AP Environmental Science

Population Cycles

Directions: Complete the graph on graph paper and answer the questions, in complete sentences, on loose-leaf paper. Staple the graph to the back of the loose-leaf paper when you turn it in.

Part One- Hare and Lynx Populations

Populations are always changing, naturally shifting up and down; fluctuating. As an example, we will look closely at the relationship between the Canada lynx and its primary prey, the snowshoe hare. The snowshoe hare is a common species of rabbit found in North America, its range extending throughout Canada, Alaska, and into the northern United States. One distinctive quality is its 2 different coloration patterns – brown in the summer, and white in the winter to better camouflage with the snow. Its diet consists of grasses, berries, twigs, bark and leaves.

The Canada lynx is a wild cat that resembles a large house cat with a short tail and prominent tufts on its ears. It is very secretive and even experienced hunters rarely see one in the wild. Its range overlaps with the snowshoe hare, on which it almost exclusively preys upon.

For over 300 years, the Hudson Bay Company has been involved in the fur trade in Canada. Detailed company records list the number of snowshoe hare pelts and the number of lynx pelts collected by hunters and trappers every year since the late 1700's. The data shows a 200-year history of cyclical population booms and busts in the snowshoe hare population and a slightly delayed population boom and bust in the lynx population. Native Americans observed this cycle long before Europeans began trapping the hares and lynx for their pelts. Yet there are many competing theories to explain why the populations cycle in so dramatic a fashion. These theories include:

An emerging and increasingly more widely accepted theory explains: during peak years, the hares devour all the available vegetation and quite literally breed like rabbits until the environment can no longer support their blossoming population. As the hares become weakened by starvation, the lynx are better able to find and kill them, adding to their decline. The population does not reestablish itself immediately because it takes time for the vegetation to grow back.

The traditional theory is that the lynx population determines the hare population. As the number of hares increases, so does the numbers of lynx that survive to eat them. Soon, there are too many lynx for the number of hares and the lynx eat away their favorite food until they too suffer a population decline until the hare population can start growing again. Lastly, another theory provides evidence that at the peak population levels, the hares become so stressed by the increasing numbers of predators that they no longer reproduce at the same rate. Their population falls both as a result of the lowered reproductive success and the sheer number of lynx that are out to eat them.

Graphing Data

Using the graph paper provided, graph the number of hares trapped each year between 1900 and 1919. Then graph the number of lynx trapped each year between 1900 and 1919. Then graph the number of lynx trapped. (2 lines, connect the data points). Use different colors or data points to distinguish between the hare and lynx lines. Be sure to include: evenly spaced intervals, a title, labeled axes, and a key.

Year	Hares (x1000)	Lynx(x1000)
1900	30	4
1901	47	6
1902	70	10
1903	77	35
1904	36	59
1905	20	42
1906	18	19
1907	21	13
1908	22	8
1909	25	9
1910	27	7
1911	40	8
1912	57	12
1913	77	20
1914	52	46
1915	19	51
1916	11	30
1917	8	16
1918	15	10
1919	16	10
1920	18	8

Analysis Questions (Answer these on a separate piece of paper and staple it to your graphs.)

