**Oakland Schools Science Scope**

**Grade 6**

**Unit 2 – Ecosystems**



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**About Our Scope Unit/Lesson Template**

This template is designed to serve several teaching and learning principles considered as staples of state of the art science instruction. Here are the key principles in summary:

* It’s critical to **elicit prior knowledge** as a unit or lesson begins.
* **Key questions** should drive student explorations and investigations.
* **Activity Before Concept** – Student inquiry-based explorations which give personal experience with phenomena and ideas should precede a presentation of science ideas.
* **Evidence is the heart of the scientific enterprise.** Students generate evidence and analyze patterns in data that help to construct scientific explanations around key questions.
* **Concept Before Vocabulary** – Attaching science vocabulary to concepts developed by student investigations yields more success than beginning a unit or lesson with a list of science vocabulary.
* **Talk, argument** **and writing** are central to scientific practice and are among the most important activities that develop understanding.
* **Application** of the ideas provides review, extends understanding, and reveals relevance of important ideas.
* **Assessment** of knowledge, skill and reasoning should involve students throughout the learning process and be well aligned to the main objectives and activities of the unit.

The Scope Science template is designed to put these principles into practice through the design of the ***SCOPE LEARNING CYCLE FOR SCIENCE***. Each unit has at least one cycle. The components are listed below:

|  |  |
| --- | --- |
| The Key Question for the Unit | Each unit has one, open-ended driving question that relates to all the content and skills of the unit. The Key Question is presented at the opening of the unit and revisited at the unit’s conclusion. |
| Engage and Elicit | Each unit begins with an activity designed to elicit and reveal student understanding and skill prior to instruction. Teachers are to probe students for detailed and specific information while maintaining a non-evaluative stance. They also can record and manage student understanding which may change as instruction proceeds. |
| Explore | A sequence of activities provides opportunities to explore phenomena and relationships related to the Key Question of the unit. They will develop their ideas about the topic of the unit and the Key Question as they proceed through the Explore and Investigate stage of the learning cycle.  Each of the activities may have its own Key Question or central task that will be more focused than the unit question. The heart of these activities will be scientific investigations of various sorts. The results, data and patterns will be the topic of classroom discourse and/or student writing. A key goal of the teacher is to reference the Key Question of the unit, the Engage and Elicit of the students and to build a consensus especially on the results of the investigations. |
| Explain | Each unit has at least one activity in the Explain portion of the unit when students reconcile ideas with the consensus ideas of science. Teachers ensure that students have had ample opportunity to fully express their ideas and then to make sure accurate and comprehensible representations of the scientific explanations are presented. A teacher lecture, reading of science text or video would be appropriate ways to convey the consensus ideas of science. Relevant vocabulary, formal definitions and explanations are provided. It’s critical that the activity and supporting assessments develop a consensus around the Key Questions and concepts central to the unit. |
| Elaborate | Each unit cycle has at least one activity or project where students discover the power of scientific ideas. Knowledge and skill in science are put to use in a variety of types of applications. They can be used to understand other scientific concepts or in societal applications of technology, engineering or problem solving. Some units may have a modest Elaborate stage where students explore the application of ideas by studying a research project over the course of a day or two. Other units may have more robust projects that take a few weeks. |
| Evaluation. | While assessment of student learning occurs throughout the unit as formative assessment, each unit will have a summative assessment. Summative assessments are posted in a separate document. |

**Grade 6**

**Unit 2 – Ecosystems**

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**Unit 2 – Ecosystems**

**Unit Introduction**

In this life science unit, students describe the relationships and roles of biotic and abiotic factors within ecosystems, using those in the Great Lakes region as local and familiar examples. Students recognize patterns in the flow of energy in ecosystems, and categorize organisms as producers, consumers, and decomposers based on the way the organisms obtain this energy. Students explore relationships and interactions within populations and discover how interrelations impact population stability. They identify abiotic factors and examine their effect on ecosystems. Students analyze the impact, and predict the outcome of human activity affecting the balance of an ecosystem. The unit is organized into two learning cycles:

Cycle 1: What is an Ecosystem

Cycle 2: Interdependence of Organisms in an Ecosystem

The resources and opportunities to address these topics are of such abundance and quality that the unit has the tremendous potential to be a highly relevant, real-world and investigation-rich experience for students. As teachers look for ways to have students use real world data, apply interactive technology to real-world questions, and foster meaningful tasks for reading, writing, argumentation and mathematics, framed by the Common Core Curriculum Standards, the issues here provide abundant opportunity. The main limitation is the class time available, given other content demands.

*On the Common Core State Standards for English Language Arts and Literacy in Science*

All science teachers will find the Common Core State Standards of ELA a tremendous asset for reaching learning objectives in science education. Reading, writing, argumentation and discourse are central proficiencies necessary for success in science. All teachers should become fluent with the document and are likely to find it validating.

[**http://www.corestandards.org/assets/CCSSI\_ELA%20Standards.pdf**](http://www.corestandards.org/assets/CCSSI_ELA%20Standards.pdf)

These standards are best reached with science instruction that connects content to real-world problems and experiments, complimented with scientific writing, challenging questions, processes for classroom discussion and debate and use of scientific text.

It is recommended that teachers require students to use an interactive science notebook to support learning in this unit. Here are some features and policies to consider:

* Use a bound notebook, like a composition book –cut and paste or staple some other materials into it (quad-ruled notebooks are nice for graphing activites).
* The right-facing page is for teacher content, the left is for student reflection.
* Leave four pages for a table of contents.
* Leave the notebooks in the room.

