

Lesson 2.2 Teacher Notes

Lesson 2.2 Ecosystem Balance

In preparation for teaching this lesson, review Concepts, Performance Objectives, Essential Questions, and Key Terms, along with the PowerPoint® presentations. Also, review all activity, project, and problem directions, expectations, and work students will complete.

Students begin the lesson using a computer program demonstrating the relationship of organisms in a lake ecosystem. Then students learn how models are used to represent populations in an ecosystem. Students complete the lesson using conceptual and mathematical models to predict populations in an ecosystem with limiting factors introduced.

Reading Discussion



Concept 2-4 through 2-7, pages 28–45

Use the questions below to facilitate a class discussion on Day 1 of this lesson's reading assignment. Encourage student participation and assess student understanding based on the discussion.

- What is an ecosystem?
- What constitutes a population in an ecosystem?
- Which are the major components of an ecosystem?
- What are trophic levels, consumers, and producers?
- Why are decomposers found on all trophic levels?
- What happens to energy in a food chain?



Concept 4-1 through 4-4, pages 67–77

Use the questions below to facilitate a class discussion on Day 3 of this lesson about the reading assignment before Activity 2.2.2 Population Model. Encourage student participation and assess student understanding based on the discussion.

- What roles do species play in an ecosystem?
- How do species depend upon one another within an ecosystem?
- What are limiting factors?
- What is a predator-prey relationship?
- Why do populations of species in an ecosystem vary?
- Why is carrying capacity a concern when studying an ecosystem?

Activities, Projects, and Problems



Activity 2.2.1 Interdependent Organisms

Students use a computer simulation to explain how organisms within an ecosystem are dependent upon each other to survive.

Teacher Preparation

Download and install **Food Chain software** on the desktop of 10 computers. The name of the icon on the desktop will be *Master Food Chain*. The simulation will not operate on Chromebooks or tablets. If your school technology is not compatible with the simulation model, prepare to project the simulation and facilitate the simulation from your computer.

Student Performance

Part One

Students complete *Challenge 1* of *Food Chain* identifying organisms able to survive independently in a lake ecosystem. The challenge starts with students describing the organisms and ecosystem services found in the lake. Students place the organisms in a food web based upon the descriptions. Next, students predict which organisms will be able to survive on their own for ninety days. If students struggle with selecting organisms, encourage them to review the organisms towards the food chain's bottom. It may take students more than one attempt to complete Part One. They record all data and observations for each attempt in their *Laboratory Notebook*.

Part Two

Students complete *Challenge 2*, identifying the minimum number of species needed to support sunfish. If students have difficulty knowing where to start, refer them to their data and observations recorded for Part One. Students should use their knowledge of trophic levels and food chains to determine the species required to support sunfish. They record all data and observations in their *Laboratory Notebook*.

Results and Evaluation

Challenge 1

Green algae and bacteria can survive for 90 days on their own.

Challenge 2

One organism for each trophic level is needed. For instance, sunfish, copepod, green algae, and bacteria will survive for 90 days.

Table 1. Analysis Questions and Potential Responses

Part One		
Q1	What are the characteristics of organisms that can survive on their own?	<i>Organisms can survive on their own if they can produce their food. Green algae in the lake produce their food.</i>
Q2	What are the characteristics of organisms dependent upon other organisms?	<i>They are found on higher trophic levels and are dependent upon producers for energy.</i>
Part Two		
Q3	Why is a diverse ecosystem needed for all organisms to survive?	<i>Each organism is providing others with needed oxygen, carbon dioxide, or nutrients.</i>
Q4	What limits the population of a species in an ecosystem?	<i>Species are dependent upon the populations of other organisms and the services they provide.</i>
Q5	How does the supply of ecological services limit the population of a species?	<i>A species population is limited to the number of services needed to survive available to the species.</i>



Activity 2.2.2 Population Model

Students use a computer-generated conceptual and mathematical model to calculate the effect of birth rate and death rate on a deer population.

Teacher Preparation

Create a [Stella® Online](#) account. The account is free for teachers and students to use, with limitations. The curriculum concepts covered in this course are all eligible under the free platform. Each pair of students will need an account. Students can sign up using their school email, or a teacher can make premade accounts through cooperation with their IT department. Students will need access to the [Deer Herd](#) model via email or posting to your LMS platform.

Student Performance

Part One

Students begin by opening the *Deer Herd* model in *Stella® Online*. Then they identify parts of the conceptual model. Next, students observe how birth rates affect a deer herd's population by inputting

different birth rates into the model and analyzing graphs predicting future populations. Students enter the data into a table and answer analysis questions.

Part Two

Students alter death rates and birth rates into the model to observe how the rates combined affect the deer herd population. They record data while analyzing the graphs and answer analysis questions.

Results and Evaluation

Table 2 contains an example data set and responses to analysis questions. Review student answers to analysis questions to ensure they understand how to use the model.