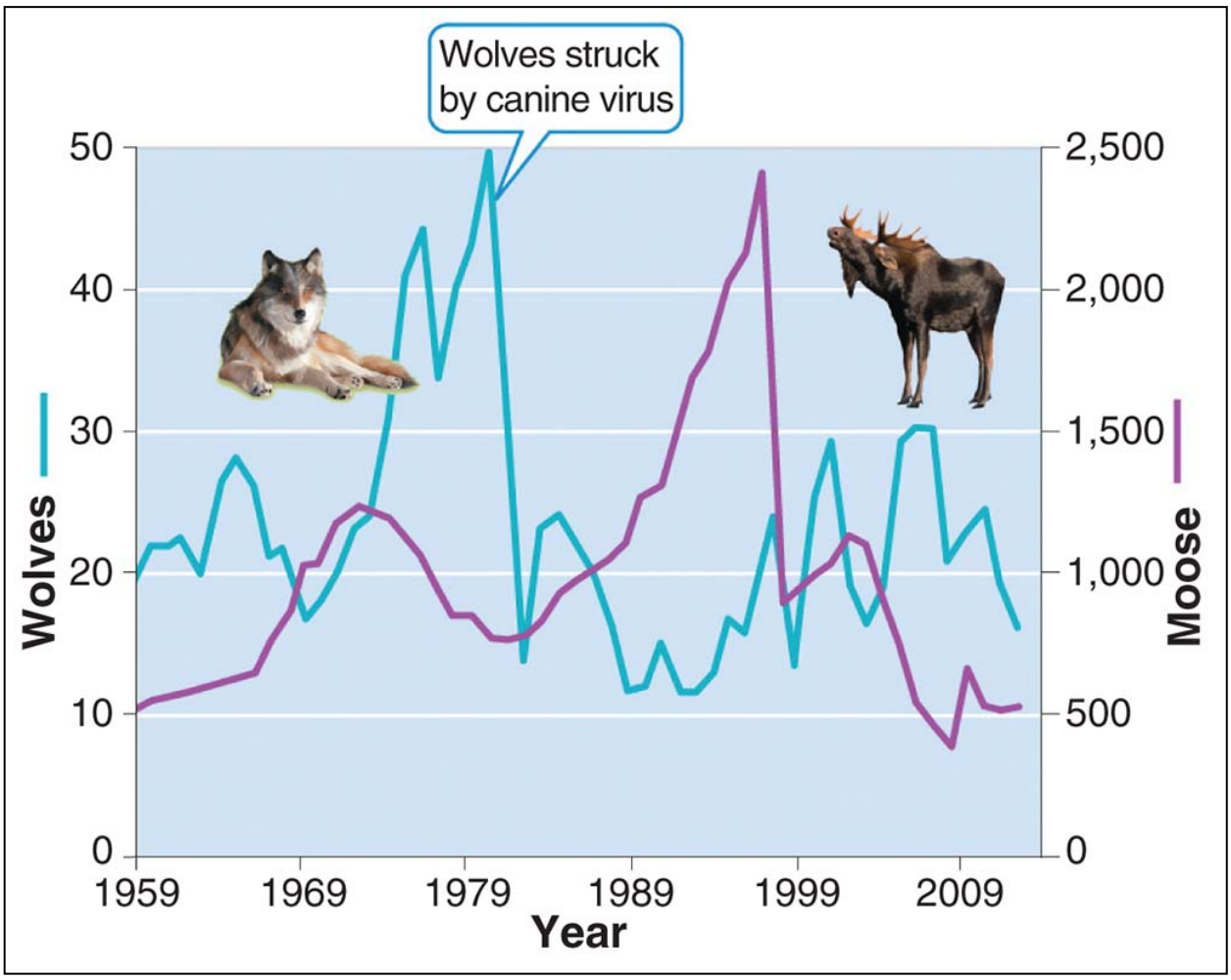
1. What patterns do you notice in the graph? (Describe the trends shown on the graph.)
2. As the number of hares *increases*, what do you think happens to the population of grass and seeds that the hares eat? **Why?**
3. As the number of hares *decreases*, what do you think happens to the population of grass and seeds that the hares eat? **Why?**
4. After a few years, the hare population begins to *increase*. **Why?** On your graph point out these periods with arrows and label them either "hardship or prosperity" and include short description of what is happening in your own words, next to the arrow.
5. Are there usually more lynx or more hares? **Why?** (Explain in terms of the trophic pyramid: primary, secondary, and tertiary consumers)**?**
6. When the hare population increases, what happens to the lynx population? **Why?** On your graph, point out these periods with arrows and label them "hardship or prosperity" and include short description of what is happening in your own words, next to the arrow.
7. Look at 1903 and 1904. Think about what is happening to the hares at this time. Is the presence of more lynx helping the hares or hurting them? **Why?**
8. On your graph point out these periods with arrows and label them "hardship or prosperity" and include short description of what is happening in your own words, next to the arrow.
9. Explain how these population cycles show both top-down population regulation and bottom-up population regulation.
10. Distinguish between the emerging, more widely accepted theory and the traditional model, in which the predator and prey populations regulate one another. Which theory do you believe best explains the relationship between the snowshoe hare and Canada lynx population cycles? Why?

Part Two- The Moose and Wolves of Isle Royale

Analyzing Data

Below is a data chart that shows the estimated population numbers of moose, wolves, and balsam fir trees on Isle Royale from 1960 to 2001.

Year	Moose	Wolves	Balsam Fir Growth Rates (estimates)
1960	637	22	Average
1965	773	28	Above average
1970	1522	18	Low
1975	1462	41	Low
1980	861	50	Average
1985	968	22	Very high
1990	1216	15	Average
1991	1313	12	High
1992	1590	12	Below Average
1993	1879	13	Average
1994	1770	17	Average
1995	2422	17	Below Average
1996	1163	22	Below Average
1997	500	24	Average
1998	699	14	Average
1999	750	25	Average
2000	850	29	Average
2001	900	19	Average



11. Between 1959 and 2014, in what year did the wolf population peak?
12. Between 1959 and 2014, in what years did the moose population peak?
13. As the moose population rises, what happens to the wolf population, prior to 1975?
14. What happened to the wolf population in the early 1980's?
15. Historical accounts report that, in 1915, a single pair of wolves (male and female) crossed an ice bridge to Isle Royale in northern Lake Superior and founded the population. How could this be a factor in the wolves' ongoing struggle to reestablish a viable population from the late 1980's to the present? How did the canine virus exacerbate the situation? (Include the following terms in your answer: *genetic diversity, genetic drift, bottleneck, founder effect etc.*)
16. Explain the relationship between the moose population numbers and balsam fir growth rates?
17. What happened to the moose population in the late 1990's? How can you account for this? Explain (use the term *carrying capacity* in your answer).
18. Consider that the wolf numbers continue to decline so that they eventually become extinct on the island. If this occurs, do you think wolves should be reintroduced into the Isle Royale ecosystem? Explain your reasoning.