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Web of Life

During this exciting predator/prey simulation game, students learn about the food web, how energy moves throughout the food web, the relationships between carnivores, omnivores, and herbivores, and the four laws of ecology.

OBJECTIVES:

1. Students will describe the Four Laws of Ecology and recognize how they relate to an animal's instinct to survive.
2. Students will list the four resources animals need for survival.
3. Students will identify native New Jersey animals and label their position in a food chain as herbivore, omnivore or carnivore.
4. Students will physically demonstrate the flow of energy in a food web by collecting resources to survive.
5. Students will discuss and evaluate altercations to a food web and relate them to natural and human interactions.

BACKGROUND INFORMATION:

While there are many natural rules that govern the science of ecology, Barry Commoner (1974) summarized the dependence of animals and their environment into four informal "laws of ecology" in order to simplify the complex interactions of earth's life-supporting systems.

The **first law** states, "Everything is connected to everything else." Therefore, we must understand the earth not as a group of separate ecosystems but as a biosphere, or "ecosphere," in which resources are constantly transferred through various trophic levels in order to sustain life. For example, nutrients from the soil and energy from the sun are captured by producers which are then transferred to consumers through the food chain, but those nutrients are later returned to the soil as the organism decomposes.

This brings us to Commoner's **second law** in that "everything must go somewhere." This can be applied not only to the energy and resources in the food chain but also man-made influences, such as hunting or pesticide use that can disrupt natural cycles.

For his **third law** of ecology, Commoner raises the disclaimer that "nature knows best." Therefore, all ecological systems are a result of trial and error over millions of years and any "unfit" elements are weeded-out through natural selection. Human can unknowingly upset the balance inherent in these ecosystems through a variety of practice, including the elimination of predator species or the introduction of foreign substances. As a result, some ecosystems can be over populated with herbivores (i.e. white-tailed deer in the northeast) or bioaccumulation of harmful toxins (i.e. DDT or mercury poisoning).

Finally, the **fourth law** states “there is no such thing as a free lunch,” which means that everything gained by an organism comes at a cost to them. Predators must spend energy catching prey in order to gain it, while prey easily gain energy and resources but must avoid predation to reproduce.

This also can be applied to a larger idea that as humans alter ecosystems they will have to face future repercussions, such as increased wildlife collisions with deer or growing numbers of threatened, endangered and extinct species.

MATERIALS:

- Arm bands for each student participating. Red= carnivore, blue= omnivore, green= herbivore. Follow a 1:2:3 ratio.
- Four lifelines for each student. Those students with red armbands receive red lifelines, those with blue receive blue lifelines, and those with green receive green lifelines.
- Four tin cans labeled ‘Food,’ ‘Water,’ ‘Shelter,’ ‘Space’ with different color washable marker in each.
- Whiteboard, markers, and easel.
- Flip chart for visual purposes.

PROCEDURE:

1. Before students arrive, strategically place cans in four different outdoor locations surrounding Long House/start point.

2. As students enter the room, hand them an armband and instruct them to tie it to their arm.

3. Explain the broad definition of ecology and the Four Laws of Ecology: everything is connected to everything else, everything must go somewhere, nature knows best, and there is no such thing as a free lunch. These will be the overall principles derived from the game.

4. Guide students in a discussion of animal instincts for survival and reproduction and the four resources they need to survive. Explain that the focus will be mainly on food. Have students define a producer and consumer, listing the types of consumers and explaining a food chain. (Food pyramid may be useful.) Have students list types of NJ wildlife and create a food web to show the difference between a web and chain. Explain predator/prey relationships.

5. Present the objectives and rules of the game using the corresponding pages on the flip chart. Using the map, clearly define the boundaries of the game area.

OBJECTIVE OF GAME:

- All organisms should try to stay alive and have as many lifelines as possible to “reproduce.”
- All organisms must collect food, water, shelter, and space in order to reproduce.
- Carnivores can take lifelines from omnivores and herbivores. Omnivores can take lifelines from herbivores. Herbivores cannot take any lifelines.
- Return to start location if you no longer have lifelines.

RULES OF GAME:

- If tagged, you must pass on one of your lifelines.
- If you lose all of your lifelines, return to the starting point.

- You may tag only one person at a time. You may not tag someone twice in a row.
- You may not guard a station or tag anyone at a station.
- You may not hide in a building or go on the road.
- Let Herbivores out first, then omnivores, and then carnivores.