Table 2. Example Data and Analysis Questions

Part One						
Q1	Is this model conceptual, mathematical, or both? What makes it so?		Both conceptual and mathematical. It has diagrams and math equations.			
Q2	What do the equations represent?		The equations represent the rate of increase or decrease of a deer population.			
Q3	Why should the birth rate be no higher than 0.5?		Only females will give birth. No more than half the population should be female.			
Q4	What does the death rate of 0.45 mean?		45% of the population dies each year.			
Birth Rate		Death Rate	25-year Population	50-year Population	75-year Population	100-year Population
0.50		0.45	346	1,199	4,154	14388
Q5	What is the relationship between birth rate, death rate, and total population?		The birth rate and death rate affect the total population of deer.			
Q6	If the entire population was female, and each deer had twins, what equation would represent the birth rate?		Births = Deer herd $\times$ 1.00 $\times$ 2			
Part Two						
Birth Rate		Death Rate	25-year Population	50-year Population	75-year Population	100-year Population
0.55		0.45	1152	13956	164,000	1.9million
0.45		0.45	100	100	100	100
0.40		0.45	100	28	8	0
Q7	What happens when the death rate of a population is greater than the birth rate?		The population goes down and may result in no population.			
Q8	Which birth rate and death rates would stabilize the population, so no growth or decline in population will occur?		The birth rate and death rate need to be equal.			
Q9	What makes this model unrealistic?		Other factors affect the births and deaths of the deer.			
Q10	Which other factors could be added to the birth rate and death rate side to make the model more accurate?		Answers may include factors such as predators, hunting, emigration, and habitat quality.			



Activity 2.2.3 Productivity Prediction

Students use a computer-generated conceptual and mathematical model to observe the effects of predators and available space on the deer population.

Teacher Preparation

Students will need access to the [Carrying Capacity](#) and [Lynx and Hare](#) models. Download the models and make them accessible to students via email or posting to your LMS platform.

Student Performance

Part One

Students begin the activity by analyzing a deer population conceptual model, including area as a limiting factor. Students sketch the model, identify all components, and answer prediction questions. Next, students run the model using different area sizes to see how available areas affect the birth, deaths, and deer population.

Part Two

Students analyze a model of a predator-prey relationship between lynx and hares. They sketch a graph representing the initial model values and answer analysis questions about the relationship between the lynx and hare. Next, students change the initial lynx and hare populations to determine how they affect each species' productivity.

Results and Evaluation

Review student answers to analysis questions upon completion of the activity. Table 3 contains example responses to analysis questions.

Table 3. Analysis Questions and Potential Responses

Part One Prediction		
Q1	Which parts of the model are related to animals per area?	<i>The area and deer herd are both parts of the equation. The animal per area affects the death rate and birth rate of the deer herd.</i>
Q2	Which factors could cause an increase in the area available for deer?	<i>Answers may include people planting a deer plot or a decrease in agricultural land.</i>
Q3	What effect will an increase in the area have on the deer population? Why?	<i>Answers may include more space to provide more food, water, and shelter.</i>
Q4	Which factors could cause a decrease in the area available for deer?	<i>Answers may include human construction, building more houses, or the addition of new roads.</i>
Q5	What effect will a decrease in the area have on the deer population? Why?	<i>Answers will vary. Less space could provide less food, water, and shelter.</i>
Part One Analysis		
Q6	How does the habitat area affect the number of births and deaths per year?	<i>The habitat and population have a direct relationship with each other.</i>
Q7	If a disease destroys half the available trees and plants, what will happen to the deer herd's productivity? Why?	<i>The population will decrease due to the loss of habitat in the ecosystem.</i>
Q8	What other information about the habitat could you add to the model?	<i>Answers may include the introduction of diseases, yearly cycles of weather, and predators.</i>
Part Two Prediction		
Q9	Which factors determine the lynx population?	<i>Factors include the area for the lynx to live and the number of hares available for food.</i>
Q10	What is the relationship between the lynx population and the hare population?	<i>Lynx prey on hares, reducing the hare population.</i>
Graph Analysis Questions		
Q11	What happens to the lynx population during the first 20 years?	<i>First, the lynx population decreases and then increases.</i>
Q12	What happens to the hare population during the first 20 years?	<i>First, the hare population decreases and then increases as the predators decline.</i>
Q13	Which population increases first, lynx or hare? Why?	<i>Hare. The hare population increases first and provides food for the lynx population to increase in later years.</i>
Part Two Analysis Questions		
Q14	What is the carrying capacity of the area for the lynx and hare? How do you know?	<i>50,000 hares and 1,250 lynx. At this point, the population becomes stable.</i>
Q15	Can the lynx survive without the hare? Why or Why not?	<i>No, lynx are dependent upon hare for food.</i>

Q16	Can the hare survive without the lynx? Why or why not?	<i>Yes, hares are not dependent upon lynx to survive. However, environmental conditions would limit the growth the model predicts.</i>
Q17	How does eliminating the lynx population affect the carrying capacity of the ecosystem for hare?	<i>The carrying capacity for hare increases if the lynx population disappears.</i>
Q18	How does changing the initial populations affect the stability of the population?	<i>If the lynx population is too high initially, the hare population cannot recover, and both the lynx and hare will be eliminated from the ecosystem.</i>

Assessment



Lesson 2.2 Check for Understanding

Lesson 2.2 Check for Understanding is included for you to use as an assessment tool for this lesson. Use **Lesson 2.2 Check for Understanding Answer Key** for evaluation purposes.