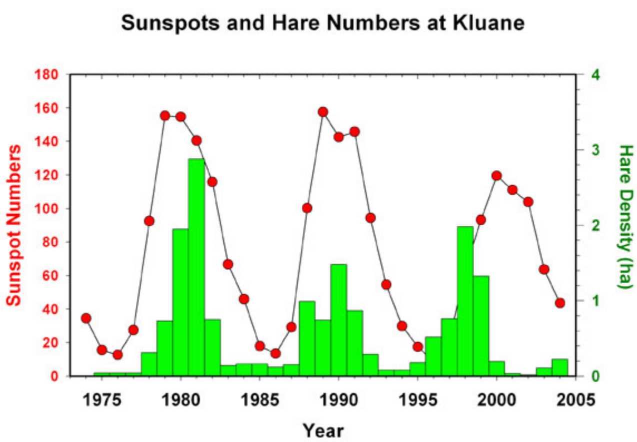
Snowshoe hares and porcupines track sunspot cycle in some areas, at some times

by Ed Berg



Snowshoe hare populations roughly track the sunspot cycle near Kluane Lake in the Yukon Territory. Unpublished data from Charles Krebs, University of British Columbia.

In my *Refuge Notebook* of October 3rd I described some of the causes of the boom-and-bust snowshoe hare cycle. During the increase phase of the hare cycle predator numbers also increase, through influx and improved reproductive success. Lynx, hawks, goshawks, and owls predate the adult hares, and red squirrels hammer the babies. Psychological stress cuts the mother hares' reproductive output in half, and the population crashes. The predators then go hungry, disperse, or switch to voles and other prey.

The beaten down hare populations can take many years to recover, especially if the supply of winter browse is low, either due to having been overeaten or if the forests are maturing. Kenai hares are only now starting to recover from the last low phase which began in 2001, possibly due to a shrinking hardwood browse supply as the forest matures in the big 1947 and 1969 burn areas.

Canadian researchers have examined the 10-year hare cycle in many areas all across the boreal forest of Canada. Hudson Bay Company records of hare pelts cover 1788 to 1903, and trapper questionnaires cover 1904 to 1935. A record of hare browse marks on white spruce in the Kluane (Yukon) area goes back to 1751. Two very striking facts emerged from the Canadian data.

First, the hare cycle is roughly synchronized all across Canada. The cycles generally peak at about the same time, in some areas a year or two sooner, in others a year or two later. This is a simply astounding fact for an animal that doesn't migrate. Hares are not like migratory ducks or even caribou. Why would hares in the Yukon track the same cycle as hares in New Brunswick? This is truly a major puzzle!

The second fact is even more astounding: the hare cycles all across Canada generally track the 11-year sunspot cycle. More precisely, they track the sunspot cycle during periods of high highs in the sunspot cycle. Like the ocean tides, sunspots have runs of high highs and runs of low highs. At present we appear to have come off a run of high highs (1947, 1957, 1968, 1979, and 1989) which averaged 80% more sunspots than the preceding run of low highs (1883, 1893, 1905, 1917, 1928, and 1937). The last high (2000) reached only 79% of the 1947-89 mean, which probably indicates that we are starting into a period of low highs and that the hare peaks will not coincide well with sunspot peaks.

The Hudson Bay Company fur records and trapper questionnaires show that the hare cycle generally peaked four years after the sunspot cycle peak. Since the 1969 sunspot high, however, the hare cycle has peaked sooner, within a year or two, or even before the sun spot high, for reasons unknown, as shown in the graph.

What could possibly make these hare cycles track the sunspot cycle, even roughly? The most likely hypothesis is weather, especially annual snow accumulation. Climatologists have long noted sunspot cycle correlations with atmospheric variables such as air temperature, air pressure, and precipitation. The correlations vary regionally, and can change from positive to negative, or be completely non-existent, in different parts of the world.

The instrumental weather record at Kluane, and indeed throughout most of boreal Canada, is not long enough to make a tight statistical case for tying together snowshoe hare cycles, snow accumulation, and sunspots. A recent study of porcupine cycles, however, was done in southern Quebec which has a long weather record (back to 1877). In this area adjoining the St. Lawrence River, winter precipitation tends to be greatest two to four years after sunspot cycle peaks.

Using tree-ring dating of porcupine gnawing scars on jack pine, graduate student Ilya Klvana at the University of Quebec developed a 130-year record of porcupine abundance. The porcupine scars (and hence porcupine numbers) were most abundant during sunspot lows (five to six) years after the sunspot peaks). During these years, winter precipitation and presumably snow accumulation was less, making it easier for porcupines to get around in the winter. Porcupines have short legs and don't do well in deep soft snow.

This study is the most convincing example that I have seen of a connection between sunspots and an animal population cycle. The strength of the connection here seems to be through winter precipitation which, in this area, correlates strongly with the sunspot cycle at the periodicities of both 11 and 22 years. Klvana found, however, that the sunspot connection with weather was rather local; weather records from several other stations within a couple hundred miles did not show the same 11- and 22-year cycles.

The chief difficulty with sunspot and weather correlations is finding a mechanism for how sunspots could affect weather, in any way at all. Sunspots and other forms of solar activity produce a very slight (0.1%) increase in the brightness of the sun, but it is very hard to see how this tiny bit of brightness could affect the weather. Clouds on the other hand can easily knock the sun's brightness down by 50% with an obvious dramatic effect on the weather.

Danish physicist Hans Svensmark has recently proposed a mechanism that may explain the solar activity and weather connection, both on the scale of the 11- and 22-year sunspot cycles, as well as on the scale of geologic time with the Earth's four alternating "icehouse" and "hothouse" cycles over the last 600 million years.

According to Svensmark's theory, clouds are produced by the steady stream of cosmic rays coming in from outer space. Cosmic rays are created by exploding super novae, and are most intense when the solar system is passing through the arms of our galaxy, which have lots of super novae. The normal or default condition for the Earth is to have a lot of incoming cosmic rays, and hence a lot of clouds, especially the lowest level clouds which have the greatest affect on weather.

When the sun is active, however, it ejects huge quantities of electrically charged particles out into the solar system. These moving charges produce a temporary magnetic field called the "heliosphere." The heliosphere partially shelters the Earth from cosmic rays, so there are fewer clouds and sunnier weather.

It would be easy to test this theory if we had good meteorological records of cloud cover. Unfortunately, weather stations generally don't record cloud cover, and it is only since 1980 that satellites have provided cloud cover data for the whole Earth. In his provocative book *The Chilling Stars: A New Theory of Climate Change* (2007) Svensmark argues that the correlation between low-level cloud cover and cosmic ray intensity is quite high. Cloud cover and cosmic rays were low, for example, during the 1989-1991 sunspot high, and again declined sharply through the 2000-2002 sunspot high.

Svensmark proposed his cosmic ray theory as an alternative to the greenhouse gas theory of climate change, but most climatologists would argue that in the last several decades human-caused CO_2 has become the driving force of climate change, and that solar activity has become a relatively minor player. This may well be the case, but Svensmark must be credited for proposing a testable mechanism that connects solar activity to weather and hence to animal population cycles, at least in the past if not in the future.

Even if Svensmark is right about cosmic rays producing clouds, it still remains to be shown that cloudy winters have heavier snowfall, and that this increased snowfall either helps or hinders the hares. We're making progress on this story, but there is a lot more to be learned!

Ed Berg has been the ecologist at the Kenai National Wildlife Refuge since 1993. Previous Refuge Previous Refuge Notebook columns can be viewed on the Web at http://www.fws.gov/refuge/kenai/.