Lab 9. Population Growth: How Do Changes in the Amount and Nature of the Plant Life Available in an Ecosystem Influence Herbivore Population Growth Over Time?

Introduction

A population is a group of individuals that belong to the same species and live in the same region at the same time (the figure to the right shows an example of a rabbit population). Populations have unique attributes such as growth rate, age structure, sex ratio, birth rate, and death rate. The growth rate of population describes how the size of the population changes over a set time period. The age structure refers to the distribution of individuals based on age. The sex ratio is the proportion of males and females in the population. The birth rate is the frequency of births within a population over a set time period. The death rate is the frequency of deaths over a set time period. The characteristics of a population can change over time because of births, deaths, and the dispersal of individuals from one population to another.

The population of rabbits at the Myxomatosis Trial Enclosure on Wardang Island, Australia

Populations of animals interact with each other and their environment in a variety of ways. One of the primary ways a population interacts with the environment and with other populations is through feeding. Animals can eat plants, other animals, or both. Animals that feed on plants are called herbivores. The plants that herbivores eat, however, are not all the same. Some plants grow quickly and are plentiful, which makes them easy to find, whereas others grow slowly and are sparse. Some plants are drought resistant, whereas others do not grow well unless there is plenty of water available. Finally, and perhaps most important, some plants are loaded with nutrients (vitamins and minerals) but low in calories, some are high in calories but have fewer nutrients, and some are high in both calories and nutrients.

There are a number of factors that might influence the size of a herbivore population in an ecosystem. These factors include, but are not limited to, the amount of food available to eat, the type of plants available to eat, and the nutritional value of these plants. In this investigation, you will explore how the size of a herbivore population changes over time in response to changes in the nature and type of plants available for it to eat.

Your Task

Explain how the size of a population of rabbits (herbivores) changes over time in response to changes in the amounts and characteristics of the plants available in an ecosystem.

The guiding question of this investigation is, **How do changes in the amount and nature of the plant life available in an ecosystem influence herbivore population growth over time?**

Materials

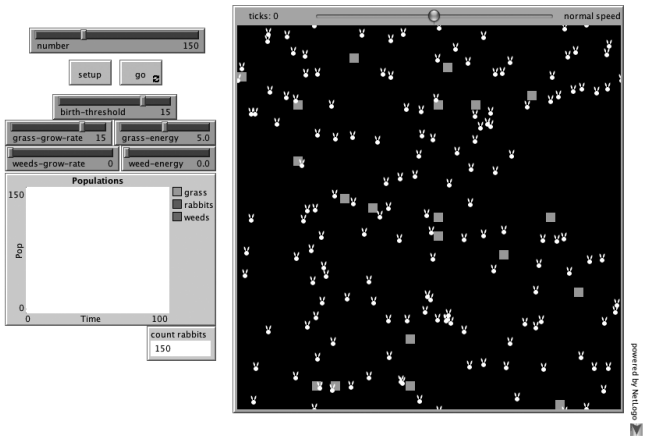
You will use an online simulation called *Rabbits Grass Weeds* to conduct your investigation. You can access the simulation by going to the following website: *http://ccl.northwestern.edu/netlogo/models/RabbitsGrassWeeds*.

Safety Precautions

1. Use caution when working with electrical equipment. Keep away from water sources in that they can cause shorts, fires, and shock hazards. Use only GFI-protected circuits.
2. Wash hands with soap and water after completing this lab.
3. Follow all normal lab safety rules.

Getting Started

A screen shot from the *Rabbits Grass Weeds* simulation



The *Rabbits Grass Weeds* simulation allows you to explore a simple ecosystem made up of rabbits, grass, and weeds (see the figure to the right). The rabbits wander around randomly, and the grass and weeds grow randomly. When a rabbit bumps into some grass or weeds, it eats the grass and gains energy. If the rabbit gains enough energy, it reproduces. If it doesn't gain enough energy, it dies. The grass and weeds can be adjusted to grow at different rates and give the rabbits differing amounts of energy.

This simulation is easy to use. Click the SETUP button to set up the ecosystem with rabbits and grass, then click the GO button to start the simulation. It is also easy to adjust the characteristics of the simulated ecosystem. The NUMBER slider controls the initial number of rabbits (0–500). The BIRTH-THRESHOLD slider sets the energy level at which the rabbits reproduce (0–20). Rabbits can reproduce at any time when the threshold is set at zero. When the threshold is set at 20, a rabbit must eat enough food to have an energy level of 20 before it can reproduce. The GRASS-GROWTH-RATE slider controls the rate at which the grass grows (0–20). When the grass growth rate is set to 0, no grass will grow in the simulated ecosystem. The WEEDS-GROWTH-RATE slider controls the rate at which the weeds grow (0–20). The GRASS-ENERGY slider and the WEED-ENERGY slider allow you to set the amount of energy a rabbit can get from a plant when it is eaten (0–10).

