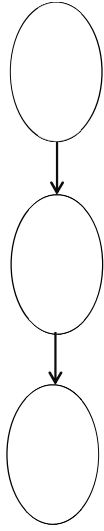


2. Using your bubble maps as a guide, create a food chain of the three organisms that are involved in a trophic cascade in Yellowstone National Park.



3. With the elimination of wolves from the ecosystem, how was the population of plants (producers) indirectly affected?

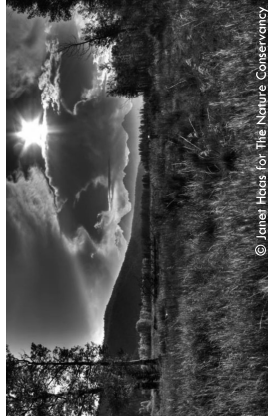
4. Predict what would happen to the wolf and elk populations if there was a drought that caused many of the plant species to dry up and/or die.

**Background:**

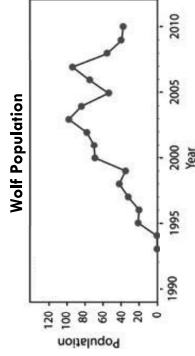
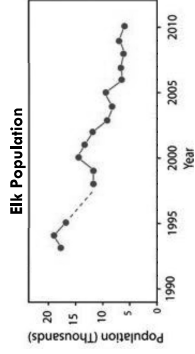
The graphs in the next section were taken from the 2012 study by William Ripple and Robert Beschta on trophic cascades in Yellowstone National Park. Aspen, willow, and cottonwoods are common foods for browsers like elk. Willows are also commonly eaten by beavers. If scientists want to measure trees and shrubs to look for the impact that browsers are having on their growth, they might measure the following things:

- Height
- Recruitment
- # of Rings

A measure of height can tell scientists how tall the trees are allowed to grow. If the mean tree height in one area is low compared to another area that could be an indication of heavy browsing by elk. **Recruitment** is the growth of seedlings or sprouts above the level of browsers. In other words, the trees are able to grow taller than the level at which elk and other browsers can eat them. **Tree rings** indicated the age of a tree – the more rings a tree has, the older it is. Increases in these three measurements can indicate an increase in the level of health of the woody plants. Decreases in these measurements could indicate a higher level of browsing pressure on the plants.



Use the graphs below to answer questions 5-8.



5. You have already identified that wolves are a predator of elk. Describe the general trend of the elk and wolf populations between 1993 and 2003.

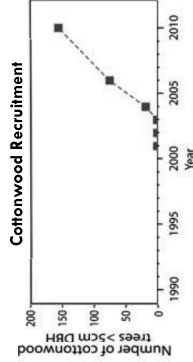
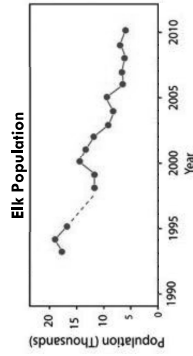
6. Based on the graphs, what year do you think wolves were introduced to Yellowstone? Explain why you think this.

7. Using information from the graphs, describe what happens to the wolf and elk populations in 2005. Indicate what you think might have happened during this year to cause this change.

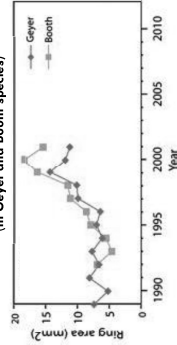
8. In 2010, the wolf population was lower than in previous years. Make a prediction about the elk population in the years beyond 2010 if the wolf population continues to stay at the 2010 level.

Examine the graphs below and use them to answer questions 9 and 10.

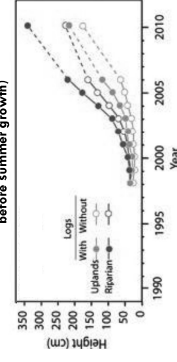
Note that the willow tree rings were measured in two different species of willow (Geyer and Booth). The aspen heights were measured in two different habitats — the uplands and riparian (stream side). During the aspen measurements, it was also noted if there were logs in the area since logs could impede browsers from getting to the trees, which would possibly decrease herbivory on those trees. In the cottonwood recruitment graph, the measurement “>5cm DBH” means that the scientists measured the number of trees that had reached a “diameter at breast height” greater than 5 cm.



Willow Tree Ring Area  
(in Geyer and Booth species)



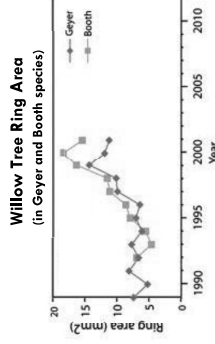
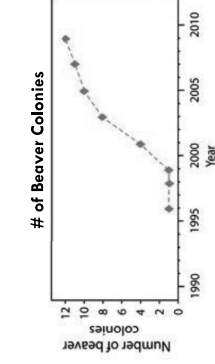
Mean Aspen Heights  
(early spring after winter browsing but before summer growth)



9. Use information from the graphs to describe the change in the size and growth of the trees and the population of elk during the data collection periods depicted in the graphs.

10. What can you infer about the relationship between elk population and tree growth?

Use the graphs below to answer questions 11-13.



11. Describe what happened to beaver colonies after 1995 (when wolves were reintroduced). Then describe the relationship between the number of beaver colonies and the willow tree ring area.

12. After about 1999, the willow tree ring area started to decrease again. What might account for this decrease?

13. Based on what you know about tree growth and elk population, use data from the graphs to make a statement about how the elk population impacts the beaver population. In your answer, address why there was a lag between the change in elk population and the change in beaver population.