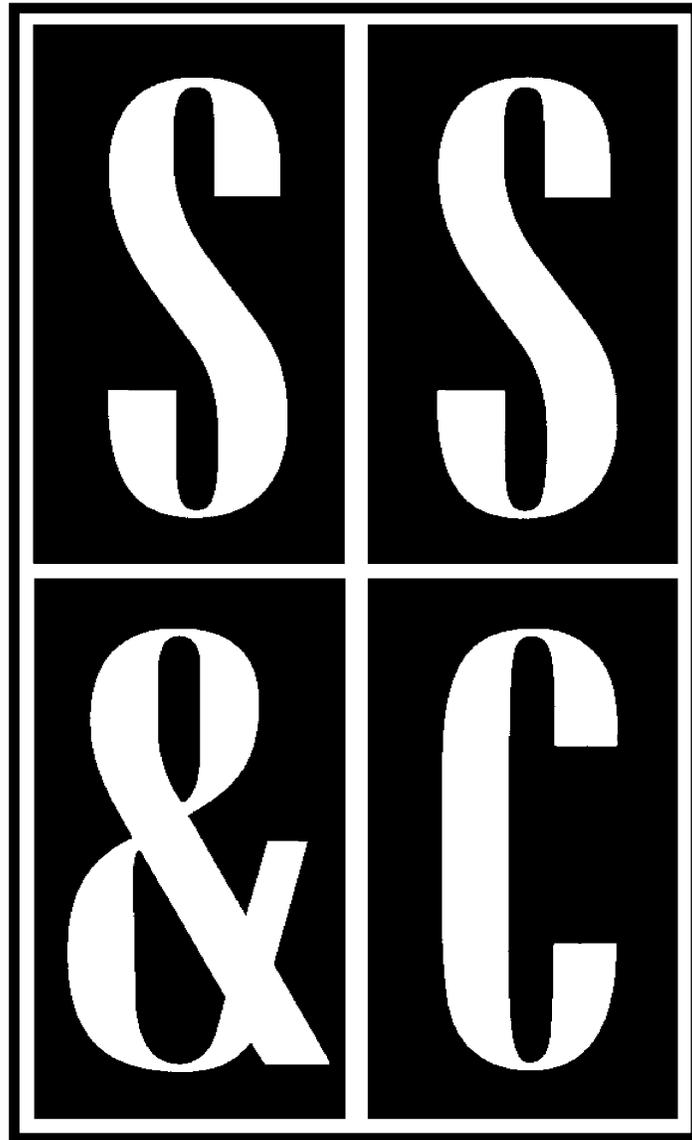


Scope, Sequence & Coordination

A National Curriculum Development and Evaluation Project for High School Science Education



A Project of the National Science Teachers Association



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SS&C Research and Development Center

Bill G. Aldridge, *Principal Investigator
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Evaluation Center

Frances Lawrenz, *Center Director*
Doug Huffman, *Associate Director*
Wayne Welch, *Consultant*
University of Minnesota, 612.625.2046

Houston SS&C Materials Development and Coordination Center

Linda W. Crow, *Center Director*
Godrej H. Sethna, *School Coordinator*
Martha S. Young, *Senior Production Editor*
Yerga Keflemariam, *Administrative Assistant*
Baylor College of Medicine, 713.798.6880

Houston School Sites and Lead Teachers
Jefferson Davis H.S., Lois Range
Lee H.S., Thomas Goldsburly
Jack Yates H.S., Diane Schranck

California Coordination Center

Tom Hinojosa, *Center Coordinator*
Santa Clara, Calif., 408.244.3080

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Keith Lippincott, *School Coordinator*
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Iowa School Sites and Lead Teachers
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North Carolina Coordination Center

Charles Coble, *Center Co-Director*
Jesse Jones, *Center Co-Director*
East Carolina University, 919.328.6172

North Carolina School Sites and Lead Teachers
Tarboro H.S., Ernestine Smith
Northside H.S., Glenda Burrus

Puerto Rico Coordination Center**

Manuel Gomez, *Center Co-Director*
Acenet Bernacet, *Center Co-Director*
University of Puerto Rico, 809.765.5170

Puerto Rico School Site
UPR Lab H.S.

