Lesson 3: Why Are There Not More Elephants?: Population Dynamics

Overview

This lesson explores how animal populations can grow and decline over time through use of a simulation (Figure 1). This very simple model allows students to impact the birth and death rates based on input for different animals. The simulation displays what happens to the different populations over time. Students can compare the resulting trends for different animals and consider why those trends occur. Students may also research additional animal data in order to create their own runs.

Learning Goals:

- Compare animal population trends through use of a simulation.
- Represent and interpret data on a line graph.
- Describe what impacts an animal population’s growth and decline over time.
- Explain why animals are limited in their growth by a carrying capacity.

Materials:

- One computer for every 2-3 students
- Simulation online at http://www.clexchange.org/curriculum/complexsystems/oscillation/Oscillation_PopulationB.asp
- Handouts (Pages 5-10)

Curricular Connections:

- Science: Populations, ecosystems, scientific method
- Math: Representing and interpreting data*
- Reading: Describing connections among ideas*

* Common Core Standards

Key system dynamics concepts and insights:

- Nature contains limits (carrying capacity) so that populations do not grow forever.
- Populations may grow or decline to carrying capacity.
- Various factors affect how a population grows.

Student Challenge

Compare animal populations in order to determine which population is most successful over time. Be able to explain why.
Lesson Details

Preparation:
1. Create groups of two to three students each.
2. Copy included handouts for each student or student group. Note: Make multiple copies of page 6, based on the number of simulation runs you would like students to complete. The simulation includes settings for five different animals.
3. Check computers to make sure you can access the simulation.

Session 1:
1. Discuss the following in preparation for using the simulation:
   1. Introduce any vocabulary as needed, including population, lifespan, area, productive female, animal density, birth rate, death rate, and litter size.
   2. Brainstorm a list of animal populations.
   3. How are animal populations similar and different in terms of their reproductive patterns? While answering the question, ask them to consider average lifespan, litter size, productive females and how these elements interact to help a particular species survive over time. For example, a mouse has many litters and many babies per litter which offsets its short lifespan. An elephant lives a very long time but has very few offspring in comparison to the mouse.
   4. How much space do animals have to live? In the simulation, each of the animals (except the elephant) has 1000 units of land. In reality, different animal populations might have more or less land. For example, a mouse might live on the vacant lot next to a neighborhood or on thousands of acres within a forest.
Lesson Details

2. Using the handout (page 5), have students open the simulation, read the introduction, and view the parts of the simulation on the “Introduction” screen (Figure 2).

3. Students can use the handout (page 6) to record data as they explore different populations and compare the resulting trends (Figures 3 and 4). Note that students will need five or more copies of the handout page, so they can complete multiple simulation runs, making comparisons for different animals.

4. Additional Options:
   1. Students can make minor adjustments to the settings for the animals within the simulation, asking questions such as, “What if there were fewer than 1000 animals to begin?” or “What if the animals had more space or less space to live?” Through exploring these questions, they can compare additional trends.
   2. Do research on other animals and run the simulation with the new data. Note that not all animals will fit within the confines of the simulation parameters. For example, students would not be able to enter data for an amoeba, since the simulation parameters are not designed to handle the required settings. In addition, if the sliders are pushed to their extremes, the graphs may produce erratic behavior.

5. After they have completed the desired number of simulation runs, students can begin working on the comparison handout (page 7), representing all the animals on the one graph.

Session 2:

1. If needed, have students complete the simulation within their small groups.

2. After running the simulation multiple times, students can continue to the “Debrief” and “Next Steps” sections (Figures 5 and 6).

Bringing the Lesson Home:

- Have students explore the “Debrief” section of the simulation within their small group or as a class.
- Consider why the animal population did not grow forever.
- Discuss carrying capacity and how that impacts population growth.

Assessment Ideas:

- Have students use one or more assessments to summarize their learning:
  - Assessment 1 (page 8) to describe the parts of the model and the loops embedded within the simulation.
  - Assessment 2 (page 9) to have students add components to the map to represent an animal they researched.
  - Assessment 3 (page 10) to make connections between the patterns seen in the simulation and other life systems.
3. Debrief the simulation experience using ideas for bringing the lesson home and assessment. For example, after researching an endangered species, collecting information about what impacts both births and deaths, students can complete Assessment 2 (page 9). See below for an example of a completed map (Figure 7). Note how the student added additional connections (in blue) about their particular animal. They can then “tell the story” of the map, describing the additional elements they included. You might also ask students to include their recommendations for new policies for protecting the species and preventing extinction. The student example shows how a captive breeding program could add to the births.
Animal Populations Simulation Handout

Click the Start button.
Read the Introduction screen, View the See Parts section, and then answer the following.

What is a carrying capacity?

What affects the number of animals in a population?

Click Decisions.
Read through the information on each of the slidebars by clicking the question marks (?). After reading each one, write a definition in your own words below.

Animals:

Litters per female per year:

Surviving young per litter:

Productive females in population:

Area:

Average lifespan:

Click on Animal Settings and look at the settings for each of the animals. Which one do you predict will have the largest population after 20 years? Explain why.

Now choose an animal population you would like to explore. Make sure to record all of the information on the simulation record sheet.
Lesson 3 - Handout

Simulation Record Sheet for Run #: ________ Animal: ________________________

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial animals</td>
<td></td>
</tr>
<tr>
<td>Productive females in population</td>
<td></td>
</tr>
<tr>
<td>Litters per female per year</td>
<td></td>
</tr>
<tr>
<td>Surviving young per litter</td>
<td></td>
</tr>
<tr>
<td>Average lifespan</td>
<td></td>
</tr>
<tr>
<td>Area</td>
<td></td>
</tr>
</tbody>
</table>

What do you think will happen to the population?

What actually happened? Record the final Population #: ______________________

Draw, title and label the y-axis on the graph.

Explain why you think the population changed as it did.
Animal Comparisons:

Create a key for each of the animals and draw the trends on the graph below.

How are the trends similar and different?

Using vocabulary from the simulation, explain why the populations are similar.

Which population grew most quickly? Why?
Assessment 1:
Look at the map below. Describe the parts and how they impacted the population over time.

These are two loops within the simulation. Tell the story of each loop in your own words.
Assessment 2:

Add at least four elements below for an animal that you researched. To add an element, create a circle and add an arrow to show what the element affects. Possible elements could include hunting, poaching, poison within the environment, and conservation efforts. Include an element only if you found evidence to support your connection.

Explain the connections you added.

---

---

---

---
Assessment 3:

Look at the graph, which is similar to many of the animal populations that grew and reached a carrying capacity. What other situations in the world work in a similar manner?

Make a quick list of as many examples as you can.

Choose one of your ideas and tell the story of the graph above using the example you identified.
Acknowledgements:
Lesson 3 - Level B
Why Are There Not More Elephants?: Population Dynamics
©2012 Creative Learning Exchange
www.clexchange.org

This model with accompanying lesson is one in a series that explore the characteristics of complex systems.

Model created with contributions from
Jen Andersen
Anne LaVigne
Michael Radzicki
George Richardson
Lees Stuntz
with support from Jay Forrester and the Creative Learning Exchange.

Image Credits:
Mouse - NIH.gov, Public Domain.
Rabbit - Anne LaVigne
Meadow - Wikimedia Commons, Ace2209, Public Domain.
Elephant with baby - Wikimedia Commons, John Storr, Public Domain.
Hockey players, by Robert Merkel, Wikimedia Commons, Public Domain.
French Horn, Websters Dictionary, 1911, Wikimedia Commons, Public Domain.
Spring - photo by LaVigne.