Population Dynamics Lab Activity Instructions

THIS VERSION IS FOR STUDENTS HAVING TECHNICAL ISSUES WITH THE LAB. MUST COMPLETE: HYPOTHESIS AND ANALYSIS QUESTIONS

Title: Population Dynamics

Objectives: After doing this lab, you should be able to
- Analyze data sets and frequency graphs to determine the carrying capacity of two marine species.
- Explain how predation, birth, and death rates impact population size and carrying capacity of marine populations.
- Describe how biotic and abiotic factors influence the carrying capacity of marine populations.

Hypotheses:
Note: Read the procedures section before completing your hypotheses.

Part 1:
1. If the population of whales increases and the population of seals decrease, the carrying capacity for whales will _______decrease_______ and the carrying capacity for seals will _______increase_______.
2. If the population of whales and seals are equal, the carrying capacity for whales will _______increase_______ and the carrying capacity for seals will _______decrease_______.

Part 2:
1. If the growth rate of seals increases, the carrying capacity for whales will _______increase_______ and the carrying capacity for seals will _______decrease_______.
2. If the death rate of whales increases, the carrying capacity for whales will _______increase_______ and the carrying capacity for seals will _______increase_______.

Part 3:
1. If the capture efficiency of whales increases, the carrying capacity for whales will _______increase_______ and the carrying capacity for seals will _______decrease_______.

Materials:
- Population Dynamics Lab Form

Procedures:
Note: Read all the instructions for this lab before you begin working! Pre-reading the procedure will give you a mental picture of what you will be doing and a better understanding of the process.

**Part 1: Predation and Carrying Capacity**

1. Go to the population dynamics lab at [http://www.uccp.org/courses/APEnvironmentalScience/course%20files/assignments/applet/esol_popdyn.htm](http://www.uccp.org/courses/APEnvironmentalScience/course%20files/assignments/applet/esol_popdyn.htm)

   - IF THIS LINK IS UNAVAILABLE OR DOES NOT WORK, SEE THE TABLE OF DATA INSERTED BELOW THE PROCEDURES TO COMPLETE THE LAB.

2. Before you begin conducting your population dynamics lab, review the following descriptions for each lab variable.

   - **Prey Initial Size**: The total number of prey at the beginning of the simulation run. (Assume that the seals have an unlimited amount of food.)
   - **Prey Growth Rate**: The inherent capacity of the prey population size to increase (related to birthrate). The larger the growth rate the faster the prey population will increase.
   - **Predator Initial Size**: The total number of predators at the beginning of the simulation runs.
   - **Predator Death Rate**: Instantaneous death rate of the predators when no prey are present. A larger death rate means predators will die out quicker in absence of prey.
   - **Capture Efficiency**: This number represents the ability of the predator to capture the prey over some time interval. A larger value for this parameter means that the predators have a better chance of capturing prey. In contrast, a smaller value means the prey is better at eluding the predator.

3. For this first trial, your birth and death rates should be the same. You will test the effects of birth and death rates in part 2 of this lab. For now, set both growth and death rate boxes to 0.5.

4. Set the population size of prey (the seals) to 100 and the predator population (the whales) size to 50. Set the capture efficiency at 0.006. Record your population size for each population in the data chart labeled **Table 1: Predation and Carrying Capacity**.

5. Press the start button and observe the graph for the next 60 seconds. Pay careful attention to the time that passes between rise and fall of the curves. Press the stop button when you reach the 60 second mark on the graph. The plotted pink line represents the seals’ population and the plotted black line represents the whales’ population. The carrying capacity of each population occurs at the peaks of each line. Record the carrying capacity of each population in the data chart labeled **Table 1: Predation and Carrying Capacity**.

6. For trial 2, press the reset button. Change the seal population to 50 and the whale population to 100. Record this for trial 2 on the **Table 1: Predation and Carrying Capacity**. Before starting trial two, predict the results of the new simulation. Place your prediction in the hypothesis section of the lab report. Your hypothesis should be written as follows:

   If the population of whales increases and the population of seals decrease, the carrying capacity for whales will ______________ and the carrying capacity for seals will _______________.

7. Press the start button and let the simulation run to 60 seconds. Record the carrying capacities for both populations on the **Table 1: Predation and Carrying Capacity**.

8. For trial 3, press the reset button. Change the population of seals to 100 and the population of whales to 100. Record this for trial 3 on the **Table 1: Predation and Carrying Capacity**. Before
starting the third trial, predict the results of the new simulation. Place your prediction in the hypothesis section of the lab report. Your hypothesis should be written as follows:
If the population of whales and seals are equal, the carrying capacity for whales will ______________ and the carrying capacity for seals will ________________.

9. Press the start button and let the simulation run to 60 seconds. Record the carrying capacities for both populations on the Table 1: Predation and Carrying Capacity.

**Part 2: Birth and Death Rates**
1. Press the reset button. Leave the populations at 100 seals and 100 whales but change the growth rate (birth rate) to 0.8 for the seals. The death rate should stay at 0.5 and the capture efficiency should stay at 0.006. Record the growth and death rate for trial one on the Table 2: Birth and Death Rate. Before starting the first trial, predict the results of the new simulation. Place your prediction in the hypothesis section of the lab report. Your hypothesis should be written as follows:
If the growth rate of seals increases, the carrying capacity for whales will ______________ and the carrying capacity for seals will ________________.
2. Press the start button and observe the graph for the next 60 seconds. Press the stop button when you reach the 60 second mark on the graph. Record the carrying capacity of each population in the data chart labeled Table 2: Birth and Death Rate.
3. For trial 2, press the reset button. Change the growth rate of prey to 0.5 and the death rate of predators to 0.8. Record this for trial 2 on the Table 2: Birth and Death Rate. Before starting the second trial, predict the results of the new trial. Place your prediction in the hypothesis section of the lab report. Your hypothesis should be written as follows:
If the death rate of whales increases, the carrying capacity for whales will ______________ and the carrying capacity for seals will ________________.
4. Press the start button and let the simulation run to 60 seconds. Record the carrying capacities for both populations on the Table 2: Birth and Death Rate.