**Learning Cycle 1:** **What is an Ecosystem?**

**Introduction**

In this unit, students discover relationships between **abiotic** and **biotic** factors in an ecosystem. They identify habitats and recognize the role of living and nonliving members in a variety of habitats. They discover how changes in one factor in an ecosystem result in changes in population sizes within that ecosystem.

**Learning Objectives**

Students will be able to:

* Identify the living (biotic) and nonliving (abiotic) components of an ecosystem.
* Identify the factors in an ecosystem that influence changes in population size.

**Key Question: What are the relationships between and among abiotic and biotic factors in an ecosystem?**

**Engage and Elicit**

**Activity 1 – Ecology Walk**

**Purpose**

Students will explore the basics of an ecosystem and the differences between abiotic and biotic components of an ecosystem.

**Activity Description**

Students in sixth grade have been exposed to a wide variety of environmental information both through school and the popular media. To ascertain any prior knowledge and potential misconceptions, the activity begins with a class exploration for the essential components of an ecosystem.

**Focus Question**

What are the parts of an ecosystem?

**Duration**

Two class periods.

**Materials**

* Schoolyard
* If schoolyard not available, use outdoor or nature magazines.

**Teacher Preparation**

1. Take a walk around the school and make a list of biotic and abiotic factors.
2. Select a path that gives a wide variety of factors students can observe.

**Classroom Procedure**

1. Begin by discussing what an ecosystem is and what biotic and abiotic means.
2. If practical, plan a hike outside to go all around the schoolyard.
3. If that is not possible, then provide students with a selection of magazines to cut up and create posters showing abiotic and biotic factors.
4. For the outdoor hike, students will hike the schoolyard to observe and record data. They will list ten abiotic and ten biotic factors found around their school.
5. The whole school cannot be listed as an abiotic factor. Students must focus on the individual components of the school and schoolyard.
6. Glass windows and metal doors are abiotic as well as the air and water-clouds that students see. The grass, wooden benches, and trees are biotic. The essential needs of all living organisms are food, shelter, air, water, correct temperatures, and space. These items fall into two categories: the ones that are derived from living (made of cells) BIOTIC items. The second group, ABIOTIC, are those items that have never been alive (air, water and the mineral part of soil).
7. The place where organisms find these items is called their habitat.
8. Habitats exist within ecosystems.
9. Distribute the hike Data Sheet (attached) before going into the schoolyard.
10. Return to class and debrief by making a list of abiotic and biotic factors discovered on the hike.

**SKILLS**: Data collection, Observation **CONCEPT**: Differentiate between elements of an ECOSYSTEM

**TASK**: Get to know your ecosystem. Find ten (10) different things in the environment that can

be classified as either:

**Living=BIOTIC**, or **Non-living=ABIOTIC**. Write your list clearly below.

Do the best you can with the spelling.

A. **Record** ABIOTIC, non-living things B. **Record** BIOTIC, living things

(Things that have never been living.) (Things which are living, were living,

and are made of cells.)

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**Explore**

**Activity 2** **–** **Alive, Not Alive, Never Lived**

**Explore**

**Activity 2 – Alive, Not Alive, Never Lived**

**Purpose**

The purpose of this activity is to help students recognize and understand the various ways biotic and abiotic factors appear in manufactured materials.

**Activity Description**

Students have more trouble identifying the abiotic factors once factors have been changed into products like shoes and furniture. Students will research how certain items are produced. For example, cotton T-shirts. The cotton comes from plants, and plants are biotic, so the shirt is also biotic, depending on what it’s made from.

**Focus Question**

How can biotic and abiotic materials be identified in manufactured products?

**Duration**

Two class periods. First class period is to research items and second class period to share student research and discuss.

**Materials**

List of items found in home or school to be classified as biotic or abiotic. This list can be teacher generated or developed through class discussion.

**Teacher Preparation**

1. Make a list of common products found around home and school.
2. Ensure the list has enough items so every student has one to research.
3. Make available a class set of reference books.
4. Have computers with Internet access available.
5. If computers not available, arrange for class to go to library for researching items.

**Classroom Procedure**

1. Teacher assigns each student an item from the list.
2. Ask students to research contents of the item.
3. Identify the category in which the item or its components belong (biotic or abiotic).
4. Bring the class together and share the results of each student’s research.
5. Give class an opportunity to question and/or discuss items.
6. Remind the students they will have to think about what an item is made from. The wooden benches aren’t alive, but they are made of wood that comes from trees, which are living things. The requirements that all living things need to remain living come from both abiotic and biotic sources. An ecosystem is comprised of both, and ecology is the study of how these biotic and abiotic factors interact.

**Explain**

**Activity 3 – Identifying the Components of an Ecosystem**

**Purpose**

To provide students with the scientific description of biotic and abiotic factors found in the environment and to present an evidence-supported explanation of the role of these factors.

**Activity Description**

Class is divided into teams and each team is assigned an ecosystem to research and identify biotic and abiotic factors in the ecosystem.

**Focus Question**

What are the biotic and abiotic factors in each of a variety of ecosystems?

**Duration**

One class period.

**Materials**

Website for abiotic factors and cycles

<http://www.youtube.com/watch?v=wrY8nZuZMFY&feature=related>

**Teacher Preparation**

1. Make a list of several ecosystems.
2. Preview the video on Youtube at the site above.
3. Make a class set of the article Biotic/abiotic.
4. Have computers with Internet access available.
5. If computers not available, arrange for class to work in library or have reference materials available in class.