To answer the guiding question, you must determine what type of data you will need to collect, how you will collect it, and how you will analyze it. To determine *what type of data you will need to collect,* think about the following questions:

- What will serve as your independent variables (presence of grass, presence of weeds, grass growth rate, amount of energy obtained from grass, weed growth rate, and so on)?
- What will serve as your dependent variable (population size of rabbits, population size of weeds, population size of grass, and so on)?
- What type of measurements or observations will you need to record during your investigation?

To determine *how you will collect your data,* think about the following questions:

- What will serve as a control (or comparison) condition?
- What types of treatment conditions will you need to set up and how will you do it?
- How long will you need to run each simulation?
- How often will you collect data and when will you do it?
- How will you make sure that your data are of high quality (i.e., how will you reduce measurement error)?
- How will you keep track of the data you collect and how will you organize the data?

To determine *how you will analyze your data,* think about the following questions:

- How will you determine if there is a difference between the treatment conditions and the control condition?
- What type of calculations will you need to make?
- What type of graph could you create to help make sense of your data?

Investigation Proposal Required? ☐ Yes ☐ No

Connections to Crosscutting Concepts and to the Nature of Science and the Nature of Scientific Inquiry

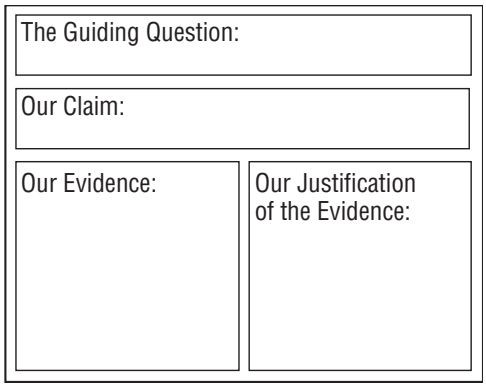
As you work through your investigation, be sure to think about

- the importance of identifying patterns,
- how models are used to study natural phenomena,
- how living things or systems go through periods of stability and change,
- the different types of investigations that can be designed and carried out by scientists, and
- the difference between data and evidence in science.

Argumentation Session

Once your group has finished collecting and analyzing your data, prepare a whiteboard that you can use to share your initial argument. Your whiteboard should include all the information shown in the figure to the right.

Argument presentation on a whiteboard



To share your argument with others, we will be using a round-robin format. This means that one member of your group will stay at your lab station to share your group's argument while the other members of your group go to the other lab stations one at a time to listen to and critique the arguments developed by your classmates.

The goal of the argumentation session is not to convince others that your argument is the best one; rather, the goal is to identify errors or instances of faulty reasoning in the arguments so these mistakes can be fixed. You will therefore need to evaluate the content of the claim, the quality of the evidence used to support the claim, and the strength of the justification of the evidence included in each argument that you see. In order to critique an argument, you will need more information than what is included on the whiteboard. You might, therefore, need to ask the presenter one or more follow-up questions, such as:

- How did you use the simulation to collect your data?
- What did you do to analyze your data? Why did you decide to do it that way? Did you check your calculations?
- Is that the only way to interpret the results of your analysis? How do you know that your interpretation of your analysis is appropriate?
- Why did you decide to present your evidence in that manner?
- What other claims did your group discuss before you decided on that one? Why did your group abandon those alternative ideas?
- How confident are you that your claim is valid? What could you do to increase your confidence?

Once the argumentation session is complete, you will have a chance to meet with your group and revise your original argument. Your group might need to gather more data or design a way to test one or more alternative claims as part of this process. Remember, your goal at this stage of the investigation is to develop the most valid or acceptable answer to the research question!

Report

Once you have completed your research, you will need to prepare an investigation report that consists of three sections that provide answers to the following questions:

1. What question were you trying to answer and why?
2. What did you do during your investigation and why did you conduct your investigation in this way?
3. What is your argument?

Your report should answer these questions in two pages or less. This report must be typed, and any diagrams, figures, or tables should be embedded into the document. Be sure to write in a persuasive style; you are trying to convince others that your claim is acceptable or valid!