reaches its lowest point, predators have difficulty finding prey; therefore they will have to find alternate prey or disappear from their normal feeding environment. In the absence of predators, the lemming population will again increase exponentially, and reach a maximum population following a 3-4 year minimum population. At the same time the stoat population suffers a mortality rate directly related to prey availability.

The following diagram shows the direct relationship between the stoat population and lemming population.



Lemming-stoat model.

"The roles of predator mutation delay and functional response in the periodicity of predator-prey cycles, Hao Wang et. Al, 2009"

Although predator-prey interactions are commonly argued to be the cause of the lemming population cycles, the role of the environment in such dynamics is often poorly understood in natural systems.

The following paragraphs discuss the large-scale lemming outbreaks in Finmark, Norway. The lemmings have a particular demographic evolution trait that has adapted them to the long and cold Artic-Alpine winters. It is thought that the steep lemming outbreaks are caused by breeding and population growth during the long winters (winters in the northern part of Norway (Finmark) last from November – April), the longer the winter, the longer the lemming breeding period.

The lemming population outbreaks increase with increased altitude and decreased temperatures. The lemming outbreaks are predicted to depend on low temperatures caused by snow cover properties. The subniveal space provides thermal insulation, access to food and protection from predators. The high summer lemming outbreaks are therefore thought to come from successful winter reproduction in the subniveal space. At higher altitudes the temperature is usually lower giving better snow conditions and thus a better environment for lemmings. Since the lemming population is highly sensitive to variation in climate, this can be the most likely reason for why the population decreases steeply and reaches a relatively low population density during mild winters.

Analyzing fluctuating populations is a controversial field, and there are several theories for this phenomenon. I have presented the two main accepted explanations; predator-prey relationships and local ecological factors. Even though I have presented these two findings as individual reasons for lemming outbreaks, many would agree that both factors together would be the natural reason for this phenomenon.

References:

- Krebs CJ (2010) Of lemmings and snow shoe hares: The ecology of northern Canada.
- Hao Wang, John D. Nagy, Olivier Gilg, Yang Kuang, The roles of maturation delay and functional response in the periodicity of predator-prey cycles, Mathematical Biosciences 221 (2009) 1–10.
- Rolf A. Ims, Nidel G. Yoccoz, Siw T. Killengreen, Determinants of lemming outbreaks, Department of Arctic and Marine Biology, University of Tromsø, N-9037 Tromsø, Norway, 2010.