Resource Sustainability

Background

We are a consumption-based society. On an individual scale and as a population – with everything from cell phones and items of clothing to vehicles and even buildings – we continually discard old and used goods for newer ones. Everything that we own contains materials harvested from the earth or that required the use of natural resources to create. Clothing is commonly spun from cotton fibers; other types of clothing are made of polyester, which requires petroleum to produce. The quantity of resources and energy that you consume is known as your ecological footprint.

Resources can be categorized as either renewable or nonrenewable. Renewable resources can be harvested and replaced by an ecosystem over a relatively brief period. When resources are extracted at a rate greater than can be formed, they are considered nonrenewable. Nonrenewable resources cannot be replaced, or they may take vast spans of time to replenish. Fossil fuels are nonrenewable resources, taking millions of years to be formed from the fossilized remains of organisms. Consider this contrast: cotton T-shirts are made from a renewable resource; cotton plants can be grown and harvested and replaced readily. Polyester shirts, however, require the use of nonrenewable petroleum products to manufacture.

The use of resources can be categorized as either sustainable or unsustainable. If resources are consumed or used in a sustainable manner, the rate of harvest does not compromise the needs of future generations. When resources are consumed at an unsustainable rate, they will eventually be exhausted. For example, it is an unsustainable practice to harvest lumber by clear-cutting. It is obvious that a forest cannot provide lumber for future generations if every tree is cut down. A sustainable alternative, for instance, is harvesting lumber from deadfalls (naturally fallen trees) combined with selectively cutting trees while leaving others to grow and create offspring. The trees that are lost can be replaced by the ecosystem.

In large part, sustainable resource consumption is possible because healthy ecosystems can compensate for human utilization of such resources in a relatively short time frame. Human actions such as recycling and reusing materials also can contribute to resource sustainability. An aluminum can that is recycled can prevent additional bauxite, an aluminum ore, from being mined.

Many countries are increasingly emphasizing alternative energy sources that are renewable or perpetual, such as wind, water, and solar energy. As supplies of petroleum and other fossil fuels have decreased, it has become more pressing to find renewable resources and sustainable use practices so that we can provide energy and resources for future generations.

Resources must be managed properly in order to ensure that they are protected and only used in a sustainable manner. Conservation management, the field of science that deals with the use of resources in a sustainable way, involves making decisions about how much of a resource to harvest to maintain healthy, sustainable populations and ecosystems. The U.S. National Park Service and the U.S. Fish and Wildlife Service both make decisions and issue specific numbers of permits for resource harvesting. They do so by applying conservation management science to real-world situations in an effort to conserve resource populations and protect ecosystems while meeting the needs of an ever-growing human population.

Objective(s)

- ✓ to recognize the reality of consumption as well as the value and necessity of conservation
- ✓ to think critically about sustainable and unsustainable resource use practices
- ✓ to learn the difference between renewable and nonrenewable resources
- ✓ to make decisions to establish sustainable practices in a simulated ecosystem
- ✓ to investigate ways to practice conservation in your own community

Materials

- clear, plastic container
- toothpicks (x10)
- coarse sand
- gravel
- black sand
- plastic spoon
- green dough
- brown dough
- black beads
- green beads
- yellow beads

Pre-Lab Questions

Answer the following questions on your lab paper. For actual questions, you must either write out the questions, or include the questions in your responses. Be sure to use complete sentences and show your work for math problems.

1. Other than the resources included in this activity – lumber, precious gems and metals, and fossil fuels, create a table listing at least 5 other resources and classify them based on the following: living versus non-living, and renewable versus nonrenewable. Then, list at least one type of ecosystem or biome where those resources are extracted/harvested. Finally, include a brief description of the use of each of the resources you included.

✓ Use a ruler to recreate the Data Table(s) below neatly on your lab paper, and be sure it is drawn approximately the same size

Safety

★ *There are no special safety precautions for this activity*

Procedure

In this activity, your group will build a model of a forest ecosystem using dough, sand, gravel, and beads. Then you will trade models with another group and manage the resources in the forest ecosystem over a period of 100 years. You earn points for successfully mining and obtaining natural resources as well as for having undisturbed land available for recreation. You lose points for harvesting those resources in a manner that cannot be sustained over time. At the end of the activity, you will compare your results with those of other groups and discuss the benefits and drawbacks of the various strategies used to manage the model ecosystems.

Assembly of a Forest Ecosystem:

1. Spread the brown dough across the bottom of the clear, plastic container. The brown dough represents the deep, bedrock layer of soil.
2. Place 5 black beads randomly on top of the brown dough layer. The black beads represent fossil fuels such as oil and coal deposits.
3. Cover the dough and beads with gravel. The gravel represents the intermediate layer of soil, composed primarily of weathered rock fragments.
4. Distribute 1 or 2 green beads and 1 or 2 yellow beads at random on top of the gravel. The green beads represent gems or crystals, such as emeralds, diamonds, and quartz. The yellow beads represent precious metals, such as gold, copper, and iron.
5. Cover the gravel with coarse sand. The coarse sand represents the subsoil layer.
6. Distribute 1 or 2 green beads and 1 or 2 yellow beads at random on top of the sand.
7. Cover the coarse sand with black sand. The black sand represents topsoil.
8. Place any remaining beads in the black sand layer.
9. Place the green dough on the lab bench. Use your hands and the plastic spoon to flatten the green dough until it is spread out enough to cover the sand in the container completely. Place the green dough on top of the other layers in the container. The green dough represents the humus layer of soil.
10. Insert 10 toothpicks upright in the green dough, in any configuration and spacing you desire. The toothpicks represent trees.