**Classroom Procedure**

1. The teacher asks the class to read the article below entitled Biotic/abiotic.
2. The teacher divides the class into teams of three or four, depending on class size.
3. Teacher assigns each group an ecosystem.
4. Each team researches their ecosystem and identifies 5 biotic and 5 abiotic factors in their ecosystem.
5. Each team reports their findings to the class and includes an explanation for each factor.

**Biotic/abiotic**

Ecosystems come in different forms all across the world. There are terrestrial ecosystems which include most of the land-based systems. Tundra, forests in tropical and temperate areas, grasslands, and deserts are all considered terrestrial ecosystems. Freshwater ecosystems cover lakes, rivers and marshlands. Marine ecosystems include the various environments of open-water oceans and coastal sea life. Ecosystems affect human civilization in a number of ways. Crops and livestock, two primary sources of food for people around the world, are provided through ecosystems. Ecosystems also provide clean water and oxygen for humans to drink and breathe. Materials, such as wood, are taken from ecosystems and are used to build and make a variety of products. The biotic factors of an ecosystem refer to all of the living organisms in that particular system. The word "biotic" is taken from the Greek word bios, which means "life." Biotic organisms include fungi, bacteria, plants and animals. All of these organisms work to promote the vitality, adaptation and preservation of the ecosystem.  The types of organisms vary from ecosystem to ecosystem. The abiotic factors in an ecosystem refer to the non-living components involved in that system. These factors are not living themselves but they do allow biotic organisms to live in their particular ecosystems. Abiotic factors include elements like hydrogen, oxygen, nitrogen, phosphorus and carbon. It also includes sunlight, temperature, soil and water.

**Elaborate**

**Activity 4 – Bottle Biology**

**Purpose**

Students will apply knowledge of the factors influencing an ecosystem and observe how changes in some factors cause changes in others and the ecosystem as a whole.

**Activity Description**

Students will study the impact of biotic and abiotic factors at work in a closed ecosystem. Students will construct a terrarium to create and observe an ecosystem. The students will identify all biotic and abiotic factors in the ecosystem. During a two-week observation period, observations will be measured and recorded with emphasis on changes within the system.

**Focus Question**

How does an ecosystem respond to changes?

**Duration**

One day to prepare the bottles and two weeks of observations and data collection.

**Materials**

* Soda pop bottles
* Gravel
* Soil
* Moss plants
* Plastic spoons
* Charcoal
* Spray water bottle
* Vascular plants
* Plastic wrap
* Large rubber band.

**Teacher Preparation**

1. Have a supply of plastic soda bottles, enough for one for each student.
2. Prior to activity, cut off the top part of the bottle.
3. Have moss, gravel, soil, charcoal, and small vascular plants in quantities large enough for class use.

**Classroom Procedure**

1. If bottles were not previously cut by teacher, students cut the top off their bottle
2. Use a spoon to fill the bottom with 2.5 cm of gravel followed by 1 cm of charcoal.
3. Spoon in 8 cm of soil and tap it down to pack the layers together. Do NOT stir.
4. Scoop out a hole for a vascular plant.
5. Place plant in so the roots are completely covered, and pack the soil around the stem.
6. Use the spray water bottle to moisten the soil until you see the water seep into the gravel.
7. Cover the soil with the moss plants completely around the stems of the vascular plant and spray with water.
8. Tightly cover the bottle opening with the plastic wrap and hold in place with the rubber band.
9. Set the bottle terrariums in bright indirect light. (If the sides fog, move the container to a location with a different amount of light.)
10. Have students keep a science journal. Have them record their daily observations of the terrarium for two weeks.
11. Teacher should follow up after two weeks.
12. Predict: What do you think might happen if a plant-eating insect were added? Would it survive?

# Data Chart:

(Daily Observations)

Date Plant Growth Water Levels Population Changes

|  |  |  |  |
| --- | --- | --- | --- |
| Day 1 |  |  |  |
| Day 2 |  |  |  |
| Day 3 |  |  |  |
| Day 4 |  |  |  |
| Day 5 |  |  |  |
| Day 6 |  |  |  |
| Day 7 |  |  |  |
| Day 8 |  |  |  |
| Day 9 |  |  |  |
| Day 10 |  |  |  |
| Day 11 |  |  |  |
| Day 12 |  |  |  |
| Day 13 |  |  |  |
| Day 14 |  |  |  |

\*\***Quantitative questions:**

Exactly how many?

Exactly what size?

How many days?

\*\***Qualitative questions:**

What color?

What shape?

Slow or quick movement?

**Learning Cycle 2: Interdependence of Organisms in an Ecosystem**

**Introduction**

What are the similarities and differences in the way organisms obtain energy, and what type of relationships between and among populations result? Students also discover how different interacting populations form an ecosystem. Finally, students recognize the high level of interdependence of organisms that exists in an ecosystem and how changes in one part can and will affect all parts.

**Learning Objectives**

Students will be able to:

* Distinguish between the ways in which consumers and decomposers obtain energy.
* Identify and describe examples of populations, communities, and ecosystems, including the Great Lakes region.
* Describe common patterns of relationships between and among populations (competition, parasitism, symbiosis, and predator/prey).
* Explain how two populations of organisms can be mutually beneficial and how that can lead to interdependency.
* Predict how changes in one population might affect other populations based upon their relationships in the food web.
* Classify producers, consumers, and decomposers based on their source of food (the source of energy and building materials).

