

The Bottled Ecosystem

Annotation

Students investigate the interactions that take place among several variables of a closed ecosystem simulation. The activity described herein will cover the day of the ecosystem setup. Instruction is given in concepts, hypothesis formation, building the ecosystem and data collection preparation. The following lesson, given one to two weeks after this part, will cover data presentation, comparative analysis of results and hypothesis confirmation/rejection.

Hypothesis

A self-sustained ecosystem is dependent on all biotic and abiotic interactions.

Primary Learning Outcomes

At the end of this lesson, students will be able to:

- Describe the role each biotic and abiotic variable plays within the ecosystem.
- Observe, record, and interpret how different components of an ecosystem change as they interact with each other and the environment.

Assessed GPS

SCSh3. Students will identify and investigate problems scientifically.

- a. Suggest reasonable hypotheses for identified problems.
- c. Collect, organize and record appropriate data.
- e. Develop reasonable conclusions based on data collected.
- f. Evaluate whether conclusions are reasonable by reviewing the process and checking against other available information.

SCSh7. Students analyze how scientific knowledge is developed.

Students recognize that:

- b. Universal principles are discovered through observation and experimental verification.
- d. Hypotheses often cause scientists to develop new experiments that produce additional data.

SCSh8. Students will understand important features of the process of scientific inquiry.

Students will apply the following to inquiry learning practices:

- a. Scientific investigators control the conditions of their experiments in order to produce valuable data.
- b. Scientific researchers are expected to critically assess the quality of data including possible sources of bias in their investigations' hypotheses, observations, data analyses, and interpretations.
- e. The ultimate goal of science is to develop an understanding of the natural universe which is free of biases.

SB4. Students will assess the dependence of all organisms on one another and the flow of energy and matter within their ecosystems.

- a. Investigate the relationships among organisms, populations, communities, ecosystems, and biomes.
- c. Relate environmental conditions to successional changes in ecosystems.

Duration

90 minutes

Materials and Equipment

Teacher supplied:

- Sand
- Packing tape
- Elodea, feed fish, feed shrimp, etc. for aquatic chamber
- Potting soil
- Seeds
- Measuring cups
- Scale
- Graduated cylinders, Erlenmeyer flasks, beakers, etc.
- Straws
- Electric/hand drill with appropriate bit for drill holes in bottle caps

Optional:

- water dechlorinizer
- Optional: fruit flies, snails, etc. for terrestrial chamber
- Optional: worms, fungi for decomposition chamber
- Optional: fertilizer

Student supplied:

- Five 2L/3L soda bottles (Note: all 5 should be same size per ecosystem)
- Leaves, Grass, Banana peel, apple core, etc.

Optional:

- small insects, small animals, etc.
- additional aquatic animals
- algae and other aquatic plants
- aquarium rock(s)
- soil from their yard
- potato

Procedures**Step1: Introduction, 20 minutes**

Lead discussion on ecosystem, biotic and abiotic factors, ecosystem stability, limiting factors, purpose of this experiment and expectations and outcomes of experiment. Distribute **Student Worksheet 1** to define, clarify and review pertinent terms and concepts. Answers may be found

on answer key. It is important that students make note of the interrelationships that occur among abiotic and biotic factors. Distribute **Handout 1**, which contains instructions on ecosystem assembly and observation. Distribute **Handout 2**, which has diagrams of both the manner in which to cut the bottles and assemble the ecosystem, and the way the completed ecosystem is supposed to look like. Distribute **Data Collection sheet**.

Step 2: Group work, 50 minutes

Students break up into groups and conduct Lab activity as outlined in student handout. Circulate classroom, aid students in set-up, answer questions.

Step 3: Review, 20 minutes

Students gather as a class. Experiment is further analyzed to key in important factors. Hypotheses are discussed and shared. Students should be reminded about diligent record keeping.

Assessment

Completed student worksheets (worksheet 1) will be collected and graded.

Student understanding of activity components may be assessed by unit examination.

Student affect and work ethic may be assessed by affect/ethic rubric.

