NATURAL CONTROLS OF POPULATIONS

Adapted from Kim Foglia

I. Introduction: (Read this first)

The size of populations in a community are regulated in many ways. Some of the controls acting on populations are:

- the amount of food and water available to feed the population
- the amount of nesting sites available to support raising young
- the size of the predator population
- the amount of disease and parasites infecting the population

Because of these limitations a certain area can only support a certain size population of each type of organism. The population size of each creature that the environment can support is called the **carrying capacity** of that community. This limit represents how many of a certain species that can survive in that area. In this lab we will study two real life examples of **populations**, their **natural controls**, and the carrying capacity of their community.

II. THE KAIBAB DEER

In the early 1900s, the Kaibab plateau, north of the Grand Canyon in Arizona, supported a population of about 4000 deer on over 700,000 acres. Predators, such as coyotes, wolves, and pumas, helped to keep the deer population in check. It was estimated at the time that the plateau had a carrying capacity of about 30,000 deer, so that there seemed to be plenty of food for the population that existed.

Ranchers who moved into the area lost many sheep and cattle to the predators. Then on November 28th, 1906, President Theodore Roosevelt created the Grand Canyon National Game Preserve to protect the "finest deer herd in America." In an effort to save livestock and increase the deer population for tourists, the Forest Service tried to exterminate the predators of the deer. Between 1907 and 1939, 816 mountain lions, 20 wolves, 7388 coyotes and more than 500 bobcats were killed.

With the successful removal of many of the predators, the deer herd increased dramatically. But signs that the deer population was out of control began to appear as early as 1920 and the range (the deer habitat) was beginning to deteriorate rapidly. The food supply was being over- grazed by the high population of deer. Trees and grass were being damaged to the point they couldn't recover for next year's growing season. Soon there wasn't enough food to feed the growing population. By 1923, the deer were reported to be on the verge of starvation and the range conditions were described as "deplorable."

The Kaibab Deer Investigating Committee recommended that the number of deer be cut in half as quickly as possible. Hunting was allowed, and during the fall of 1924, 675 deer were killed by hunters. However, these deer represented only one-tenth the number of deer that had been born that spring. Over the next two winters, it is estimated that 60,000 deer starved to death.

Today, the Arizona Game Commission carefully manages the Kaibab area. Hunting permits are issued to keep the deer in balance with their range. Predators were re-introduced and are now protected to help keep herds in balance with food supplies. Tragic winter losses are now reduced by keeping the number of deer near the carrying capacity of the range.

1. In Table 1 is the historical data for the Kaibab deer population. Graph the data (curve of best fit) and then answer the summary questions.

Year	Population Size (thousands)	Comments
1900	4	predators maintain control of population
1905	5	predator removal program begins
1910	9	
1915	25	
1920	65	
1924	100	
1925	60	40,000 deer die of starvation and disease
1926	40	
1927	37	
1928	35	
1929	30	
1930	25	
1931	20	
1935	18	
1940	10	
1946	25	
1949	40	
1950	60	
1951	19	
1955	30	
1956	10	
1960	13	
1962	10	
1973	8	
1986	20	
1998	18	
2000	19	

Title: _____

III. THE MOOSE OF ISLE ROYALE

Isle Royale is a forested island in the middle of Lake Superior in Michigan. The island is about 50 miles long and about 8 miles wide and is a protected forest reserve. A herd of moose lives on the island, but there were no moose-predators, like wolves, living on the island with them. In 1970 the moose population of the island was about 2000 animals. Although the island had excellent vegetation for feeding, the food supply obviously had limits. Thus the forest management personnel feared that overgrazing might lead to mass starvation. Since the area was too remote for hunters, the wildlife service decided to bring in natural predators to control the moose population. It was hoped that natural predation would keep the moose population from becoming too large and also increase the moose quality (or health), as predators often eliminate the weaker members of the herd. In 1971, ten wolves were flown into the island.

The results of this program are shown in the following table. The Moose Population Change is the number of moose offspring born minus the number of moose that died during that year.