Pilot Sites

Site Coordinator and Lead Teacher
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William George
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* Western NSTA Office, 394 Discovery Court, Henderson, Nevada 89014, 702.436.6685

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National Science Education Standard—Life Science
The Interdependence of Organisms

The atoms and molecules on the Earth cycle among the living and nonliving components of the biosphere.

Energy flows through ecosystems in one direction, from photosynthetic organisms to herbivores to carnivores and decomposers.

Teacher Materials

Learning Sequence Item:

954

Trophic Pyramids and Levels

March 1996

Adapted by: Diane Schrank

Cycles in the Biosphere and Energy Flow through Ecosystems. Students should explore the relationships of plants, animals, fungi, bacteria, and protists to the trophic pyramids, placing these groups into trophic levels as producers, consumers, secondary consumers, tertiary consumers, and decomposers. (*Biology, A Framework for High School Science Education*, p. 117.)

Contents

Matrix

Suggested Sequence of Events

Lab Activities

1. To Build a Pond
2. Of Dibbles, Dinks, Woks, and Dorgs
3. I Call a Leaf My Home
4. My Own Little World

Assessment

1. Predator-Prey Relations
2. Biomass Pyramid
3. Energy Available to Trophic Levels
4. Direction of Energy Flow
5. Survival of Lions
6. Nutrient Cycles
7. Decaying Wood
8. Energy Pyramid
9. Energy Pyramid

954

Learning Sequence

Cycles in the Biosphere and Energy Flow through Ecosystems. Students should explore the relationships of plants, animals, fungi, bacteria, and protists to the trophic pyramids, placing these groups into trophic levels as producers, consumers, secondary consumers, tertiary consumers, and decomposers. (*Biology, A Framework for High School Science Education, p. 117.*)

Science as Inquiry	Science and Technology	Science in Personal and Social Perspectives	History and Nature of Science
<p>To Build a Pond Activity 1</p> <p>Of Dibbles, Dinks, Woks, and Dorgs Activity 2</p> <p>I Call a Leaf My Home Activity 3</p> <p>My Own Little World Activity 4</p> <p>Predator-Prey Relations Assessment 1</p> <p>Biomass Pyramid Assessment 2</p> <p>Energy Available to Trophic Levels Assessment 3</p> <p>Direction of Energy Flow Assessment 4</p> <p>Survival of Lions Assessment 5</p> <p>Nutrient Cycles Assessment 6</p> <p>Decaying Wood Assessment 7</p> <p>Energy Pyramid Assessments 8, 9</p> <p>The Coyote: A Hardy Survivor Reading 1</p> <p>The Rat That Never Drinks Reading 2</p>			

Suggested Sequence of Events

Event #1

Lab Activity

1. To Build a Pond (30 minutes + observation time)

Event #2

Lab Activity

2. Of Dibbles, Dinks, Woks, and Dorgs (45–55 minutes)

Event #3

Lab Activity

3. I Call a Leaf My Home (45 minutes)

Event #4

Lab Activity

4. My Own Little World

Event #5

Readings from Science as Inquiry, Science and Technology, Science in Personal and Social Perspectives, and History and Nature of Science

Reading 1 The Coyote: A Hardy Survivor

Reading 2 The Rat That Never Drinks

Readings can be found in the student version of this publication.

Assessment items are at the back of this volume.

Assessment Recommendations

This teacher materials packet contains a few items suggested for classroom assessment. Often, three types of items are included. Some have been tested and reviewed, but not all.

1. Multiple choice questions accompanied by short essays, called justification, that allow teachers to find out if students really understand their selections on the multiple choice.
2. Open-ended questions asking for essay responses.
3. Suggestions for performance tasks, usually including laboratory work, questions to be answered, data to be graphed and processed, and inferences to be made. Some tasks include proposals for student design of such tasks. These may sometimes closely resemble a good laboratory task, since the best types of laboratories are assessing student skills and performance at all times. Special assessment tasks will not be needed if measures such as questions, tabulations, graphs, calculations, etc., are incorporated into regular lab activities.

Teachers are encouraged to make changes in these items to suit their own classroom situations and to develop further items of their own, hopefully finding inspiration in the models we have provided. We hope you may consider adding your best items to our pool. We also will be very pleased to hear of proposed revisions to our items when you think they are needed.