**Key Question: Who eats whom or how does energy flow in an ecosystem?**

**Engage and Elicit**

**Activity 1– Food Chains in a Web**

**Purpose**

To learn about interactive relationships within and among the populations in an ecosystem.

**Activity Description**

Students use the elements of an ecosystem to discover the connections between the various elements of an ecosystem.

**Focus Question**

How does a single factor in an ecosystem affect all the parts of an ecosystem?

**Duration**

Depending on class size, one or two class periods.

**Materials**

* One long ball of twine
* One index card per student
* Pen or marker
* Tape
* Class set of 4x5 cards listing elements of an ecosystem.

**Teacher Preparation**

1. Teacher creates a set of 4x5 index cards listing the elements of an ecosystem. These can be specific to a particular site, such as a rain forest habitat, or they can be general.
2. Make one card per student so the whole class can participate. There are many variations of this activity that can be adapted to address any specific ecosystem.
3. Use as many labels as you need to make sure you cover each trophic level, e.g., producers, consumers, secondary consumers, decomposers;

Sun, Cloud, River, Atmosphere, Groundwater, Soil, Rocks

(More advanced – carbon, nitrogen, carbon dioxide)

**BIOTIC Animals**

Primary consumers – Rabbit, Grasshopper, Butterfly, Squirrel, Caterpillars

Secondary consumers – Fox, Crow, Weasel, Apex predators – Shark, Owl, Eagle, Wolf

**BIOTIC Plants**

Weed, Grass, Dandelion, Daisy, Maple tree, Oak tree, Pine tree, Corn, Flower, Soy beans, Hay, Moss, Lichen, Algae, Sunflower, Rose, Tomato, Apple, Pumpkin, Potato

**Decomposers**

Mushrooms, Bacteria, Woodlice, Worms

1. Teacher Explanation: Explain that energy flows through an ecosystem as each organism collects the things it needs to survive. Plants get their energy from the sun and use it to create the sugars and starch they need to grow. Consumers eat the plants to get the energy they need.

**Classroom Procedure**

1. Sit the students in a circle.
2. Each student will be given an index card with something from the environment to represent, such as wind, the soil, the sun, an ant, a daisy, or any one of many other things.
3. Make sure you have at least one identity card for each student in the group. Each person will play a different role.
4. Starting with the sun, have each student identify an element of the ecosystem that is needed to survive.
5. One person should hold the end of the string and pass the ball of string to another student in the circle with whom she or he can be “related.” The first student will then explain to the whole group what this relationship is. For example, the “daisy” student holds the end of the string. He/she passes the ball to the “water” student and says, “I need water to grow.” The “water” student takes hold of the string, passes the ball to the “fish” student, and says, “I am your home.”
6. As each person passes the ball of twine, they identify the person to whom they will pass it and explain why they need that person to survive.
7. Each person hangs onto the twine and then passes the twine ball to another. They construct a web.
8. Remind the class not to tug on the twine as they pass it to each other.
9. Keep going until everyone in the circle is included.
10. When everybody is connected in the web, discuss how each element is part of the whole, either by direct or indirect connection. Have the group observe the web pattern they have created. Even if they are not the one directly connected when there is a stress in one part of the ecosystem, the whole is affected.
11. Demonstrate by tugging gently on one part of the web. The students on either side are directly connected; however, the others will also feel the tug.
12. To conclude, have the group reverse the flow and roll up the ball as they explain, again, how the energy flows from one element to the other.
13. Ask students if the web will be the same or different if you build another web.
14. In an ecosystem, many animals eat more than one thing (web rather than chain) which creates a more stable food source. In a habitat with a diverse population, there are more food sources. Biodiversity provides a more stable food web. If one component is removed, the remaining organisms still have potential food.
15. What would happen if one part of the environment were removed?
16. Test your prediction. As a group, pick one person to let go of the string. Which part(s) of the environment would you not want to release the string?
17. Which parts seem to be the most important for maintaining the relationships in the circle?
18. Look at the connections to air and to water. Why are there so many?

# Wind

# Sun nnnnnnnnnnnnnnnnnn

# Air

# Grass

# Earthworm

# Bird

# Soil

# Daisy

# Dog

# Ant

# Fish

# Mosquito

# Water

**Explore**

**Activity 2 – The Food Pit**

**Purpose**

To reinforce the concept of energy transfer and loss as energy travels through a trophic pyramid and to understand that one of the relationships between living things is the transfer of energy.

**Activity Description**

Student groups will be dealt a hand of cards (jpg included), which they must then trade with other groups until they have a complete food chain. The purpose of this activity is to develop a series of possible relationships that illustrate the transfer and loss of energy in a food chain.

**Focus Question**

How does competition affect an animal’s ability to get energy?

**Duration**

Two class periods.

**Materials**

The following materials list yields enough cards for four teams competing against each other. Have the students create the objects themselves on the cards.

* 1 deck of 62 playing cards made by each student team and consisting of:
* 4 cards labeled “sun” – draw a sun
* 24 cards labeled “producer” – draw 8 pine cones, 8 deciduous, and 8 dandelions
* 16 cards labeled “herbivore” – draw rabbits, cardinals, and squirrels
* 8 cards labeled “carnivore/omnivore – fox, opossum, blue jay, and skunk
* 4 cards labels “keystone predator” – Great horned owl, coyote, bobcat, and hawk
* 4 cards labeled “decomposer” – worms
* 1 card labeled “People”
* 1 card labeled “pollution” – trash.