Sustainable Management of a Forest Ecosystem:

Year 1

11. Exchange your forest model ecosystem for the one created by another group. Then, move on to the next part of the activity.

12. As a group, begin making conservation management decisions about how the resources in your ecosystem should be developed or preserved. First, consult the "Value of Resources" table on the **Data Tables** section. You will record the results of your management practices in the "Resource Sustainability Tracking" table, and the point benefits that result from your decisions in the "Resource Point Totals" table.

13. In Year 1, you can opt to remove trees for their lumber value, but you can also preserve space for recreation. (Every 10 years, your group can reevaluate how to manage your forest ecosystem. In the future, you will be also able to mine gems, precious metals, and fossil fuels.) Decide how many trees to harvest in Year 1. Remove the corresponding number of toothpicks from your forest ecosystem, and set them aside. For each tree removed, you earn 2 points for the lumber resources harvested. *NOTE: You cannot remove any more than half of the existing forest during a given year.*

14. Look at the overall land area available in the forest ecosystem (i.e., inside the plastic container). If you do not disturb any of the available land space, you earn 10 points for recreation use. If 51-99% of the total land space in the ecosystem is conserved, you earn 5 points for recreation. If 10-50% of the land space is conserved, you earn 1 point for recreation. If all the trees are removed or if less than 10% of the total ecosystem is conserved, you do not earn any points for recreation.

15. Consult the "Value of Resources" table to determine how many points you have earned.

16. Record the results of your decisions in the "Resource Sustainability Tracking" table and the "Resource Point Totals" table.

Year 10

You have discovered that there are gems and precious metals in the layers of soil underneath the forest.

17. As a group, determine whether or not to mine these resources. If you choose to mine, use the spoon to mark a square quadrant identifying the boundaries of the excavation. Remove all the trees from inside the mined quadrant, and record the points gained for the lumber resource. Use the spoon to dig within the quadrant boundaries, mining for precious metals and gems. Do not dig outside the boundaries of the quadrant.

18. For every gem (green bead) uncovered, gain 5 points. For every precious metal (gold bead), earn 10 points.

19. Consult the key to determine how many points you have gained.

20. Record the Year 10 data in the data tables.

Year 20

21. For every two trees that remain in your forest, plant one tree (i.e., insert one toothpick) at a random location in your area of undisturbed land. This represents the renewable nature of the forest resource. Round down; for example, if 9 trees remain, plant 4 trees. If only one tree remains, plant one tree.

22. As a group, decide how to manage your forest. Determine how many trees to remove (if any), and then remove the corresponding number of toothpicks. Determine whether to mine. If so, plot a second quadrant and carry out mining as before.

Year 30

You have discovered fossil fuels buried in the bedrock underneath the forest.

23. Decide as a group whether or not to excavate the available fossil fuels. For every black bead recovered, earn 15 points.

24. Continue to manage the harvesting of lumber and mining of gem and metal resources as before.

25. Consult the key to determine how many points you have gained.

26. Record the data in the data tables.

Years 40-100

27. Continue making conservation management decisions about the resources in your forest ecosystem.

28. In years 40, 60, 80, and 100, **before you remove trees**, plant one tree for every two trees that remain in the forest (rounding down). If only one tree remains, plant one tree. No new trees can be planted during years 50, 70, and 90.

29. Consult the key to determine how many points you have earned for resources.

30. Record the data in the data tables.

31. Repeat the steps for each decade through year 100.

Data Tables

Value of Resources

Resource	Representation	Point Value
Recreation		10 points: 100% undisturbed land 5 points: 51-99% conserved land 1 point: 10-50% conserved land 0 points: <10% conserved land and/or all trees removed
Lumber	toothpick	1 point
Gemstones	green bead	5 points
Precious Metals	yellow bead	10 points
Fossil Fuels	black bead	15 points

Resource Sustainability Tracking

Resources	Year										
	1	10	20	30	40	50	60	70	80	90	100
Trees Removed											
Trees Remaining											
Gems Recovered											
Precious Metals Recovered											
Fossil Fuels Recovered											

Resource Point Totals

Points	Year											Total
	1	10	20	30	40	50	60	70	80	90	100	
Recreation (0-10)												
Lumber (1)												
Gems (5)												
Precious Metals (10)												
Fossil Fuels (15)												
Total												

Clean Up

✓

Results & Analysis

Answer the following questions on your lab paper. For actual questions, you must either write out the questions, or include the questions in your responses. Be sure to use complete sentences and show your work for math problems.

1. What did your forest ecosystem look like after 100 years? How many points did you accumulate? Which resources earned you the most points? Do you believe there is any rationale behind the varying point values between the resources? If so, explain.
2. Estimate the percentage of land area disturbed by the mining process. Subtract 5 points for every 10% of estimated land area "lost" to the mining process. Subtract another 20 points for each decade that you mined. These are "reclamation" fees collected for the damage done to the ecosystem's land and water supplies. How does this affect your point value?
3. Think about the land model you used in this activity. Describe two ways in which this model does not accurately represent renewable and nonrenewable resources in a real ecosystem?
4. Most countries in the world depend primarily on nonrenewable resources like coal and other fossil fuels for energy. Based on your observations during this activity, what are some of the problems inherent in relying too much on nonrenewable resources such as fossil fuels?
5. Did your forest ecosystem stop producing resources? If so, in what year? Explain why this is so, and brainstorm solutions that would be implemented in a real forest ecosystem to correct this problem. If not, explain your resource management style and why it worked.