**Grass, Rabbits, and Wolves – Oh My!**
**Understanding Food Chains and Ecosystem Interactions**
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## Engineering Challenge

Conduct your own modeling experiments to understand how population changes in an ecosystem based on available food.

## Model

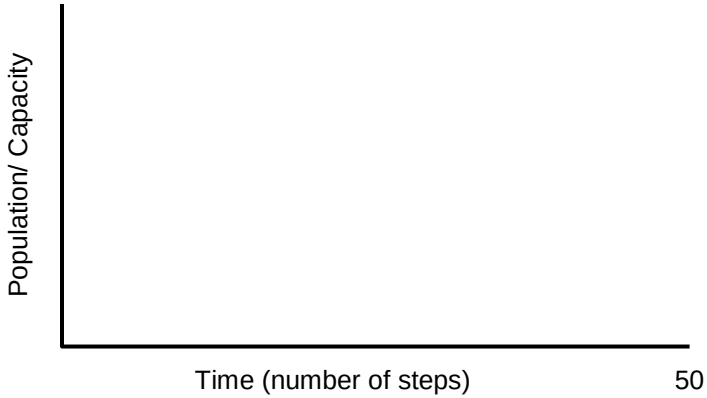
*Interactivate: Rabbits and Wolves*
http://www.shodor.org/interactivate/activities/RabbitsAndWolves/
This computer program includes three levels in an ecosystem's food chain: grass, rabbits, and wolves.

## Background

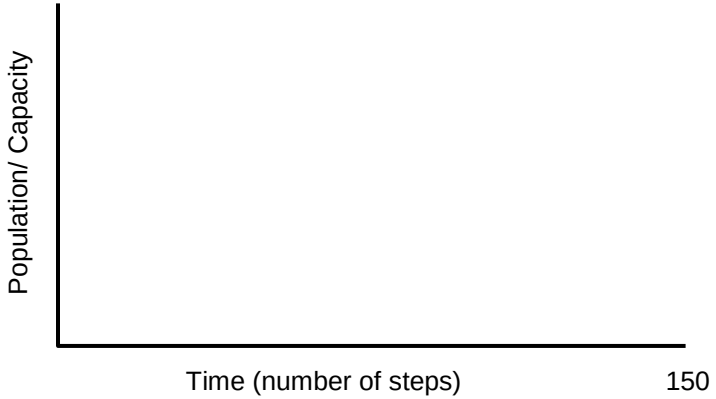
This model is a method to study the species dynamics of an ecosystem, the patterns of energy transfer, survival, and growth of species in the system. The model includes simplified plant and animal behaviors including food consumption, growth, reproduction, and death. Rabbits eat grass, and wolves at rabbits. Each individual animal has a store of fat that increases when the animal eats and decreases as it moves around and reproduces. Both rabbits and wolves reproduce when they reach a certain age in the model; for simplicity, the simulation ignores gender. Any individual with enough energy simply duplicates itself, passing on a fraction of its energy to its offspring. Death occurs when an individual's energy level drops too low to survive.

## Grass and Rabbits

In the model's Start-Up Parameters, set number of rabbits to 20 and wolves to 0. Run the model and click View Population Graph. Let the model run until the largest number on the horizontal axis is approximately 50. Pause the model. On the graph below, sketch the shapes of the lines on the population graph to show how the grass and rabbit populations changed over time. Use green pencil for grass, blue for rabbits.




Resume the model. Run the rabbits simulation until the number of time steps reaches about 150. Pause the model. On the graph below, sketch the shapes of the lines on the population graph again.

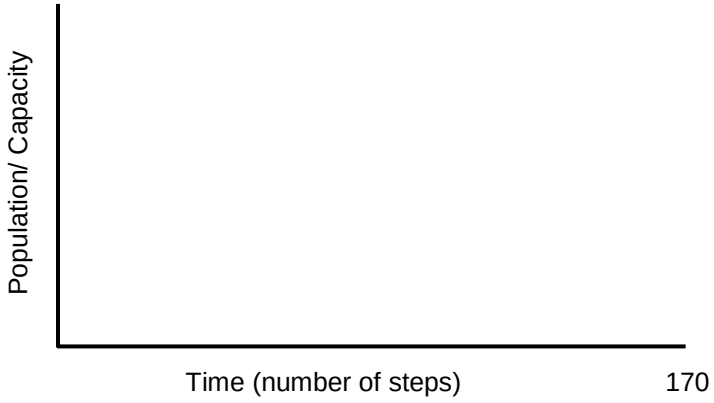


**Sample Grass-Rabbits Modeling Questions:**

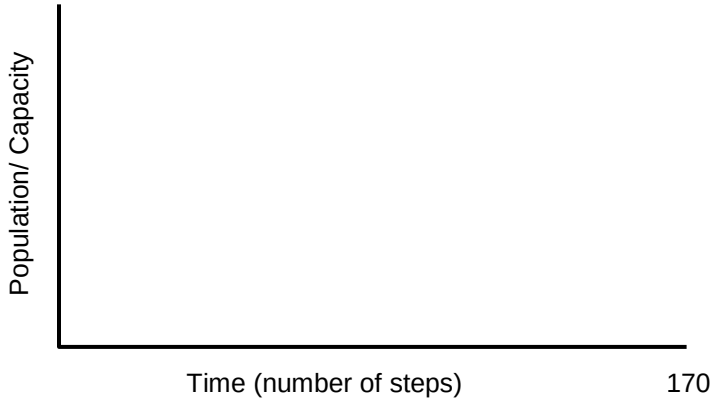
- What happens to grass as rabbit population increases in the 50-step model?
- Did the rabbit population increase, decrease, or both in the 150-step model? Why do you think that happened?
- Which was there more of: grass or rabbits? (Hint: which has the highest population/capacity on your graph) Why do you think that is?

**Grass, Rabbits, and Wolves**

Open the model's start-up parameters and set initial wolves to 5. Keep all other parameters the same. Restart the model and run it until the number of time steps on the population graph reaches about 170. Pause the model. On the graph below, sketch the shapes of the population lines graph for grass, rabbits, and wolves. Use red pencil for wolves.




Open the model's start-up parameters and set initial wolves to 3, keeping all other parameters the same. Restart the model and run it until the number of time steps on the population graph reaches about 170. Pause the model. On the graph below, sketch the shapes of the population lines for grass, rabbits, and wolves.




**Sample Grass-Rabbits-Wolves Modeling Questions:**

- Explain the effect that adding more wolves had on the ecosystem. Did the rabbit population grow differently in the second model with more wolves? How? Why?
- Why don't grass, rabbit, or wolf populations increase and decrease at the same time?
- Both of these grass-rabbits-wolves models ended with no animals left. What kind of animal was the last surviving animal in the first model? The second model? What caused that to happen?

**Extra Exploration**

Design a model that with the best combination of initial rabbits and wolves to keep any species population from reaching zero and disrupting the food chain. You may need to add both rabbits and wolves to design a sustainable ecosystem.