**Part 3: Capture Efficiency**
1. In our first scenario, overfishing of near-by oceans has depleted the fish population in the arctic. Since fish are the main food source for seals, they venture further away from their protected habitats in search of food. This makes them easier prey for the whales, increasing their capture efficiency to 0.008.
Press the reset button. Leave the populations at 100 seals and 100 whales and change the growth rate and death rate back to 0.5. Change the capture efficiency of 0.008 for trial one and record it on the Table 3: Capture Efficiency.
2. Press the start button and observe the graph for the next 60 seconds. Press the stop button when you reach the 60 second mark on the graph. Record the carrying capacity of each population in the data chart labeled Table 3: Capture Efficiency.
3. In our second scenario, the arctic whale population has contracted a viral pox infection during their migration to the warmer waters of the Pacific Northwest. In their weakened condition, the whales normal hunting cuts in half, reducing their capture efficiency to 0.004.
Press the reset button. Leave the populations at 100 seals and 100 whales and change the growth rate and death rate back to 0.5. Change the capture efficiency of 0.004 for trial two and record it on the Table 3: Capture Efficiency. Before starting the second trial, predict the results of the new trial. Place your prediction in the hypothesis section of the lab report. Your hypothesis should be written as follows:
If the capture efficiency of whales increases, the carrying capacity for whales will _______________ and the carrying capacity for seals will _______________.

4. Press the start button and observe the graph for the next 60 seconds. Press the stop button when you reach the 60 second mark on the graph. Record the carrying capacity of each population in the data chart labeled *Table 3: Capture Efficiency* for trial 2.

**Data and Observations:**

**Table 1: Predation and Carrying Capacity (4pts)**

<table>
<thead>
<tr>
<th></th>
<th>Seal population</th>
<th>Whale population</th>
<th>Seal carrying capacity</th>
<th>Whale carrying capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial 1</td>
<td>100</td>
<td>50</td>
<td>175</td>
<td>250</td>
</tr>
<tr>
<td>Trial 2</td>
<td>50</td>
<td>100</td>
<td>130</td>
<td>200</td>
</tr>
<tr>
<td>Trial 3</td>
<td>100</td>
<td>100</td>
<td>160</td>
<td>110</td>
</tr>
</tbody>
</table>

**Table 2: Birth and Death Rate (4pts)**

<table>
<thead>
<tr>
<th></th>
<th>Seal growth rate</th>
<th>Whale death rate</th>
<th>Seal carrying capacity</th>
<th>Whale carrying capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial 1</td>
<td>0.8</td>
<td>0.5</td>
<td>170</td>
<td>350</td>
</tr>
<tr>
<td>Trial 2</td>
<td>0.5</td>
<td>0.8</td>
<td>180</td>
<td>180</td>
</tr>
</tbody>
</table>

**Table 3: Capture Efficiency (4pts)**

<table>
<thead>
<tr>
<th></th>
<th>Whale Capture Efficiency</th>
<th>Seal carrying capacity</th>
<th>Whale carrying capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial 1</td>
<td>0.008</td>
<td>140</td>
<td>560</td>
</tr>
<tr>
<td>Trial 2</td>
<td>0.004</td>
<td>160</td>
<td>110</td>
</tr>
</tbody>
</table>

**Analysis and Conclusion (20pts):**

1. For part one of this lab, what caused the increase and decline of population size for the whale and the seals?

2. For part one of this lab, you collected three sets of data using different population sizes for the whale and the seal. Use your *Predation and Carrying Capacity* table to answer the following questions.

   a. Which of the three trials produced the highest carrying capacity for both the whale and the seal?

   b. What were the population sizes and carrying capacities for each population during that trial?
c. Why do you think your chosen trial had the best outcome for the whale and seal populations?

3. For the second trial in part one, we doubled the whale population and reduced the seal population by half. However, the carrying capacity for the seals only decreased slightly from the first trial. What do you think caused this outcome?

4. Using your Birth and Death Rate table, explain how growth and death rates affected population size for both trials.

5. For part two of this lab, birth and death rates, was your prediction for trial 2 correct? Explain how your hypothesis was similar or different from the results.

6. In part three of our lab, how did the loss of available fish (a biotic factor) increase the growth of the whale population? How did the viral infection of the whales (another biotic factor) increase the growth of the seal population?

7. Climate change (an abiotic factor) has slowly decreased habitat for the arctic seals. Predict how a reduction in habitat could change the capture efficiency of the killer whales in our simulation? How might this affect the population of both the whales and the seals?

8. If another source of prey were available to the whales, what changes in population size would you expect for the seals and the whales?

9. In this lesson, you learned about two patterns of population growth and decline, the sigmoid and peak phenomena. Does the seal and killer whale relationship represent a sigmoid or peak phenomenon? Please provide supporting details.

10. What are the limitations of the population dynamics lab? Is the whale and seal simulation of predation a realistic representation of an arctic marine ecosystem? Note: Please provide detailed support for your opinion.