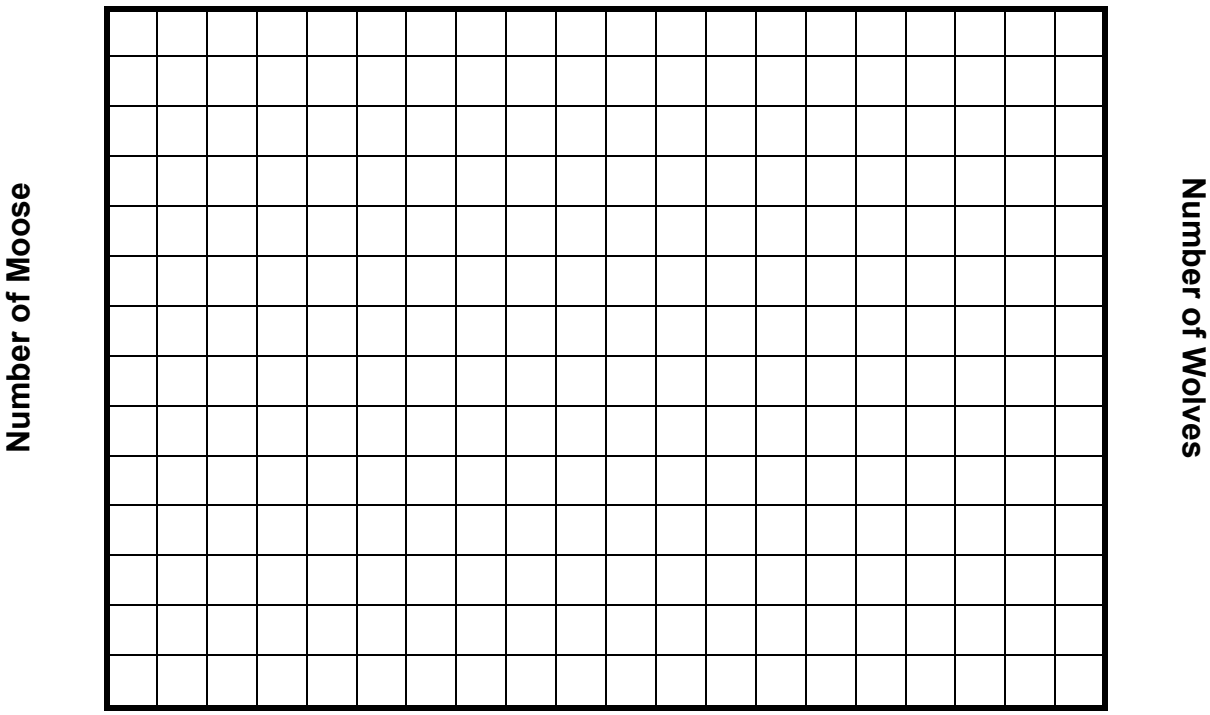
Table 2. Changes in population of moose and wolves on Isle Royale, Michigan 1971-1980						
Year	**Wolf Population**	**Moose Population**	**Moose Offspring**	**Died: Predation**	**Died: Starvation**	**Moose Population Change**
1971	10	2,000	800	400	100	**+300**
1972	12	2,300	920	480	240	
1973	16	2,500	1,000	640	500	
1974	22	2,360	944	880	180	
1975	28	2,244	996	1,120	26	
1976	24	2,094	836	960	2	
1977	21	1,968	788	840	0	
1978	18	1,916	766	720	0	
1979	19	1,952	780	760	0	
1980	19	1,972	790	760	0	

1. Calculate the population change for each year and enter it into the last column in Table 2. The population change is equal to the number of moose that were born minus the number of moose that dies during the year.

2. Graph both the moose and wolf populations on the graph below. Use the left axis for the moose population and the right axis for the wolf population. Plot each line using a **different** color.

Biology B / Sanderson Name_____ Per_____

Title _____



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SUMMARY QUESTIONS - please answer in complete sentences

THE KAIBAB DEER

1. During 1906 and 1907, what methods did the Forest Service use to protect the Kaibab deer?
   _____
   _____

2. Were these methods successful? Use the data from your graph to support your answer.
   _____
   _____
   _____

3. Why did the population of deer start to increase in 1905?
   _____
   _____

4. Why did the population of deer decline drastically in 1925, even though their predators were eliminated?
   _____
   _____

5. The deer eat Aspen trees, especially tender young saplings. What would you expect to find if you counted the Kaibab plateau Aspen tree population that would have started in the 1920's?
   _____
   _____

6. Based on these lessons, suggest what YOU would have done in the following years to manage deer herds.
   a. 1915: _____
   _____
   _____
   b. 1923: _____
   _____
   _____

7. What happens to populations as they reach or exceed the carrying capacity of their ecosystem?
   _____
   _____
   _____

8. It is a criticism of many population ecologists that the pattern of population increase and subsequent crash of the deer population would have occurred even if the bounty had not been placed on the predators. Do you agree or disagree with this statement. Explain your reasoning.
   _____
   _____
   _____

THE MOOSE OF ISLE ROYALE

1. Describe what happened to the moose and wolf populations between 1971 and 1980.

2. What do you think would have happened to the moose on the island had wolves NOT been introduced?

3. Most biology textbooks describe that predators and prey exist in a balance. This "balance of nature" hypothesis has been criticized by some scientists because it suggests a relationship between predators and prey that is good and necessary. Opponents of this hypothesis propose the following questions:
   a. Why is death by predators more natural or "right" than death by starvation?

   b. How does one determine when an ecosystem is in "balance"?

   c. Do predators really kill only the old and sick prey? What evidence is there for this statement?

   d. What is your opinion of the balance of nature hypothesis? Would the moose on the island be better off, worse off, or about the same without the wolves. Defend your position.

Notes to teacher:

The Kaibab deer story has been controversial. See:

Does the classic Kaibab deer story warrant confidence as a landscape-level demonstration of the importance of predation in regulating food webs, or is the value of the story limited to a historical account of misguided ecology? Mitchell and Freeman (1993) reviewed a wealth of primary sources apparently not examined by Caughley (1970) and concluded that a deer irruption and die-off had occurred, but that the drivers included both reductions in predation (including human hunting) and livestock competition, followed by overbrowsing, severe drought, and a change in the long-term fire regime. Young (2002) provided the most thorough synthesis of the story; his primary conclusion was that whatever the real dynamics of the deer population might have been, the Kaibab deer story is an excellent example of the interaction of science, conservation, politics, and management.
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