**Teacher Preparation**

1. Within an ecosystem, such as a forest, energy is constantly traveling from one trophic level to another and then being recycled back into the system. It is important for students to understand how this energy is passed along in the ecosystem and that there cannot be infinite trophic steps because of the energy lost from one step to another. At each stage of the trophic pyramid, energy is lost through metabolism, growth, reproduction, waste production, and other aspects of living. This energy cannot be passed on to the next level; therefore, the living things at the next level must acquire more of the living thing at the previous level to survive. The animal occupying the highest trophic level, the keystone predator, must spend considerable amounts of time and energy acquiring food.
2. Ask students to describe a time when they were in competition with someone else. What was the goal?
3. Do they think that this happens in the natural world? How might it look in the natural world?
4. Prepare cards as directed above.

**Classroom Procedure**

1. Divide the class into four groups. Explain that they will be playing a game and the object is to create a set of cards consisting of: the sun, six producers, four herbivores, two carnivore/omnivores, one keystone predator, and one decomposer. If you wish to make the challenge greater, you could require the students to have working food chains within the trophic pyramid.
2. Shuffle cards and deal each group cards until they are all gone (some groups may have more cards that others groups due to the odd number of cards). Students in each group should secretly look at the hand and determine which cards they want to trade. One group representative then goes to the designated trading area to trade with another group.
3. NO ONE MAY SHOW THEIR CARDS.
4. Each group can only trade with a group that wants to trade the same number of cards. As the swaps take place, no group knows what they are getting until the traders return to the group and the group looks at the new cards together.
5. When a group has a set, they announce that they have a complete set by shouting “Food Chain!”
6. The group must prove to the others that they have a complete pyramid. If not, the game resumes.
7. The winning team gets 100 points, and there should be several rounds of play. You may decide to keep score on the board.
8. The “people” and “pollution” cards are special. If a group has the people card, they may use it as a wild card to replace any card that they are missing. BUT, they must be careful about hanging onto this card because if another group completes their food pyramid first, 50 points will be deducted from the score of the team with the people card in their possession. Should the group with the people card complete a food pyramid without needing to use the people card, they pick up an extra 50 points.
9. The pollution card is always bad, and whichever group has the card when the round is complete loses 50 points. Both cards may be traded just like any other card.
10. At the completion of the activity, ask the students to share what they thought was going on as they competed for cards.
11. Why did they need so many producers?
12. Were there certain types of cards which were more difficult to acquire?
13. Why?
14. What advantage does an omnivore have over a carnivore?
15. Explain that when an animal eats another animal, it gets energy from that animal. However, not all of the energy goes to the next animal; this makes what is called a trophic pyramid.
16. Can the students take the cards and make them into a trophic pyramid?
17. Why do they think that some of the energy does not move on to the next level? It is NOT lost, it is USED.
18. Why do only the producers use the sun’s energy?
19. What about the animals? Were they all the same?
20. What makes some predators and some prey?
21. Why doesn’t the pyramid have as many predators?
22. Are the herbivores predators? (Yes, they prey on plants.)
23. Where do the decomposers get their energy?
24. The development of an understanding of the passing of energy from one trophic level to the next is key to the development of the next concepts. Many interrelationships are based upon energy transfer.

**Explain**

**Activity 3 –** **Energy Pipeline** (adapted from Project WILD)

**Purpose**

Students explore the dissipation of energy across trophic levels. They model the transfer of energy and the recycling of organic materials.

**Activity Description**

This activity is an assembly-line style simulation activity in which students play the roles of each trophic level and pass tokens to indicate growth as well as energy loss at each level. Energy enters the system from sunlight transformed by producers (green plants). It is moved on by the primary consumers, the herbivores (plant eaters), and then into the carnivores. It takes a large quantity of green plants to support the top predators.

**Focus Question**

How does energy get used up as it moves up the trophic levels?

**Duration**

One to two class periods.

**Materials**

* Pea-size gravel (or dried beans or a large quantity of poker chips)
* Large bucket labeled “Used up calories”
* Reusable plastic baggies
* Laminated copies of the metabolism cards
* 52 bowls or cups – one for each metabolism card
* 6 small paper cups
* 3x5 cards
* Display copy of the Total Growth Chart
* Display copy of a trophic pyramid (plants on the bottom and the apex predator at the peak)
* Optional – colored gravel and whistle

**Teacher Preparation**

**Concepts for teacher to consider before lesson:**

1. Energy links the components of any ecosystem.
2. Starting with sun energy, the green plants (producers) utilize photosynthesis to create sugars and enable the plant to grow and thrive.
3. This activity simulates the trophic levels to show how energy is transferred up the energy pyramid.
4. The components that recycle through an ecosystem are: water, oxygen, carbon, nitrates, and phosphates.
5. The simulation assembly-line illustrates how energy is ‘lost’ or transferred at each level.
6. Each successive layer has approximately 10% available energy to move on to the next layer, i.e., 90% is lost. This is why it takes such a wide base (producers) to support relatively few top predators.
7. As much as a million calories of plant material may be needed to support a thousand calories stored in a top carnivore.
8. The tokens represent a calorie that the plant can use for growth. A calorie is a unit of energy generally defined as the amount of heat required to raise the temperature of 1 gram of water 1 degree Centigrade.
9. The metabolism cards represent the ways that energy is used by each living organism.
10. The bowls or cups will be used to collect the calorie tokens as they move up the trophic levels.

**Classroom Procedure**

1. Identify teams of students to represent the following (adjust for class size):

* Six pairs of plants, seated on one side of the room
* Three pairs of primary consumers, seated in the middle
* One pair of secondary consumers, seated away from the plants
* One pair representing the sun, standing with a large bucket of tokens (gravel beans or other).