Science as Inquiry

To Build a Pond**Materials:****Per lab team of three-four:**

1 two-liter soda bottle, clean and without label
thermometer
pipette
hand lens
clear packaging tape
pond water
aquarium sand
small fish (two or three)
pond cultures of algae—Daphnia, Planaria, etc.
water plants
aquatic snails and other invertebrates
scissors

Procedure:

Have students cut the top curved portion of the bottle off and save it. They put about three inches of sand into the bottom of the bottle and carefully add the pond water until the bottle is about half-full. They should then plant the water plants. A good rule of thumb is to plant two plants for each fish. More is better than less.

Students should slowly add more pond water, being careful not to disturb the sand or plants. Have them fill the bottle to within one inch of the top. At this time they can add the snails and any other invertebrates. It is suggested that each team receive a measured amount of the invertebrates.

After allowing the project to rest undisturbed overnight, students should add two or three small fish (guppies are OK, goldfish too large). After the fish are in the water, the top can be put back on the bottle and sealed with clear packaging tape. The bottle top is to remain on.

The bottle ecosystem should be placed near a light source, but be careful that the temperature of the area does not get too hot. Algae growth should be encouraged.

Students should make short observations of their ecosystems at time intervals determined by the teacher (every day for temperature; every other day for water level, condensation, and general health of animals). Once a week students should pipette a few drops of water so that they can make slides to determine the viability of the plants and animals.

Note: The idea is to close the bottle top and allow the materials to cycle naturally. Feed the fish only if you feel they cannot survive.

Science as Inquiry

Of Dibbles, Dinks, Woks, and Dorgs**Materials:****Per lab team of two-three:**

four sheets (4 × 6) of different colored construction paper per student
one hole puncher (more if available)
waxed paper squares (3 × 3) for glue
glue
toothpick to apply glue
white paper, 8 × 11

Procedure:

Have students determine the trophic level of each of the organisms: dinks are the producers (125); woks are the primary consumers—herbivores (25); dorgs are the secondary consumers—first-level carnivores (50); dibbles are the tertiary consumers—predator (1).

Students determine how many of each of the other organisms are needed to feed one dibble for one day based on a 5:1 ratio. They then create an energy pyramid based on these numbers. Encourage them to try to maintain the shape of a pyramid.

Further Variations:

Have students observe a mini-ecosystem within the schoolyard or near home. Ask them to construct a pyramid based on their observations.

Science as Inquiry

I Call a Leaf My Home

This is an observational activity during which students discover organisms residing within leaf piles. The ideal leaf pile to study is one that has been dormant for all or most of a year so that little critters have had the opportunity to move in and take up residence. These piles can be found beside buildings, bases of rocks, and under hedges. Look for these piles well in advance of when you wish to do this activity. Make sure that students obtain all necessary measurements before they disturb the leaf layer.

Materials:**Per lab team of four:**

- sandwich bag
- pencil
- field guide for insects and invertebrates
- craft stick
- paper
- tape measure
- thermometer

Procedure:

Secure leaf piles in sufficient quantities for each team of four students. Make sure that students do not disturb the piles before the initial measurements are recorded.

Have students record the following temperatures: above the pile, at the surface of the pile, midway through the depth of the pile, and at the lowest point of the pile. Record the measurements. Students then measure the area of the pile on which they are working.

Beginning at the top of the pile, students should remove one layer of leaves at a time, noting the presence of moisture and the amount of decay, fungus, and animal life. They are to count the observable critters, classify leaf types, and make observations as to the level of decomposition.

Note: The dead leaves are still considered to be the producers because they originally obtain their energy from the sun and their current role would remain as the primary food source for the resident critters.

Science as Inquiry

My Own Little World**Materials:****Per lab team of two:**

1 two-liter soda bottle (clean, with label removed)
soil mixture
charcoal
2–3 plants (monkey grass is ideal)
small insects
dead leaves
thermometer
rainwater
pea gravel
2–3 earthworms
land snails (small)
clear packaging tape
scissors

Procedure:

Have students cut off the top curved portion of the soda bottle and save it for later. They should add the following to the bottle: 1 inch of pea gravel for drainage; 1 inch of charcoal; 2 inches of potting soil; and 1 inch or a little more of *old* dead leaves.