References

Rutherford, S. & Coffman, M. (2004 September). Earth System Science Project. *The Science Teacher* pp.30-35

Name _____

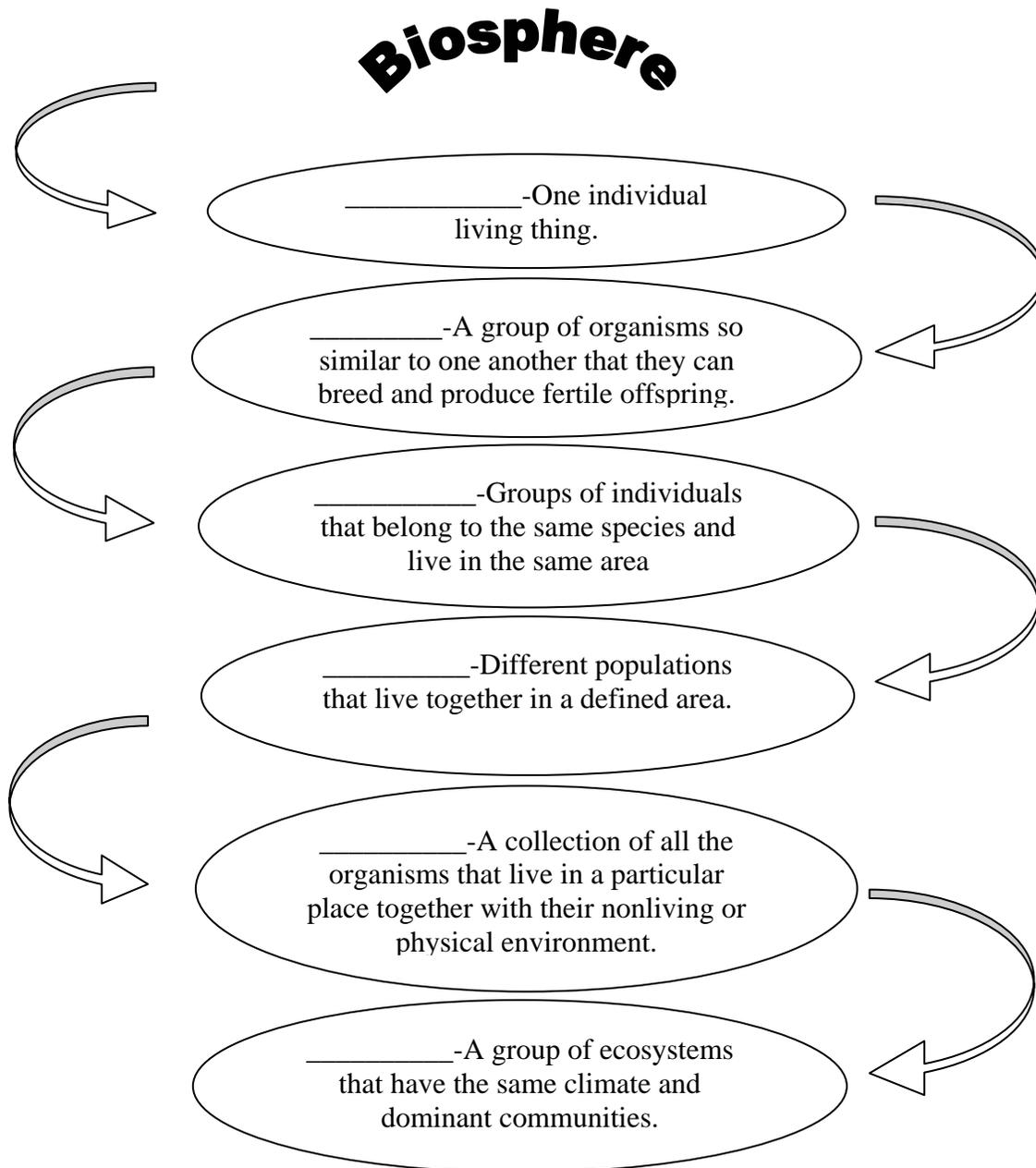
The Bottled Ecosystem

Worksheet 1

I -THE ECOSYSTEM

The ecosystem refers to _____

Ecologists have divided the **ecosystem** into different organizational levels. These include:



II - Monitoring an ecosystem

In order to monitor an enclosed ecosystem, various components need to be observed.

1. Distinguish between **biotic and abiotic** factors

a. Biotic factors refer to _____

Name three biotic factors necessary for the terrestrial chamber.

Name three biotic factors necessary for the decomposition chamber.

Name three biotic factors necessary for the aquatic chamber.

b. Abiotic factors refer to _____

Name five or more abiotic factors necessary for the terrestrial chamber.