1. Each team gets five cups or bowls and a set of five metabolism cards for their identity.
2. Instruct teams to place one metabolism card in each bowl or cup.
3. Give the carnivores a whistle or other device to indicate the end of each round.
4. Give each pair a 3x5 card to record their growth progress.
5. Have the teams mark a tally on their 3x5 card for each baggie of ten GROWTH tokens they pass on up the pyramid.
6. Give the sun pair a bucket to carry tokens to the plants.

**Round one**: Activity proceeds until an apex predator pair has acquired ten GROWTH tokens in their Metabolism cup.

1. The sun pair counts out ten tokens (only ten per each round) to distribute to each plant pair.
2. The plant pairs distribute these tokens into their metabolism cups according to the directions on each card.
3. Once the tokens are distributed, the plants must ask the sun for more (ten tokens) energy.
4. The sun pair distributes ten more tokens as requested, keep going until the predators signal to stop. When the plant pair has ten tokens in their GROWTH bowl, they are large enough to be harvested by a primary consumer.
5. The plant pair puts the ten GROWTH tokens into a baggie and hands them over to an herbivore pair.
6. Every time their GROWTH tokens reach ten, the rest of the Metabolism cups are emptied into the “Used up Calories” bowl.
7. The herbivore pair distributes the ten into their Metabolism bowls.
8. The herbivores keep going until they have ten tokens in their GROWTH bowl.
9. When the herbivores have sufficient GROWTH (ten tokens) to be harvested, they put the ten tokens into a baggie and give them to a predator pair.
10. Every time a pair acquires ten GROWTH tokens to pass along, they must also mark a tally on their 3x5 card.
11. Every time their GROWTH tokens reach ten, the rest of the Metabolism cups are emptied into the “Used Up Calories” bowl.
12. The predator pair distributes the ten tokens into their Metabolism Bowls.
13. The moment the predators have sorted their first baggie into the Metabolism cups, the round is done.
14. The predators blow a whistle or ring a bell to stop the round.
15. The moment the signal is given, all the pairs halt all activities and count how many bags they created.
16. Teacher records the numbers from each pair onto the class chart.
17. Debrief the activity with the students. Here are suggested questions:
    1. To interpret the data on the class growth chart: How many bags of ten were recorded by all the pairs at each level? How were the calories distributed among the levels? What caused the differences? What are some of the ways energy is used up at each level?
    2. Where did the plants acquire their energy? Why were there no limits on their available amount of token/calories? How are plants limited in a real ecosystem?
    3. How were the token/calories used by the plants? Name other ways (*besides the ones on their cards*) that organisms use energy.
    4. What would happen to the number of bags needed for the entire system if the predator had been allowed to “grow” to full size? That is, how would the numbers have changed if the round had been allowed to continue until ten calorie stones had accumulated in the carnivore growth bowl? [10x the number of bags would have been needed at each level.]
    5. Why are food chains often short? [A tenfold number of plants would be needed to support each level added above the primary carnivore.] The number (biomass) of plants is therefore limited to the height of the food pyramid.
    6. To consider the impact of the above (tenfold) on the structure on human food supplies.
    7. To consider whether a lower trophic level could pass all of its calories directly to a higher level?
    8. What would be the consequences for the organism if it did pass all of its calories on to the next higher level?
    9. Given the same original amount of calories, how could an organism transfer more to the next level and still survive? [Reduce its other metabolic activities such as seed production or movement.]
    10. What consequences would such metabolic distribution changes have for the survival of the organisms? [Fewer seeds, possibly fewer adult plants, less movement, possibly less successful hunting.]

**Total Growth Chart**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Round One** | | **Round Two** | | **Round Three** | |
| GROWTH  Calories | GROWTH  Calories | | GROWTH  Calories | | Nutrients |
| Carnivore |  | |  | |  |
| Herbivore |  | |  | |  |
| Plant |  | |  | |  |
| Bacteria |  | |  | |  |