Students then do their planting, selecting those plants that will have room to grow in the bottle. They should also be cautioned against planting too many. They then add a few small insects and the earthworms to the bottle, and add only enough water to cover the pea gravel on the bottom. Have them replace the top of the bottle and seal it with clear packaging tape.

The date and the students' names should be placed on a label and attached to the bottle. Place the bottle in a source of indirect light.

Items for Discussion:

The following questions can be used throughout the year as the topic presents itself.

1. What are the nonliving things affecting this ecosystem?
2. Which organisms are the producers?
3. Which organisms are the consumers and at what level?
4. Explain the water cycle as it relates to your project.
5. Explain the carbon dioxide cycle as it relates to your project.
6. What evidence do you see of decomposers?
7. Draw an energy pyramid of the organisms in your project.
8. Why don't you have to add water?
9. Where do the various organisms find their food?

10. Draw the food chains present in your project.
11. Draw a food web using the organisms in your project.
12. Do the plants need the animals in order to stay alive? Justify your answer.
13. Did you notice any change in the plant growth patterns as the seasons change? Justify your answers.
14. Explain the energy pathway as it relates to your project.

Science as Inquiry

Predator-Prey Relations**Item:**

Snakes, frogs, crickets, and grasses make up a biomass pyramid. What do you think possibly happened if the snake population in the chain doubled?

- A. There was a ten-fold increase in the number of grasshoppers.
- B. There was a two-fold increase in the number of grasshoppers.
- C. There was no increase in the number of grasshoppers.
- D. There was a five-fold increase in the number of grasshoppers.

Justification:

Give a reason to support your answer.

Answer:

B. Selection of distracters A, C, or D would indicate that the student has not understood predator-prey relations.

Science as Inquiry

Biomass Pyramid**Item:**

Snakes, frogs, crickets, and grasses make up a biomass pyramid. The greatest amount of mass would be made up of:

- A. the grass
- B. the crickets
- C. the frogs
- D. the snakes

Justification:

Draw and label a biomass pyramid, including each of the organisms listed above. Label the trophic level in which each organism belongs.

Answer:

A.

Science as Inquiry

Energy Available to Trophic Levels**Item:**

Scientists have estimated that plants use about one percent of the sun's available energy. About 1/10 of one percent of energy from the sun is available to primary consumers; about 1/100 of one percent of energy is available to secondary consumers; and about 1/1000 of one percent is available to tertiary consumers. What is the significance of this information in reference to food chains and the organisms involved in the chains?

Answer:

The energy available to organisms at each trophic level is 1/10 of that available to the previous level. This places a limit on the number of trophic or feeding levels that are possible in a food chain and the number of consumers at each level. The direction of energy flow is from autotrophs to heterotrophs.

Scoring Rubric:

- 3 The response discusses all three points—that is, a limit on the number of trophic levels, a limit on the number of individuals at each level, and the unidirectional flow of energy. Also included is an explanation involving dependence on organisms for transfer of energy.
- 2 The response discusses the effect on trophic levels and population size at each level but lacks understanding of the direction of energy flow.
- 1 The response has only one of the three major points.
- 0 The response is inappropriate and “off the mark.”

Science as Inquiry

Direction of Energy Flow**Item:**

A food chain has the following components: squirrels, dead leaves, mushrooms, and hawks. Arrange them in the correct order to show the direction of transfer of energy, starting from the first level.

- A. mushrooms, dead leaves, squirrels, and hawks
- B. hawks, squirrels, dead leaves, and mushrooms
- C. hawks, squirrels, mushrooms, and dead leaves
- D. dead leaves, mushrooms, squirrels, and hawks

Justification:

Give a reason to support your answer.

Answer:

D. Selection of distracters A, B, or C would indicate that the student has not understood predator-prey relations, the resultant energy flow, and the role of fungi (mushrooms) as decomposers.

Science as Inquiry

Survival of Lions**Item:**

A remote foothill community is composed of deer, shrubs, grass, rabbits, mountain lions, and decomposers. Observations by wildlife management researchers studying the mountain lion population over many generations has concluded that the number of adult lions in the area has been declining. Which of the other living organisms in the community could affect the lions' ability to survive as a species?

- A. deer only
- B. deer and rabbits only
- C. deer, rabbits, grass, and shrubs only
- D. deer, shrubs, grass, rabbits, and decomposers

Justification:

Describe how each organism listed in the question above interacts with other organisms in the community. Include all organisms for which any relationship exists.