Name five or more abiotic factors necessary for the decomposition chamber.

Name five or more abiotic factors necessary for the aquatic chamber.

c. An enclosed ecosystem is considered **stable or self- sustaining if materials are cycled and there is a flow of energy. List 4 material cycles necessary for ecosystem stability.**

d. What is meant by **limiting factors**? Provide three examples of limiting factors pertinent to our self-sustaining ecosystem.

e. State the purpose of the **Bottled Ecosystem** experiment.

f. State your hypothesis for this experiment. Suggest three hypotheses for each of the three chambers.

g. List 3 scientific expectations from this experiment.

ANSWER KEY

I – Organism, Species, Populations, Communities, Ecosystems, Biomes

II - Monitoring an ecosystem

In order to monitor an enclosed ecosystem, various components need to be observed.

2. Distinguish between **biotic and abiotic** factors

a. Biotic factors refer to all living things present in an ecosystem.

Name three biotic factors necessary for our enclosed ecosystem.

Animals, plants, decomposers

b. Abiotic factors refer to all nonliving or physical factors present in an ecosystem.

Name five or more abiotic factors necessary for an enclosed ecosystem.

Water, oxygen, carbon dioxide, carbon, nitrogen, sulfur, temperature, light, humidity, pH

c. An enclosed ecosystem is considered stable or self-sustaining if materials are cycled and there is a flow of energy. List 4 material cycles necessary for ecosystem stability.

Nitrogen Cycle, O₂ – CO₂ cycle, Water cycle, Sulfur cycle, Energy Cycle

d. What is meant by limiting factors? Provide three examples of limiting factors pertinent to our self-sustaining ecosystem.

A limiting factor is one which can limit the survival of an organism. For our experiment, these include pH, O₂, CO₂, Carbon, Nitrogen, Chlorine, water, temperature, light, humidity,

These statements will be reviewed in more detail during the review portion of the lesson.

e. State purpose of the Ecosystem in a Bottle experiment.

-to observe a self-sustaining ecosystem

-study, determine and analyze biotic and abiotic relationships,

-analyze the interrelationships among living organisms and their environment.

-draw conclusions

f. State your hypothesis for this experiment.

Student based answer

g. State 3 biological understandings that you consider may result from this experiment.

-Plants and animals exchange O₂ and CO₂

-Plants and animals share many of the same physiological processes.

-Organisms may die when there is no stability in an ecosystem.

The Bottled Ecosystem

Handout 1

Bottled Ecosystem assembly and observation instructions.

1. Gather all materials.
2. See **Handout 2** for cutting and bottle assembly instructions.
3. Record what you put in each chamber and how much (measured or weighed) while assembling your ecosystem. Also, take notes on how you assembled your ecosystem so you can write instructions for others who want to duplicate your work in order to compare results.
 - a. Terrestrial chamber must include soil (e.g., potting soil or soil you brought in) and seeds or plants. You may add other organisms and abiotic factors.
 - b. Decomposition chamber must include leaf/grass material, potting soil, animals (especially known decomposers like worms), a piece of fruit, fungus, or potato.
 - c. Aquatic chamber must include substrate material (e.g., sand/gravel/aquarium rock), at least one fish and one aquatic plant.

Remember to record exactly what you put in – including appropriate quantities when applicable!

4. Add precipitation to the bottle ecosystem once it is assembled. Record the volume of water you put in. Throughout the data collection and observation period, you may add precipitation, but again be sure to record the dates and volume of water added.
5. Look for changes in each chamber and collect data at intervals specified in class. Record your data.
 - a. You will be given a fixed time period to collect your data. If you need more time, come in briefly during free time, lunch, etc. to finish collecting data. It shouldn't take that long....
 - b. Use the supplied data collection table to record your results or use your own if you like.
6. Complete the following tasks once you have assembled your chamber and supplied initial precipitation:
 - a. Complete the student worksheet, answering all questions.
 - b. Begin a write up of the lab, including:
 - i. A labeled diagram of the bottle ecosystem. Identify all contents of each chamber as well as the locations of the bottle caps and straws.
 - ii. A sheet with a Title, Purpose, Three hypotheses for each chamber, materials list, procedure.

The completed write-up and diagram will be due at the end of the ecosystem project (**1-2 weeks**).