**PLANT CARD INSTRUCTIONS** Copy these cards onto index cards

**PLANT METABOLISM CARD**

**1 - UNUSED SUNLIGHT**

Not all sunlight can be converted into organic matter

Place two calories into this cup

**PLANT METABOLISM CARD**

**2 - REPRODUCTION**

Plant uses energy to produce seeds

Place three calories in this cup

**PLANT METABOLISM CARD**

**3 - PHOTOSYNTHESIS**

Plant absorbs energy from the sun and produces organic matter

Place three calories in this cup

**PLANT METABOLISM CARD**

**4 - GROWTH**

Plant uses energy to grow

Place one calorie in this cup

**PLANT METABOLISM CARD**

**5 - RESPIRATION**

Plants burn energy in the process of photosynthesis

Place one calorie in this cup

**CARNIVORE CARD INSTRUCTIONS** Copy these cards onto index cards

**CARNIVORE METABOLISM CARD**

**1 - DIGESTION**

Carnivore uses energy to break down consumed food

Place two calories in the cup

**CARNIVORE METABOLISM CARD**

**2 - MOVEMENT**

Carnivore uses energy to search for prey and to hunt food

Place three calories in the cup

**CARNIVORE METABOLISM CARD**

**3 - RESPIRATION**

Carnivore uses energy to build a shelter

Place one calorie in the cup

**CARNIVORE METABOLISM CARD**

**4 - REPRODUCTION**

Carnivore uses energy for courtship display and extra hunting to feed young

Place three calories in the cup

**CARNIVORE METABOLISM CARD**

**5 - GROWTH**

Carnivore uses energy to grow

Place one calorie in the cup

**HERBIVORE CARD INSTRUCTIONS** Copy these cards onto index cards

**HERBIVORE METABOLISM CARD**

**1 - DIGESTION**

Herbivore uses energy to break down consumed food

Place two calories in the cup

**HERBIVORE METABOLISM CARD**

**2 - MOVEMENT**

Herbivore uses energy to search for water

Place three calories in the cup

**HERBIVORE METABOLISM CARD**

**3 - RESPIRATION**

Herbivore uses energy to watch for predators

Place one calorie in the cup

**HERBIVORE METABOLISM CARD**

**4 - REPRODUCTION**

Herbivore uses energy to create nest and raise young

Place three calories in the cup

**HERBIVORE METABOLISM CARD**

**5 - GROWTH**

Herbivore uses energy to grow

Place one calorie in the cup

**Explain**

**Activity 4- Pond Water Food Web**

*Adapted from T. Trimpe 2006 http://sciencespot.net/*

**Purpose**

As a result of this lesson, students will become familiar with common organisms found in a pond and discover their importance in a balanced aquatic habitat as they create food webs. Students will also investigate how an environmental change (pollution, disease, introduction of exotic species, etc.) affects a pond habitat.

**Activity Description**

Students will use cards representing plants and animals found in a pond. They will identify producers and consumers and construct food webs. Finally, they will predict the effects of changes in one population in a food web on the food web as a whole.

**Focus Question**

What are the parts of a food web and how do they affect each other?

**Duration**

Two class periods.

**Materials**

* Copies of *Life in a Pond*cards for each group
* Scissors
* Glue
* Large sheets of construction paper
* Copies of student worksheets

**Teacher Preparation**

1. If you have a subscription to United Streaming, download the *Food Webs and Chains* video, which provides a good overview of the concepts discussed in this lesson.
2. Make copies of *Life in a Pond* cards for each group.
3. Laminate cards for reuse.
4. Make copies of worksheet for each student.

**Classroom Procedures**

1. Complete questions #1-3 on the student worksheet using the image of the food web provided.
2. Provide copies of the *Life in a Pond* cardsfor each group. Have each group cut apart the cards.
3. Discuss the different organisms found in a food web: producers, consumers, and decomposers. Have the groups separate their cards into the different categories and record the organisms on the student worksheet.
4. Create food chains of varying length using the cards provided. Students should write the food chains on their worksheet. If you have time available, challenge the students to make longer food chains to see how many organisms can be connected.
5. Instruct the students to lay out two of their food chains from #4, starting with producers on the left and the consumers spread across the page to the right. Students should glue their cards onto the large piece of paper and draw arrows to show the direction of energy flow.
6. Ask students if they can connect the two chains by drawing arrows to other organisms and allow time for them to add new connections.
7. Remind students that the food webs must use at least 10 of the cards, including the 3 cards with stars. Students will need to work together to figure out a way to add additional cards to their food webs to meet this requirement.
8. When students are finished, allow time for the groups to compare their food webs and record their answers on the student worksheet.
9. **Note on blank cards:** Students may think of other organisms that would work in their food webs, such as humans. Allow them to use the blank cards to add these additional organisms.
10. Ask the following questions to conclude the discussion.

* What would happen to the food web if a specific organism was removed due to disease or pollution?
* What would happen to the food web if the population of one of the organisms was to double?
* How would the introduction of an exotic (invasive) species affect the food web?

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**Pond Water Webs**

**Student Worksheet**

Use the food web to complete #1-3:

1. Which organisms are the producers?
2. Identify the consumers using these letters

C – Carnivore

O – Omnivore

H – Herbivore

1. Answer these questions about the food web above.
2. What would happen to the limpet population if the mussels were to die out because of disease?
3. How would the zooplankton be affected if the fish population increaseed?
4. How would the whelk population be affected if crabs were removed?

**Pond Water Food Web**

1. Cut apart the *Life in a Pond* cards and sort them into three categories: producers, consumers, and decomposers. Create 4 food chains in the space below. Remember, each food chain must start with a producer!
2. Use at least 10 of the cards to create a food web to show the relationship between the organisms in a pond habitat. You must use the 3 cards with stars! After you have created the food web, glue the pieces onto a large sheet of construction paper and add arrows to show the feeding relationships.
3. After you have finished your web, answer these questions:
4. What would happen to your food web if the aquatic plants died out because of pollution?
5. What would happen to your food web if the population of great blue heron was to double?
6. Asian carp consume zooplankton, which many fishes typically feed on in their juvenile stages, and have no known predators. How would the introduction of an Asian carp affect your food web?

**Pond Water Food Webs ANSWER KEY**

**Student Worksheet**

Use the food web to complete #1-3.

* 1. Which organisms are the producers? **Answer:** *Seaweed Phytoplankton.*
  2. Identify the consumers using these letters.

C – Carnivore

O – Omnivore

H – Herbivore

**Answer:** *See food web diagram for answers.*

* 1. Answer these questions about the food web above.