Answer:

The correct choice is D. Organization of ecosystems is based upon populations interacting with each other and with abiotic factors of the environment. Interactions of populations sets up a community. Predator-prey relationships show a positive as well as negative association. The cycling of nutrients in an ecosystem is essential to maintain a balance in that ecosystem and the overall health of each species in the community. Ecosystems are dependent upon resources that used by organisms and the recycling of wastes disposed by them.

Science as Inquiry

Nutrient Cycles**Item:**

Consider an ecosystem that includes plants, animals, fungi, bacteria, and protists. In this ecosystem, the plants would be considered:

- A. producers
- B. consumers
- C. secondary consumers
- D. decomposers

Justification:

Explain the energy source for plants and how they would fit into a typical food chain.

Answer:

Choice A is correct. Plants are producers; animals are consumers and secondary consumers; fungi are important decomposers; and many forms of bacteria and protists are also decomposers. Some bacteria (e.g., cyanobacteria) and some protists (e.g., algae) are plantlike in that they do produce their own food and are, therefore, producers. All producers convert sunlight, carbon dioxide, and water into sugar and oxygen. They typically are the first link in a food chain and are fed upon by consumers.

Science as Inquiry

Decaying Wood**Item:**

What type of organisms derive their energy most directly from decaying wood?

- A. producers
- B. secondary consumers
- C. primary consumers
- D. decomposers

Justification:

Name an organism as an example of your choice above and describe how it gets its energy from the wood.

Answer:

The correct choice is D.

Science as Inquiry

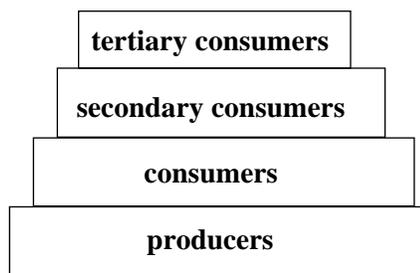
Energy Pyramid**Item:**

Figure 1

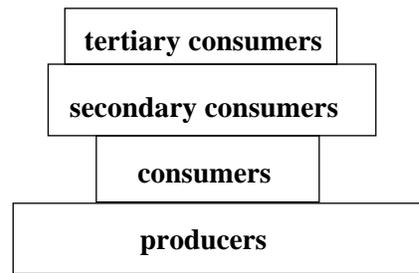


Figure 2

Figure 1 above shows an energy pyramid that represents a stable ecosystem. Figure 2 shows the same ecosystem a while later that is no longer in a stable condition. Draw a pyramid to show what you think the pyramid would look like one or two years later than shown in Figure 2.

Answer:

The upper portions should shrink so that they form a new but smaller pyramid on the reduced-size consumers (herbivores). The herbivore population would likely recover to a somewhat larger size.

Science as Inquiry

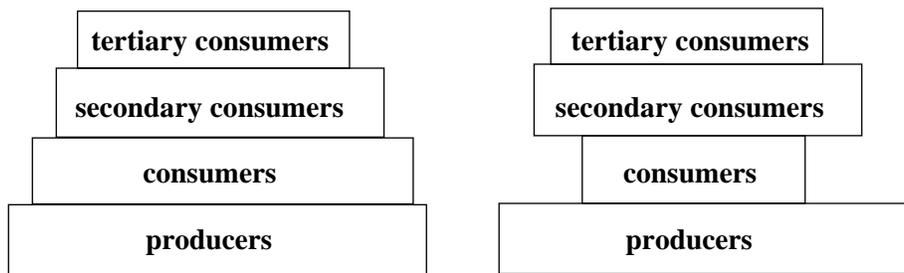
Energy Pyramid**Item:**

Figure 1

Figure 2

Figure 1 above shows an energy pyramid that represents a stable ecosystem. Figure 2 shows the same ecosystem a while later that is no longer in a stable condition.

Explain what features of this diagram represent an energy flow and why the stable ecosystem is expected to have a pyramid shape.

Answer:

The amount of stored energy is decreased, while the amount of energy "lost" as heat to the surroundings increases as the food chain progresses from autotrophs to secondary consumers. The sizes of the boxes represent these changes and the number of individuals that the energy can support.