OPTION:
Add another category – **Elements** (weather or other natural abiotic or biotic factors). Elements tag animals in order to take lifelines, and they may take as many lifelines as they want. **Elements leave after all other teams.**

ADDITIONAL OPTION:
You may play with the addition of human(s). The human(s) leave after the carnivores. **Human(s) do not need to gather resources. Human(s) may take lifelines from any animal from a distance of twenty feet simply by pointing to the victim and saying "Hasta la vista."**

6. Each simulation runs for about 15 minutes or until desired results occur. All animals receive 2 lifelines at beginning of round. (Switching of teams occurs at discretion of instructor based on time and students.)
    a. First Round – Send students out in progression to collect resources and stay alive. Play until herbivore population has significantly decreased.
    b. Second Round – Introduce the new rule that resources collected may be redeemed for a new lifeline in which they can "reproduce." The object is to collect as many lifelines as possible. However, if a team member is dead and a returning student has extra lifelines, a lifeline must be given to the teammate to "reproduce." This only applies to herbivores and omnivores that feed off the land. Also introduce Elements (either a counselor, staff or carnivore with highest number of lifelines) to prey on carnivores. Play until carnivore population has decreased and herbivores are abundant.
    c. Third Round - Give herbivores additional yellow lifeline, which must be given away first by any animal that is tagged. Play similar to second round and advise Elements to avoid taking animals with yellow lifelines.

7. When each game ends, compare the starting number of living and dead animals for each group. Have students make observations about the changes in population.
    a. First simulation – Discuss over predation and crash of prey population such as herbivore and omnivores. Hypothesize would happen if all herbivores died.
    b. Second simulation – Demonstrate decrease of predators to Elements, such as disease, starvation, natural disasters, humans, etc. Show how without predators, herbivores recover. Hypothesize would happen if all carnivores died.
    c. Third simulation – Summarize the boom-bust cycle of predator/prey relationship and ideal of "dynamic equilibrium." Tally the number of omnivores and carnivores with yellow lifelines. Explain how they have suffered from bioaccumulation in that toxins have traveled through the food chain to higher trophic levels. Discuss biomagnification as predators died from ingesting toxic prey, give examples such as DDT and bald eagles.

SUMMARY:

Everything in the food web is connected to everything else, and thus, it is an extremely sensitive system. If one part of the web is compromised (i.e. a disease that eradicates many herbivores), the rest of the organisms in that web will suffer, including humans. Therefore, we can assume the health of one part of the web by assessing the health of another. For example, if the carnivores are healthy, then their food supply of herbivores and omnivores are most likely

healthy also. Because the food web is so sensitive, we, as humans, must be cognizant of the ways in which we affect it.
Pesticides, pollution, and deforestation can all have perilous consequences to an ecosystem.

BIBLIOGRAPHY:

Commoner, B. The Closing Circle: Nature, Man, and Technology. New York: Bantam Books, Inc., 1974.

Revised 2014 by Stephanie Sherman
2017 by JCK and TC

NJ Student Learning Standards

This field lesson touches upon the following NJ Science Performance Expectations and can be tailored to focus on any of the following standards

MS-LS1: From Molecules to Organisms: Structures and Processes

- MS-LS1-4 Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

- MS-LS1-5 Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

- MS-LS1-6 Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

- MS-LS1-7 Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.

MS-LS2: Ecosystems: Interactions, Energy, and Dynamics

- MS-LS2-1 Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

- MS-LS2-2 Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

- MS-LS2-3 Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

- MS-LS2-4 Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

MS-LS4: Biological Evolution: Unity and Diversity

- MS-LS4-4 Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.

Climate Change

- MS-LS2-4 Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

Comprehensive Health and Physical Education

- 2.2.8.MSC.7 Effectively manage emotions during physical activity (e.g., anger, frustration, excitement) in a safe manner to self and others.

- 2.3.8.PS.1 Assess the degree of risk in a variety of situations, and identify strategies needed to reduce deliberate and non-deliberate injuries to self and others

Scientific and Engineering Practices / NGSS

This field lesson can be tailored to have students directly involved with

- Asking Questions and Defining Problems
- Analyzing and Interpreting Data
- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence
- Obtaining, Evaluating, and Communicating Information

Social and Emotional Learning

All of our field lessons integrate the concepts of self-awareness, self-management, social awareness, responsible decision-making, and relationship skills found in the New Jersey's Core Social and Emotional Learning (SEL) Competencies.