1. What would happen to the limpet population if the mussels were to die out due to a disease? **Answer:** *We would expect the limpet population to decrease since the organisms that eat mussels would have to eat more limpets.*
2. How would the zooplankton be affected if the fish population were to increase? **Answer:** *We would expect the zooplankton population to increase, since the increased fish population would cause a decrease in the prawn population.*
3. How would the whelk population be affected if crabs were removed? **Answer:** *The whelk population would likely increase since there would be more mussels and limpets available due to the decrease in crabs. However, the gulls and lobster may eat more whelk than before with the decrease in crabs, resulting in a decrease of the whelk population.*

**Pond Water Web**

* 1. Cut apart the *Life in a Pond* cards and sort them into three categories: producers, consumers, and decomposers. Create four food chains in the space below. Remember, each food chain must start with a producer!
  2. Use at least 10 of the cards to create a food web to show the relationship between the organisms in a pond habitat. You must use the 3 cards with stars! After you have created the food web, glue the pieces onto a large sheet of construction paper and add arrows to show the feeding relationships.
  3. After you have finished your web, answer these questions:

1. What would happen to your food web if the aquatic plants died out because of pollution? Answer?
2. What would happen to your food web if the population of great blue heron was to double? Answer?
3. Asian carp consume zooplankton, which many fishes typically feed on in their juvenile stages, and have no known predators. How would the introduction of an Asian carp affect your food web? Answer?

**Life in a Pond – Food Web Cards**

**Bluegill**



Young – Zooplankton

Adult – Insect larvae, crayfish,

leeches, snails, small fish

**Crayfish**



Young - Zooplankton

Adult - Fish, plants, worms,

insects, snails, & plankton

**Largemouth Bass**



Young - Zooplankton & insects

Adult - Fish, crayfish, & frogs

**Mosquito Larvae**



Algae, plankton, & bacteria

**Aquatic Plants**

 

**Eastern Tiger Salamander**



Worms, insects, & other

salamanders

**Raccoon**

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Plants, earthworms, fish,

amphibians & crayfish

**Zooplankton**

****

(Microscopic animals)

Detritus& phytoplankton

**Phytoplankton**



(Includes algae, diatoms, &

other microscopic plant life)

**Pond Frog**

****

Young – Algae & detritus

Adult – Insects, spiders, small

fish, & worms

**Snail**



Phytoplankton, detritus,

& aquatic plants

**Leeches**



Detritus, insect larvae,

snails & worms

**Great Blue Heron**

**** 

Small fish, reptiles, & insects

**Aquatic Worms**

[](http://www.google.com/imgres?imgurl=http://www.fcps.edu/islandcreekes/ecology/Miscellaneous/Aquatic%20Worm/oligochaete.jpg&imgrefurl=http://www.fcps.edu/islandcreekes/ecology/aquatic_worm.htm&h=394&w=574&sz=22&tbnid=weyoZetIZg_lzM:&tbnh=88&tbnw=128&prev=/search?q=aquatic+worm+images&tbm=isch&tbo=u&zoom=1&q=aquatic+worm+images&docid=GSHfuLdla9sbJM&sa=X&ei=QWSRT8C-HYnZgQflyYmDBQ&ved=0CDYQ9QEwAA&dur=5008)

Detritus & bacteria

**Bullheads (Catfish)**

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Aquatic plants, algae, insects,

worms, fish eggs, & small fish

**Aquatic Insect Nymphs**



Other aquatic insects, small

crustaceans, & worms

**Mallard**



Seeds & plants; may also eat

insects, mollusks, crustaceans

**Snapping Turtle**



Invertebrates, fish, reptiles,

birds, mammals,

Make your own cards by adding a picture of the organism,

its name, and its diet (if it is a consumer).

**Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

Diet:

**Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

Diet:

***Life in a Pond* Cards - Image Credits:**

Largemouth Bass – <http://www.cannondam.com/lynnsguideservice/images/largemouthbass.jpg>

Bluegill – <http://www.wildlifedepartment.com/bluegill.htm>

Crayfish - <http://www.mackers.com/crayfish/pics.htm>

Phytoplankton/Zooplankton – <http://sherpaguides.com/georgia/barrier_islands/natural_history/index.html> \*

Mosquito larvae – “How to Bug Proof Your Home” Arizona Cooperative Extension, the University of Arizona College of Agriculture and Life Sciences.

<http://ag.arizona.edu/pubs/insects/az1320/oc_camp_larvae_groupalt.jpg> \*

Pond frog - <http://www.wigry.win.pl/plazy2/zabz6.jpg> \*

Pond snail – <http://lilyblooms.com/images/products/pondsnail.jpg> \*

Aquatic plants – <http://naturalaquariums.com/plantedtank/0509.html>

Salamander – <http://www.netstate.com/states/symb/amphibians/images/eastern_tiger_salamander.jpg>

Leeches - <http://www.upfishing.com//images/leeches_idiobdella.jpg>

Great Blue Heron – <http://www.islandnet.com/beaconhillpark/graphics/216_heron13K400.jpg>

Aquatic worm - <http://www.state.ky.us/nrepc/water/aquawo03.gif>

Bullhead Catfish - <http://www.upfishing.com/catfish.html>

Aquatic nymphs - <http://www.fishguideme.net/FlyFishing/Images/bugs.jpg>

Mallard - <http://www.forestryimages.org/browse/detail.cfm?imgnum=5364745>

Snapping Turtle – USFWS photo

[http://www.digitalmesia.fws.gov/cdm4/item\_Viewer.php?CISOROOT=/NATDIGLIB&cisorptr=13715^&cisobox=1&rec=3](http://www.digitalmesia.fws.gov/cdm4/item_Viewer.php?CISOROOT=/NATDIGLIB&cisorptr=13715%5e&cisobox=1&rec=3)

Raccoon - <http://www.hsus.org/wildlife/a_closer_look_at_wildlife/raccoons.html>