Exercise 1a Correct answers

What Drives the 10-year Cycle of Snowshoe Hares?

C. J. Krebs, R. Boonstra, S. Boutin, and A.R.E. Sinclair. *BioScience*

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In 1831 the manager of a Hudson's Bay Company post in northern Ontario wrote to the head office in London. The local Ojibway Indians were starving, he reported because of a scarcity of "rabbits," and they were unable to trap for furs because they spent all their time fishing for food (Winterhalder 1980). These shortages of so-called rabbits, which apparently occurred approximately every 10 years, are regularly mentioned in Canadian historical documents from the 18th and 19th centuries. Those rabbits were in fact snowshoe hares (*Lepus americanus*), and their 10-year cycle is one of the most intriguing features of the ecology of the boreal forest.

able = adj

Ten-year cycles were first analyzed quantitatively when wildlife biologists began to plot the fur trading records of Hudson's Bay Company during the early 1900s. The Hudson's Bay Company, established in 1671, kept meticulous records of the numbers of furs traded from different posts spread across Canada. The most famous time series drawn together from those records was that of Canada lynx (Elton and Nicholson 1942; Figure 1). The lynx is a specialist predator of snowshoe hares, and the rise and fall in lynx numbers mirrors, with a slight time lag, the rise and fall of snowshoe hare populations across the boreal region.

The spectacular cycles of snowshoe hares and their predators have captured the attention of biologists as well as historians. These cycles are highlighted in virtually all ecology texts and are often cited as one of the few examples of Lotka-Volterra predator--prey equations, a simple model which shows never-ending oscillations in the numbers of predators and their prey. Cycles seem to violate the implicit assumption of many ecologists that there is a balance in nature, and anyone living in the boreal forest would be hard pressed to recognize a balance among the boom and bust in nature's economy. The challenge to biologists has

been to understand the mechanisms behind these cycles which has not been easy. One cycle lasts 10 years, and few PhD students or researchers wish to take 10 years to obtain n = 1. Fortunately, over the last 40 years ecologists working in Alberta, the Yukon Territory, and Alaska have put together an array of studies that have resolved most, but not all, of the enigmas behind these cycles (Keith 1990, Boutin et al. 1995).

To understand any fluctuating population, one must first know in detail the mechanisms of changes in births, deaths, and movements that are the proximate causes of the changes in numbers. Before we describe these details, we should note that these 10-year hare cycles tend to occur in synchrony across broad regions. Indeed, hares across most of Canada and Alaska reached a peak in 1997-1999 during the most recent cycle. We explain the reasons behind this synchrony below, but let us note here that movements of hares cannot explain these population changes via immigration or emigration. Movements on a local level might be important, but at the regional level all populations rise and fall in unison. Population changes must be driven by changes in births and deaths.